

# **Elgin/Lake Huron SCADA Upgrades**

## **SCADA Standards**

### **Section 300 Detailed Design and Construction**

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# Elgin/Lake Huron SCADA Upgrades SCADA Standards Section 300 Detailed Design and Construction

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## **301 Detailed Design General Requirements**

### **1. General Requirements**

1. Provide expertise required for the design of the structures and facilities to service the best interests of the public, with due regard for the environmental and public concerns, capital cost and operating efficiency, in accordance with the recognized industry standards, guidelines, best practices, codes, regulations, etc. as established by the Regional Water Supply and all regulating authorities.
2. Provide continuous quality assurance and quality control (QA/QC) to verify the technical correctness of the work and high quality services during the project life are provided. Delegate senior technical leads, external of the design team, to conduct milestone QA/QC reviews. Verify that all documents have been reviewed prior to submittal to the Regional Water Supply. Apply version control to all documents.
3. Obtain drawing numbers from the Regional Water Supply.
4. Unless specifically instructed in the Request for Proposal that automation in the facility is not required, all processes shall be fully automated, allowing for unattended operation of the system. Comply with the requirements of the Regional Water Supply Water PCS Implementation Manual.

### **2. Pre-Requisites**

1. Do not proceed with detailed design engineering phase until the following tasks have been completed.
  - a. Final Pre-design Report has been accepted by the Regional Water Supply and the Project Manager has directed in writing to proceed with detailed design engineering phase.
  - b. A project workplan has been developed and presented, including the design schedule, list of project deliverables, and required approvals.
  - c. Design team members have visited and are completely familiar with the plants, facilities, and operating procedures.
  - d. Design team members have reviewed drawings of the existing facilities and have identified discrepancies on the existing record drawing details from the existing conditions.
  - e. All relevant above ground and buried utilities and services have been identified and locations have been verified.

### **3. Design Review Requirements**

1. Detailed design review packages are required at 50%, 75%, 95% and 100% design completions.
2. Include with each design review package the complete drawings list indicating percentage complete for each drawing.
3. Decisions Log – create and maintain issues log documenting decisions made with appropriate references to other documents such as meeting minutes/notes. Append decisions log with the meeting minutes.
4. Capital Costs and Schedule -Track project capital costs and schedule through out the project design period. Identify impacts of design changes on the schedule and capital costs.

### **4. 50% Design Review Package**

1. At the 50% design review, all major design decisions should have been documented clearly and agreed to by the Regional Water Supply. The package should include the following.
  - a. Updated decision log documenting the resolution of outstanding issues from the pre-design reports
  - b. Detailed design review package, which contains sufficient design details to convey the design intent. This includes the initial details related to –
    - i. New/upgraded field instruments
    - ii. New/upgraded power wiring
    - iii. New/upgraded control panels
    - iv. New/upgraded PLC hardware (remote I/O racks, etc.)
    - v. New/upgraded network hardware and cabling
    - vi. New/upgraded FECs
    - vii. New/upgraded SCADA server and workstation hardware
    - viii. New/upgraded InSQL and other server hardware
    - ix. New/upgraded software programs (PLC, FEC, SCADA server, etc.)

- x. New/upgraded paging system
2. Include with the review package the following:
    - a. Updated decision log
    - b. Draft, final list of drawings in tabular format, indicating percent complete, 95% complete
    - c. Draft tender drawings, 50% complete
- 5. 75% Design Review Package**
1. Prior to submitting the 75% design review package ensure that following tasks have been completed.
    - a. Resolution of outstanding issues from the 50% design review package.
    - b. Comments from the 50% design review package have been incorporated.
    - c. Equipment pre-selection/ pre-purchase process, if applicable.
    - d. Updated Capital Cost Estimates identifying changes to the pre-design cost estimates.
  2. Include with the review package the following:
    - a. Updated decision log
    - b. Draft, final list of drawings indicating percent complete, 95% complete
    - c. Draft tender drawings, 75% complete
    - d. Draft Table of Contents for tender specifications, 95% complete
    - e. Draft Division 1
    - f. Details of pre-selected equipment
    - g. Detailed specifications for Division 1 including summary of work, sequence of construction, requirements for operational input, constraints, training, testing, commissioning, etc., 75% complete
    - h. Draft Software Programming Requirements document, 75% complete
    - i. Detail Specifications Sections from Division 11 to Division 16 for major equipment and processes, 75% complete
- 6. 95% Design Review Package**
1. Prior to submitting the 95% design review package ensure that following tasks have been completed.
    - a. Resolution of outstanding issues from the 75% design review package.
    - b. Comments from the 75% design review package have been incorporated.
    - c. Equipment pre-selection/ pre-purchase process, if applicable.
    - d. Updated Capital Cost Estimates identifying changes to the pre-design cost estimates.
  2. Include with the review package the following:
    - a. Updated decision log
    - b. Draft, final list of drawings indicating percent complete, 95% complete
    - c. Draft tender drawings, 95% complete
    - d. Draft Table of Contents for tender specifications, 95% complete
    - e. Draft Division 1
    - f. Details of pre-selected equipment
    - g. Detailed specifications for Division 1 including summary of work, sequence of construction, requirements for operational input, constraints, training, testing, commissioning, etc., 95% complete
    - h. Draft Software Programming Requirements document, 95% complete
    - i. Detail Specifications Sections from Division 11 to Division 16 for major equipment and processes, 95% complete
- 7. 100% Final Design Package**
1. Upon final approval, submit one set of the original final tender documents for reference. Drawings are to be submitted in 11" x 17" printed form and the specifications are to be in its final form, but not bound, ready for the calling of tender. Specifications shall be printed on both sides of the paper. Insert on the drawings revisions table with "Issued for Tender" note and date. Drawings and specifications to be stamped and signed by a Professional Engineer, licensed in the Province of Ontario. Provide one (1) paper copy of 11" x 17" stamped and signed drawings.
  2. Submit electronic copy in CD of final Drawings and Specifications
  3. Provide to the Regional Water Supply all final design calculations and design notes for the process, structural, mechanical, HVAC, electrical, and instrumentation related to detailed designs for the Regional Water Supply

information and storage. Calculations to include all assumptions, design criteria and design parameters. Hard copy of all calculations in a binder.

## **8. Pre-Tender Estimate**

1. On completion of the design work, the Consultant shall prepare and submit a pre-tender estimate at the time of submitting the tender package to the Regional Water Supply.
2. Prepare the pre-tender estimate accurate to within  $\pm 10\%$ . Estimates to be completed using industry recognized standard cost estimating tools such as Means or other applicable costing manuals, guidelines and standards. As a minimum, provide a breakdown by engineering discipline.

## **302 Field Verification Procedure**

### **1. General**

1. The Field Verification Procedure should be completed as the first stage of the detailed SCADA system design in order to ensure that the design scope meets the needs of the facility. The intent is to minimize potential future claims by Contractors during construction, resulting from inaccurate information portraying existing conditions. This activity will also accurately define the scope of work required for achieving the targeted level of automation.
2. The scope includes verifying the accuracy of the existing site conditions and “as-built” documentation as well as verifying whether the existing instruments, electrical equipment, mechanical equipment, field wiring, control panels, and automation can be successfully integrated into the new operating strategies and process control system.
3. In general, the instrument testing, field wiring testing and mechanical equipment testing should be very similar to the testing which is normally completed as part of the construction supervision and acceptance testing for new facilities.

### **2. Objectives**

1. The following identifies the general objectives of the field verification procedure.
2. Verify the accuracy of all existing (and relevant) documentation and gather all outstanding related details.
3. Confirm and document whether each existing instrument meets the design requirements, including range, accuracy, reliability, and installation details. Recommend the instrument upgrades required to achieve the proposed operational requirements, as compared with existing conditions.
4. Where concerns exist, test whether the existing control devices and process equipment can be operated as required under the new strategies. This includes control valves, motors, controls, wiring connections, and other control parameters.
5. Where concerns exist, verify the capacities/ratings of each piece of process equipment versus the new process requirements.
6. Recommend the control device and process equipment upgrades required to achieve the proposed operating strategies.

### **3. Completion Criteria**

1. Verification of existing instrumentation is deemed complete when all features, functions and information required in accordance with the Software Programming Requirements and Process and Instrumentation Drawings have been documented as existing or not available, and instruments identified as suitably accurate within the anticipated operating range for the process being monitored, and the necessary improvements and costs have been recommended. This information is to also be recorded on the updated site condition drawings and details.
2. Verification of control devices and mechanical equipment control circuits is deemed complete when the design requirements have been compared against the actual site conditions, and the necessary improvements and costs recommended. This information to be recorded in the verification report and updated site condition drawings and details.
3. The Consultant shall document any concerns that are noted on the physical condition of any devices or mechanical equipment, and propose a course of action to remedy the problem.
4. Testing of wiring is deemed complete when all wiring related to a specific device or loop (Instrumentation, Control Circuits and Power) has been confirmed to have acceptable voltage and/or current draw, without losses, for all functions and information required in accordance with the Software Programming Requirements and Process and Instrumentation Drawings. This information to be recorded in the field verification report and appended detailed test reports.



5. Field Verification is deemed complete when the field verification report contains the final recommendations and associated costs for upgrading the existing field equipment. This information will then be used to finalize the scope of detailed design related to upgrading existing conditions.

#### **4. Participants and Responsibilities**

1. Consultant - Responsible for reviewing all record documentation and assessing existing conditions, scheduling verification procedures, requesting field assistance from plant personnel, reviewing schedule with plant staff, completing all field verification and tests with assigned plant staff, presenting findings and report to Regional Water Supply, all completed with the intent to proceed further with the preparation of Detailed Drawings and Specifications for the proposed SCADA System Upgrade(s).
2. Regional Water Supply - Provide copies of all existing site condition information and equipment reports, review consultant's work plan, assign staff to witness the Consultant and Operator during field testing (in accordance with the provisions outlined in the Terms of Reference).
3. Operator - Review consultant's work plan, assign plant staff to assist the Consultant with field-testing (in accordance with the provisions outlined in the Terms of Reference). Assigned Plant staff will participate and assist the Consultant in the verification testing in order to both provide site knowledge and adopt the new standardized test procedures. Coordinate outstation visits with Regional Water Supply, Plant Manager or designate.
4. This Section provides an outline of all documentation to be used and/or produced by the Consultant during the Field Verification Procedure.

#### **5. Documents Required Prior to Field Work**

1. The following documents are to be assembled and reviewed by the Consultant prior to commencing any field investigation(s):
  - a. Any existing engineering record drawings, to be provided by the Regional Water Supply;
  - b. Copies of the Software Programming Requirements and Preliminary Process & Instrumentation (P&ID) Drawings;
  - c. Any existing equipment maintenance records, calibration reports, and shop drawings, to be provided by the Regional Water Supply (Operator);
  - d. Any plans of other proposed construction works within area of project, to be provided by the Regional Water Supply;
  - e. Verification sheets as per Section 22.02.02.03, with all known information entered prior to site activities.

#### **6. Template Forms**

1. Microsoft Excel Template forms included in Section 100, have been created for use as part of the verification procedures:

#### **7. Verification Schedule**

1. Following the review of all available documentation, the Consultant shall provide a draft field verification schedule for review by the Regional Water Supply and Operator. This will include dates for when the various test procedures are to be carried out, and the plant staff assistance required to complete the field portion of the investigation.
2. For the plant and outstations, detailed schedule coordination is required in order to enter confined spaces, provide proper gas monitoring documentation, and other related tasks. The Consultant must supply all equipment and trained personnel.
3. This schedule must be approved in writing by the Regional Water Supply, Plant Manager, or designate, prior to the commencement of any field investigations.
4. The verification program will be performed in stages, one for each process area. A verification report will be submitted to the Regional Water Supply for each Process Area evaluated. Verification reports for each process area must be presented 2 weeks after completion in order to identify and resolve all critical issues which affect scope, cost, or schedule in a timely manner.

## 8. Documentation & Reporting

1. The Consultant will be required to use and/or produce the following standard documentation as part of the field verification procedures:
  - a. Field Verification Form
  - b. Updated Site Condition Drawings and Device Details, based on the findings of this investigation;
  - c. Updated Software Programming Requirements;
  - d. Updated Process & Instrumentation Drawings;
  - e. Completed Verification Report(s) - The consultant will present his findings in electronic and printed reports, which contain, as a minimum:
2. The Scope of the Specific Verification Procedure.
3. Specific Objectives, beyond the General Objectives noted above.
4. Summary of Instrument, Device and Equipment Assessments, with the Instrument Verification Report and other test reports contained in an Appendix.
5. Summary of the Condition of Existing Control, Instrumentation and selected Power Wiring, with the test reports contained in an Appendix.
6. Recommendations on Improvements/Upgrades to existing Instruments, Devices, Wiring, and Equipment.
7. Cost estimates for all recommended improvements.

## 9. Field Inspection Items with Significant Cost Impact

1. All upgrades with significant cost impact shall be documented and submitted for written approval from the Regional Water Supply prior to proceeding with any additional spending.
2. A cost-benefit analysis may be requested by the Regional Water Supply.

## 10. Execution

1. This Section outlines the activities required to be completed by the Consultant, under the Field Verification Procedure.
2. Review of Record Documentation: Collect existing record documentation, with the assistance of plant personnel and the Regional Water Supply. Review accuracy of existing record documentation with the Regional Water Supply and plant personnel.
3. Updating Documentation and Initial Assessment: Complete a field investigation to collect missing or incomplete data, confirm the accuracy of all record information, and conduct an initial (visual) assessment of instruments, devices and equipment. The actual instrument information is to be documented on the Field Verification form. Prior to commencing, the consultant is to identify all other criteria, which they consider to be important for evaluating and accepting all field components.
4. Preliminary Recommendations: Based on the documentation review and the initial assessment, prepare the following recommendations.
  - a. Recommendation on reuse/repair/replacement of each existing instrument;
  - b. Recommendation on reuse/repair/replacement of all control devices, such as motorized valves;
  - c. Recommendation on any required modifications to the mechanical equipment control circuits in order to successfully integrate the equipment into the new process control system.
5. Verification of Existing Field Instrument Installation: The Consultant will provide qualified, experienced staff to inspect each existing installation, where required. Evaluation and acceptance of existing installations will be based on the following Standards (listed in Order of Precedence):
  - a. Available Regional Water Supply Standards;
  - b. Relevant ISA (Instrumentation Society of America) Standards;
  - c. Equipment Manufacturers' Installation Guidelines;
6. The acceptance method shall be documented in detail in the final report for reference, in the event of future discrepancies.
7. All mis-installation shall be corrected by the most cost-effective of the following methods:
  - a. Correct the installation to meet the acceptable practices listed above;
  - b. Install a new instrument which results in a correct installation;

- c. Install an alternate instrument operating by the same control means, with the same process data available.
  - d. Other mutually agreed method.
8. The final approval for the course of action will be made by the Regional Water Supply.
  9. Detailed Instrument Testing: For the instruments, which are recommended, for integration into the new SCADA system, these should be tested in detail to verify that they are functioning correctly.
  10. Where concerns exist, the primary measuring elements, such as flow sensors, are to be tested for their accuracy and operation by varying the process condition (i.e. high then low pressure or level) and simultaneously measuring the process conditions using an independent measuring instrument. In some cases, flow meters will require a detailed "draw and fill" test.
  11. Detailed Device Testing: For the devices that are recommended for integration into the new SCADA system, these should be field tested in detail (by the Consultant) to verify that they are functioning correctly.
  12. Detailed Equipment Controls Testing: From the documentation review and initial instrument assessment, recommendations will be made suggesting modifications to the mechanical equipment control circuits in order to successfully integrate the equipment into the new process control system.
  13. Where there are concerns regarding the documentation accuracy, the circuitry is to be tested in detail and documented.
  14. Where electrical concerns exist, the Consultant is to complete continuity testing of existing power supply and wiring (with plant staff).
  15. Where concerns exist regarding the performance of any existing equipment, the Consultant shall conduct field testing of the mechanical equipment capacity/rating and operation (e.g. pump delivery versus head).
  16. Testing Tools and Equipment: The Consultant, and/or respective Calibration Contractors or Equipment Manufacturers will be responsible for proper protection of instruments and devices that may be damaged by high voltage tests. If damages occur, the respective parties shall be fully responsible for replacement of damaged parts and/or components.
  17. Adopt calibration method and tools that will not cause  $\pm 0.5\%$  error in any test. The accuracy of the calibration tools must be traceable to National Standards. The Consultant will review and approve all testing procedures, and tools to be used. The Regional Water Supply's preference is the use of electronic calibration equipment that will provide a form of electronic documentation, transferable in a standard spreadsheet format.
  18. For all plant areas, and in particular the collection/distribution system facilities, detailed schedule coordination is required in order to organize traffic barriers, enter confined spaces, provide proper gas monitoring documentation, and other related tasks. The Contractor must supply all equipment and trained personnel.
- 11. Specialized Testing to be Completed by Others**
1. The Consultant is to identify all other instruments, particularly control valves, analyzers, large flow measuring devices, which would require testing by specialized Instrument Calibration Contractors or Equipment Manufacturers.
  2. The Consultant will be responsible to prepare Contract Documents for the acquisition of the services of these companies and shall provide a list of proposed sub-contractors to the Regional Water Supply. All qualifications, standards to be used, and requirements for reports will be identified in these Documents.
  3. The Consultant must include sufficient time to supervise, co-ordinate and evaluate the work undertaken by said contractors and/or manufacturers.
  4. Provide a report outlining the recommendations resulting from the following testing and verification. This will be used to determine the degree of remedial works and new works required to achieve the process control system objectives.

## ***303 Project Approvals***

### **1. Approvals**

1. Secure permits/approvals required for the project.
2. The Regional Water Supply will pay the fee for the permits and approvals.
3. Ensure that all permits and approvals have been issued prior to calling the tender for the project.

## **304 Pre-Start Health & Safety Review**

### **1. General**

1. Under Ontario Regulation 851 (RRO 1990) - Occupational Health and Safety Act., as amended to O. Reg. 488/01, Regional Water Supply are required to prepare a Pre-Start Health and Safety review for: racking & stacking structures, lifting devices, flammable liquids, explosion hazards, dust collectors, safeguarding of machinery, and occupational exposure. For this project, a Pre-Start Health & Safety Review may or may not be required. Establish whether the review is necessary.
2. If needed, and upon approval of the Regional Water Supply, retain a Specialist Consultant to prepare prior to tendering (note that the preparation of the report is a provisional item in the Cost of Services). The review is to ensure that the construction, addition or installation of a new apparatus, structure, protective element or process, or the modification to existing apparatus, structure, protective element or process are in compliance with the applicable provisions of the Regulation for Industrial Establishments.
3. The work will consist of:
  - a. preparation of an initial report based upon review of the final drawings and specifications,
  - b. attendance at meetings with Regional Water Supply to review draft initial report,
  - c. modifications to detailed tender drawings and specifications as required,
  - d. finalize initial report

## **305 Services During Tender Period**

### **1. General**

1. Ensure that all required approvals are in place prior to calling tender. Ensure, prior to tendering, that all contract documents are complete and contain all the details required for the construction of the works. The Regional Water Supply will not permit tendering with incomplete and/or deficient contract documents and the necessary approvals. The tender period shall normally not be less than three weeks and usually not more than six weeks. For complex projects, it may be as long as eight weeks
2. During the tender period, receive enquiries from contractors. Prepare addenda as required for distribution by the Regional Water Supply. Submit addenda at earliest date possible and no later than one week before tender period ends.
3. Attend and chair one pre-tender closing site meeting with bidders. The meeting will be used to brief the tenders on to review the contract documents and the project and to clarify points raised by tenders, and will be followed by a site walk-through. Take an attendance record of all contractors present and record all questions raised and answers provided. Submit information to the Regional Water Supply. Include information in the next addendum for the project.
4. Where necessary, co-ordinate with Regional Water Supply staff for test pits during pre-tender closing site meeting. Consultants to arrange for all utility locates prior to undertaking the test pits (to be paid for by the Regional Water Supply). Take attendance and have the findings of the test pits recorded and reported by a geo-technical consultant. Include the report of the test pits in the next addendum.
5. Perform evaluation of tenders, including: formality, pricing, bonding, completion date, and alternatives. Submit a tender report and recommendation to the Regional Water Supply, no later than seven consecutive calendar days after the close of tender.
6. Prepare and submit recommendations to the Regional Water Supply of for award of contract including suitability of contractor to carry out the work.
7. Arrange to attend one pre-award meeting chaired by the Regional Water Supply with the lowest formal bidder. The meeting will be used to review the submitted tender and to confirm contractual obligations prior to the award of the Contract.

## ***306 Tender Specifications Content***

### **1. Division 1 Content**

1. Include a suggested construction schedule or sequence, any construction constraints imposed by operations, the maximum quantities of major mechanical equipment that can be taken off line, training program, testing, and commissioning requirements.

### **2. Division13 (or 17) SCADA Content**

1. All instrument vendors as per the Regional Water Supply list.

### **3. Division 16 Electrical Content**

1. Wiring specifications as per Section.

## **307 Tender Drawings Content**

### **1. Tender Package**

1. The tender drawing package must include the following drawings, as a minimum
  - a. Title page with list of drawings and key map
  - b. SCADA and Electrical Legends & Symbols
  - c. P&IDs
  - d. Control Schematics (typical)
  - e. Electrical power distribution (as required)
  - f. Site and building floor plans

### **2. Issued for Construction Package**

1. The issued for construction package must include all tender drawings plus the following.
  - a. Control schematics per device



## 308 Services During Construction

### 1. General

1. The Consultant shall provide general engineering services for administering the contract and site inspection of the work during the construction phase. The Contractor is responsible for carrying out his obligations under the terms and conditions of the construction contract. The Contractor is also responsible for the quality of the work. The Consultant is neither responsible for the construction of the work, nor are his review services rendered for the Contractor's benefit.
2. It is the Consultant's responsibility to ensure through site inspection, verification reports, etc. that the Contractor carries out the work as designed per the contract specifications, and to confirm that the constructed plant/facility will perform and function as intended. It is the Consultant's responsibility to verify through his Quality Assurance and Quality Control programs that the Contractor carries out his obligations according to the contract documents and specifications.

### 2. Quality Assurance and Quality Control Programs during Construction

1. The Quality Assurance (QA) program provided by the Consultant shall consist of planned and systematic actions to verify that the works are being constructed as specified in the contract documents and specifications in accordance with applicable codes, guidelines and standards. The QA program includes, but not limited to the following:
  - a. Inspect all layout, construction work, and installation of equipment to ensure conformance with design drawings and specifications, and that all works are completed in a good workmanship like manner.
  - b. Maintain proper daily records of the progress of the construction work, noting unusual or unforeseen events that may have caused delays or impacts to the construction schedule.
  - c. Review shop drawings to verify that contractual requirements are met for materials and equipment.
  - d. Issue site instructions and clarification drawings in a timely manner when necessary to confirm the intent of contract requirements.
  - e. Provide technical specialists to carry out inspection of work constructed or installed to verify its compliance with contractual requirement, codes, regulations, etc.
  - f. Arrange for external specialist testing firms to verify work when necessary.
  - g. Perform check-out/verification of all equipment, process and/or mechanical systems, instrumentation & control systems and SCADA systems.
  - h. Ensure and verify that the Contractor performs all instrumentation calibration as specified.
  - i. Ensure that all regulatory agencies have been notified of completed work and that the required inspections have been performed.
2. The Quality Control (QC) program provided by the Consultant shall consist of the examination of services and work performed by the Contractor. The QC shall include management and documentation necessary to demonstrate that these services and work provided by the Contractor meet contractual and regulatory requirements during the construction phase.

### 3. General Engineering Services during Construction

1. Conduct formal construction review meetings during the construction phase of the contract. The consultant will hold project site review meetings with the Regional Water Supply and the Contractor on a monthly basis during the construction phase, and a bi-weekly basis during the commissioning phases. The meetings will review the construction progress, the procurement of equipment items with long lead-time, sub-contract status, and scheduling and milestone goals.
2. Issue supplementary details and instructions to clarify the intent of the design to the Contractor as required.
3. Contractor Requests for Information (RFI):
  - a. Respond to Request for Information (RFI) from the Contractor no later than **five (5) working days** after receipt.
  - b. The consultant shall include supplementary details and instruction for clarifications, and response to RFIs in their Contract Administration Fees.
  - c. The consultant shall maintain a log of RFIs. The RFI Listing Log must include the following column headings: RFI No.; Spec. Sec. No.; Originator; RFI Subject; Date Received; Due Date; Date Responded; Remarks. The RFI Listing Log must be reviewed at every site meeting.

4. Construction Schedule:
  - a. Review the proposed construction schedule submitted by the Contractor. Comment on the procedures, methods and sequence of work that may have conflict with operation of the plant/facility, which will potentially impact the construction schedule. Consult with Plant Operation Staff to assist in identifying any conflicts.
  - b. At each site meeting, advise the Contractor to provide a rolling schedule of the construction work proposed for the next two week period, which is between the present and the next site meeting.
  - c. Advise the Contractor to update the construction schedule when the rolling schedules are out of sequence with the proposed construction schedule.
5. Shop Drawings:
  - a. Advise the Contractor in the pre-construction meeting to prepare and submit a Shop Drawings List highlighting materials and equipment that have long delivery time. The Shop Drawings List must be submitted at the first site meeting.
  - b. Review the Shop Drawing List with the contractor and identify materials and equipment that have long delivery time frame and installation time that may impact the construction schedule and completion date.
  - c. Review shop drawings submitted for general compliance with the design requirements. The Consultant shall return all shop drawings to the Contractor no later than 14 calendar days after receipt. Do not retain any shop drawings pending the submission of additional information. Return shop drawings to Contractor indicating what information is required.
  - d. Maintain a log of all shop drawings received for review; Shop Dwg No.; Spec. Sec. No.; Shop Dwg. Title & Description; Originator; No. Copies received; date received; date reviewed & approved; Date reviewed and Not Approved; No. Copies returned; Remark.
  - e. The updated shop drawings log shall be reviewed at each site meeting and also included with each site meeting minutes until all the required shop drawings have been submitted, reviewed and returned to the Contractor.
6. Consider and advise on alternative methods, equipment and materials proposed by the Contractor as permitted by the terms and conditions of the contract.
7. Changes in Site Conditions & Scope of Work:
  - a. Investigate, report and advise on unforeseen circumstances that come to the Consultant's attention during construction such as differing underground soil condition, claims from Contractor for whatever reasons in a timely manner so that appropriate actions may be taken to mitigate damages or claims by the Contractor.
  - b. Review and advise on the validity of extra charges for additions or deletions, and extension of time to the contract. Change Orders (CO) to be issued only upon the written approval of the Regional Water Supply Project Manager. All COs issued to the Regional Water Supply for authorization must be accompanied by a letter of recommendation.
  - c. Maintain a log of EWOs issued and approved; the date approved; the amount approved with all applicable taxes included; description and rationale of the changes required; the party that requested the change/extra work.
8. Progress Payments:
  - a. Review, verify and process Contractor's progress and final payment requisitions, and forward the processed payment requisitions to the Regional Water Supply Project Manager no later than 3 working days after having receiving the requisition from the Contractor. Note date of meetings with contractor to resolve payment claims on the payment certificate.
  - b. Issue Substantial Performance Certificate in accordance with Construction Lien Act. Issue Lien Holdback payment certificate to the Regional Water Supply one week prior to expiry of the 45 days waiting period. Review with Project Manager prior to issuance.
- 4. Resident Staff Engineering Services during Construction**
  1. Resident staff services may consist of a Project Manager and Inspector who shall be provided by the Consultant on a full time or part time basis. Requirements for Resident Staff services during the construction phase will be specified in the Request for Proposal.
  2. If the Consultant determines that the Contractor is not carrying out his work in accordance with the Contract Documents, or the work does not satisfy the intent of the design, or does not conform with the plans and

specifications, or does not continue to conform to the proposed schedule, the Consultant shall report to the Regional Water Supply Project Manager, and at the same time providing recommendations on the course of action to rectify the problem(s).

3. Review and discuss weekly with the Project Manager the progress of the construction works and advise/update Project Manager, noting any contractual problems, schedules or claims and recommended strategy for resolving these issues.
4. Provide effective communication through field memos or discussions with Plant Operation Staff to ensure that Contractor and Plant Operation Staff requirements are properly co-coordinated. Any actions resulting from the discussion with Plant Operation Staff shall be confirmed in writing by a field memo.
5. Arrange for all necessary field testing, inspections or verification by specialist consulting or inspection firms to determine that the work conforms with intent of design requirements i.e. geotechnical investigations, etc.
6. Carry out site inspection to verify that the construction works and installation of equipment are in accordance with the drawings, contract document and specifications.
7. Liaise with and coordinate construction activities with respect to other construction project, both ongoing and upcoming, at the facility that may impact the construction of the project.
8. When shut-down and/or switch-over of any electrical or mechanical equipment or process is required, ensure that the contractor coordinates with all involved trades and with plant operating personnel, providing proper early notification. Ensure that the contractor arranges for alternatives to maintain plant processes with minimum interruption.
9. Ensure that all reports for all field testing, calibration reports, air balancing reports, all manufacturers' start-up report, electrical co-ordination study report etc are properly bound together in the Maintenance Manual PRIOR to the start up of the plant/facility.
10. Ensure that the contractor provides proper protection of all existing structures, finishes and equipment, which are adjacent to work areas. Ensure that the conditions of all existing facilities are appropriately recorded, photographed during and after construction, and that at the end of the contract these are returned to the same or better condition. Ensure contractor provides adequate protection to ensure plant can maintain adequate function as an operating facility without unnecessarily impacting operations.
11. Ensure that the contractor has obtained all permits that are required for the project.
12. The production and maintenance of the master Deficiency List as follows:
  - a. Throughout the progress of the work, prepare a deficiency list and update at appropriate milestones.
  - b. Prior to issuance of the Certificate of Substantial Performance, carry out an inspection of the facility with the Contractor and Plant Operation Staff. The Consultant shall produce a master Deficiency List within three days after inspection and issue it to the Contractor, Plant Operation Staff and the Project Manager.
  - c. The master Deficiency List shall be updated and/or expanded to include new deficiencies, as these become known, on a weekly basis for the first six weeks. On expiry of the sixth week, if the Contractor has not reached completion as specified in the contract, notify Contractor to perform rectification of deficiencies with a stipulated deadline of two weeks. Once the Contractor completes the rectification of the deficiencies, process the Final Payment Certificate, and provide a letter to the Regional Water Supply indicating completion of the construction project.
  - d. If the Contractor fails to rectify the deficiencies after the third notification, advise the Regional Water Supply so that the Contractor and the Surety can be advised that others are correcting the deficiencies as provided under the terms and conditions of the contract. Assist the Project Manager to retain the services of another Contractor to have the deficiencies corrected. Separately document the engineering services required to retain the new Contractor and to verify deficiency rectification. On completion of the rectification works, advise the Regional Water Supply of deduction amount withheld for work performed by the Regional Water Supply.
  - e. Once an item has been entered into the Deficiency List, removal from the Deficiency List **IS NOT PERMITTED**. The only changes permitted to the list will be in the second and last column where the status of the item is to be updated. All deficiencies corrected by the Contractor shall be shown shaded on the Deficiency List.

13. All enquiries received from the Contractor shall be promptly responded to in writing, delivered by hand, faxed or e-mailed to the Contractor, **within five consecutive working days** after receipt. All field memos must be identified in an appropriate manner in order to be able to verify the history of any site/field instructions.
14. Ensure that the Contractor prepare an inventory list of special tools, spare parts and equipment as specified in the specifications to be supplied for Plant Operation's use, three months after award of contract. Issue inventory list to Contractor, Plant Operation Staff and Project Manager.
15. Accept spare parts on behalf of the Regional Water Supply and issue same to Plant Operation Staff. Ensure that Plant Operation Staff signs for all equipment using the Inventory List form.
16. Ensure that all the required "final" shop drawings and "Record" drawings submitted by the Contractor are reviewed and accepted by the Consultant prior to recommending Completion.
17. Ensure that the Contractor prepares and submits the Contractor's Equipment Operations & Maintenance Manual a) prior to commissioning the equipment b) Final-prior to Substantial Performance.
18. Maintain a "marked-up" set of drawings to show "Record" works. The "Record" drawings shall be updated weekly.
19. Attend meetings for Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) as deemed necessary for proper co-ordination of work by the Contractor, the Sub-Contractors, suppliers or testing firms.

## **5. Manuals and Training to be Provided by Contractor**

1. Review and approve the Operation and Maintenance (O&M) manuals submitted by the contractor before submitting to the Regional Water Supply.
2. Ensure draft manuals are submitted for review by the Regional Water Supply a minimum of six (6) weeks prior to any training being conducted. Ensure final manuals are submitted to the Regional Water Supply prior to substantial performance of the project.
3. Ensure that Plant Operation Staff are fully advised of the operating characteristics and maintenance requirement of ALL equipment at the commissioning performed by the Contractor and/or equipment suppliers. Confirm that all special requirements are noted and the details included in the Maintenance Manual prepared by the Contractor.
4. Prior to commissioning of any equipment, arrange with the supplier through the Contractor to provide training as specified in the specifications to the Plant Operation Staff in the proper care, operation and maintenance of the equipment.
5. All training to be completed prior to Substantial Performance.
6. Final O&M Manuals to include written guarantees from the contractor, identifying that the contractor will undertake corrections of any and all defects in materials and/or workmanship utilized in the contract having warranties for two (2) years unless otherwise specified. All warranty periods shall commence on date of issuance of the Full Completion Certificate.

## **6. Consultant's Cost Control of Project during Construction**

1. The Regional Water Supply requires that the Consultant be fully responsible for cost control of the project with respect to engineering fees and construction contract cost. The Regional Water Supply will require timely reports of impending overrun of fees, or construction contract cost.
2. Timely report is defined as a reasonable period for which it will permit the Project Manager to report to Committee and Council **PRIOR** to the expected overrun in either engineering fees or construction contract cost. Where the Consultant does not exercise proper cost control and has incurred additional cost, the Regional Water Supply will not be obliged to honour payment for such services.

3. The Consultant shall submit update reports on the project construction contract cost control sheets to the Project Manager on a monthly basis with respect to the following:
  - a. Tender amount with contingency amount including all applicable taxes
  - b. Payment to Contractor to-date – i.e. the latest copy of payment certificate
  - c. Approved EWO issued to-date – i.e. the EWO log
  - d. Value of Contract to-date, including the projection of any additional cost to complete the construction works.
  - e. Description of work performed to-date and advice on progress to-date versus schedule submitted by Contractor.
  - f. Recommend any action to be taken by the Regional Water Supply to mitigate cost overrun.
  - g. Any changes to the contract must be made by the issuance of EWO to the Contractor, includes changes to the contract even where there is no change in the contract value, i.e. extension of time to the contract.
4. Issue EWOs that are required to meet the intent of the contract, with written approval from the Regional Water Supply Project Manager, so that the work may be completed in a fully functional manner.
5. Issue EWOs for additional work that deviates from the intent or requirement of the contract only when approved by the Regional Water Supply Project Manager
6. The Regional Water Supply **accepts no responsibility** for any such EWOs where the Consultant has issued the EWOs without first obtaining the written Regional Water Supply Project Manager approval
7. All EWOs must be approved and signed by the Regional Water Supply Project Manager and include support documentation as follows.
  - a. A RFI or RFQ or Change Directive/Notice identifying the additional scope of work to be performed;
  - b. The Contractor's response shall include scope of work to be performed, and the cost. The cost shall include impact cost, overhead and profit and all applicable taxes;
  - c. Consultant's letter noting the rationale of the recommendation to the Contractor's response along with signed EWO

## 7. Regulatory Agencies Approvals

1. Confirm that all required inspections by regulatory agencies have been performed prior to issuance of Substantial Completion Certificate.
2. Verify that the Contractor has provided a copy of all approvals, from these regulatory agencies, in each set of the Maintenance Manual.
3. Depending on the project, inspection of the constructed plant/facility may be required by some or all of the following regulatory agencies prior to operation and/or occupancy as known to the Regional Water Supply, including but not limited to:
  - a. Canadian Gas Code Association
  - b. Building Occupancy Permit
  - c. Fire Department Approval for occupancy
  - d. Ontario/Local Hydro Inspection
  - e. Electrical Safety Association (ESA)
  - f. Technical Standard & Safety Authority (TSSA)

**SUMMARY OF DELIVERABLES  
 FOR SERVICES DURING CONSTRUCTION**

<b>ITEM</b>	<b>CONSTRUCTION PHASE</b>
1	CONSTRUCTION PHOTOGRAPHS AT ALL KEY STAGES OF THE WORKS, FILED AND TITLED
2	ISSUANCE OF PAYMENT CERTIFICATES ON A MONTHLY BASIS TO COMPLETION
3	ISSUANCE OF EWOS WITHIN 15 CONSECUTIVE WORKING DAYS
4	ISSUANCE OF THE SPARE PART LISTS TO CONTRACTOR 2 MONTHS AFTER AWARD OF CONTRACT
<b>ITEM</b>	<b>PRIOR TO SUBSTANTIAL PERFORMANCE</b>
1	FACTORY ACCEPTANCE TEST REPORT
2	FIELD EQUIPMENT TEST REPORT
3	SITE ACCEPTANCE TEST REPORT
4	15 DAY COMMISSIONING REPORT
<b>ITEM</b>	<b>AT SUBSTANTIAL PERFORMANCE</b>
1	MAINTENANCE MANUALS
2	LISTING OF ALL SUB-CONTRACTORS, NAME OF CONTACT PERSON, TELEPHONE & FAX NUMBERS, & E-MAIL ADDRESS
3	LISTING OF ALL SUPPLIERS, NAME OF CONTACT PERSON, TELEPHONE & FAX NUMBERS, & E-MAIL ADDRESS
4	ALL WARRANTY & GUARANTEE CERTIFICATES IN EACH SET OF MAINTENANCE MANUAL
5	"RECORD" DRAWINGS & SOFTWARE (if applicable)
6	DEFICIENCY LIST
7	ALL APPROVALS & PERMITS FILED IN MAINTENANCE MANUAL
9	CO-ORDINATION STUDY OF PROTECTIVE DEVICES
10	CERTIFICATE OF SUBSTANTIAL PERFORMANCE
11	PAYMENT CERTIFICATE FOR HOLDBACK RELEASE

<b>ITEM</b>	<b>CONTRACT COMPLETION</b>
1	LETTER CONFIRMING COMPLETION
2	CONTRACTOR'S PERFORMANCE REPORT
<b>ITEM</b>	<b>PRIOR TO CONTRACT CLOSEOUT</b>
1	FINAL INSPECTION AND REPORT

## 309 General Testing & Commissioning

### 1. General Requirements

1. Prior to commissioning of the equipment, finalize the draft copy (prepared during the design phase) of the Pre-Start Health and Safety Report based on any change orders issued during the construction phase, and an on-site inspection of the as-constructed works. The report shall detail the measures (steps, actions or engineering control) necessary to bring the construction, addition, installation or modification into compliance before operation (note that the preparation of the report is a provisional item in the Cost of Services).
2. Testing and Commissioning generally consists of the following stages:
  - a. Testing: check out/verification
  - b. Commissioning: wet test (as applicable)
  - c. Commissioning: performance testing (as applicable)
3. It is mandatory that verification of all equipment, system and sub-system, processes, and auxiliary systems are fully tested, documented, and verified by the Consultant.
4. All verification reports must be documented and submitted at the end of the verification process.
5. A summary sheet (11X17 folded, FORM A-17) identifying all the new equipment installed must be included at the front of the verification reports. The summary sheet must as a minimum contain the following column headings across the top row:
  - a. Tag Number
  - b. Description and Equipment Location
  - c. Model Number
  - d. Drawing No.
  - e. Specifications No.
  - f. Shop Drawing No.
  - g. Delivery Date
  - h. Installed Date
  - i. Insulation test completed
  - j. Start-up Date
  - k. Verification:
    - l. Resident Staff (Consultant)
    - m. Plant Operation Staff
    - n. Red/Green Tag
    - o. Comments
6. The Consultant may not allow commissioning of the facility to commence until the start-up phase has been completed and all the reports delivered to and accepted by the Project Manager.
7. Ensure that the tagging of installed equipment during Start-up and Commissioning are carry out as follows:
  - a. Contractor shall clearly identify all equipment and/or systems that are being installed with a red tag to indicate that the Contractor is installing and responsible for the equipment. The Contractor, Consultant and Plant Operation Staff must sign the red tag.
  - b. After the equipment has been installed, aligned, started-up, tested and certified by the manufacturer/vendor as having been installed properly, remove the red tag from this equipment and/or system and replace with a green tag. The Contractor, Consultant and Plant Operation Staff must sign the green tag.
  - c. All equipment and/or systems identified with a green tag will indicate that the equipment is fully functional and may be used by the Regional Water Supply for operation of the facility.

### 2. Rotating Equipment Check-Out/Verification Requirements

1. Submit to the Project Manager a listing of all rotating equipment to be checked-out by the Contractor two months after the date of award of contract. After reviewed and accepted by the Project Manager, provide two final copies to the Contractor and two copies to Plant Operation Staff.
2. Ensure that the Plant Operation Staff, the Contractor and his Sub-Contractors, and Suppliers are presence to witness the execution of the check-out/verification procedure as provided for under the terms and condition of the contract, and note whether the equipment passed or failed its proper operation test.

3. Complete the rotating equipment check-out/verification procedure form and ensure that all parties present sign the form. Issue one copy to:
  - a. Plant Operation Staff
  - b. Contractor/Supplier
  - c. Resident Engineer
4. If the rotating equipment check-out/verification failed, reschedule for a new date to perform the check-out/verification procedure. On completion, re-issue the Form.

### **3. Mechanical/Process System Check-Out/Verification Requirements**

1. Submit to the Project Manager a listing of all mechanical/process system to be checked-out by the Contractor two months after the date of award of contract. After reviewed and accepted by the Project Manager, provide two final copies to the Contractor and two copies to Plant Operation Staff
2. Ensure that the Plant Operation Staff, the Contractor and his Sub-Contractors, and Suppliers are presence to witness the execution of the check-out/verification procedure as provided for under the terms and condition of the contract, and note whether the equipment passed or failed its proper operation test.
3. Complete the System Verification Forms for each system and/or sub-system after each test and ensure that all parties present sign the Form. Issue one copy to:
  - a. Plant Operation Staff.
  - b. Contractor/Sub-Contractors/Supplier
  - c. Resident Engineer
4. If the mechanical/process system fails to perform in the manner as designed and as per the contract specifications, arrange a new date for check-out/verification. On completion, re-issue the Form.

### **4. Instrumentation Calibration Report(s)**

1. Submit to the Project Manager a listing of all instrumentation equipment to be checked-out by the Contractor two months after the date of award of contract. After reviewed and accepted by the Project Manager, provide two final copies to the Contractor and two copies to Plant Operation Staff.
2. For the calibration of each field device, arrange for the Contractor and appropriate electrical, mechanical, instrumentation and control Sub-Contractors and Plant Operation Staff to be present for the calibration tests.
3. Ensure that the Contractor/Sub-Contractors/Suppliers carry out the proper calibration of each field instrument or devices as per the contract specifications.
4. Complete Calibration Report Form for each instrument or field device after each calibration test and ensure that all parties sign the form on conclusion of each test. Issue a copy to:
  - a. Plant Operation Staff
  - b. Contractor/Sub-Contractors/Supplier
  - c. Resident Engineer

### **5. Instrumentation & Control System Loop Check-out/Verification Requirements**

1. Provide to the Project Manager a listing of all digital and analog loops to be checked-out by the Contractor two months after the date of award of contract.
2. Submit four draft copies of a complete listing of all loop wiring between instrument and field devices, complete with its identification tag. When accepted by the Project Manager, provide two final copies to the Contractor and two copies to the Regional Water Supply.
3. Provide the Contractor and Plant Operation Staff with two sets of test procedures for all instrumentation and control loops for verification of the correctness of operation.
4. When testing instrumentation loops, ensure that the Contractor performs the testing of each loop in sequence and in group. The testing of an instrument loop will be graded on a pass/failed basis. If more than two instrument loops within a group fail the loop checkout, the entire group of loops will be deemed to have failed the checkout. When the failed loops have been repaired, the entire group must be re-tested.



5. Complete Control Loop Verification Form for each logical group of instrument loop test and ensure that the Form is signed by all parties at the conclusion of each test. Issue a copy to:
  - a. Plant Operation Staff
  - b. Contractor/Sub-Contractors/Supplier
  - c. Resident Engineer
6. Arrange for the Contractor, electrical, instrumentation and control Sub-Contractors for testing of loop wiring between instrument and field devices and advise Plant Operation Staff to be present for the procedure.
7. Verify that the Contractor has executed the work in accordance with contract specifications and/or current industrial practice. Permit no splicing of any loop wires between instrument and field devices and reject any connection not in compliance with manufacturers' recommendations or industry practice or specification.
8. Confirm the test procedure and provide one set of test records to Plant Operation Staff.

## **310 Field Instrument Acceptance Test**

### **1. General**

1. The Field Instrument Acceptance Test focuses on a detailed confirmation that the field instruments are supplied and installed in accordance with the contract documents and meet the requirements of the operation. This includes confirmation that the new units and existing units have been correctly calibrated (by qualified personnel), and verify that the equipment is available to properly receive and/or transmit information to/from the controllers.
2. Where it is identified that the original contract requirements do not achieve the operational requirements, the consultant must identify the differences, recommend solutions, and implement the necessary changes for the process control system to work properly.
3. Where it is identified that the requirements of the Contract have not been met, the Contractor is required to rectify all deficiencies immediately to allow re-testing during the same test phase.

### **2. Objectives**

1. The following identifies the general objectives of the field instrument acceptance test:
  - a. Accepting of equipment as installed by the Contractor.
  - b. Confirmation of the performance in accordance with the Consultant's Design.
  - c. Confirm and document that all new instruments meet the contract specification and drawing requirements, including range, accuracy, repeatability, reliability, calibration, and installation details (as recommended by the manufacturer).
  - d. Confirm that all discrete and analog signals (both new and existing) to be transmitted to and from the instrument are available and functioning correctly.

### **3. Completion Criteria**

1. The Instrument Acceptance phase of the Project will be deemed complete when all features, functions and information required in accordance with the Software Programming Requirements and P&IDs have been verified as present and functioning, and documented as accurate within the anticipated operating range for the process being monitored.
2. The Instrument Acceptance Report is to be used to identify and manage all outstanding issues, until they are resolved.

### **4. Participants and Responsibilities**

1. Consultant – With the assistance of the Contractor, the Consultant is responsible for planning tests, gathering information, preparing instrument test reports prior to commencing, scheduling testing, requesting field assistance from plant personnel, reviewing schedule with Operator, completing testing, then presenting findings and report to Regional Water Supply and Operator.
2. All testing procedures and tools to be used will be specified by the Consultant (if possible). The Consultant will also supervise and approve all procedures and tools used.
3. Regional Water Supply and Operator – Review consultant's work plan, assign staff to assist/witness field testing, coordinate with plant operating, maintenance, and other construction activities.
4. Contractor – Provide qualified instrument or electrical technician with experience to assist in testing and quickly repairing minor deficiencies, during the same test phase, for re-testing in the same test phase.
5. If there are any questions regarding calibration timing – Contractor shall recalibrate and sign-off at time of Field Instrument Acceptance Test.

### **5. Documents Required Prior to Field Work**

1. The following documents are to be assembled and reviewed by the Consultant prior to conducting the Instrument Acceptance Testing.
  - a. Reviewed shop drawings, including ISA data sheets, for each instrument installed (multiple copies for multiple installations);

- b. "For Construction" P&ID's, control schematics, and electrical drawings, and Software Programming Requirements document;
- c. Configuration and calibration certificates from the manufacturer(s) for each calibrated instrument, where specified by the Consultant in the Contract Documents;
- d. Results of factory performance tests, where specified by the Consultant in the Contract Documents;
- e. Instrument field calibration reports, where specified by the Consultant;
- f. Prepared instrument acceptance reports with all equipment numbers and relevant details entered;
- g. Prior to commencement of testing, the Consultant shall define the following for each piece of field equipment:
  - h. Calibration Procedure(s) to be followed by the Contractor;
  - i. Any special Procedure(s) to be followed by the Contractor;
  - j. What site verification, set-up, and calibration will be required by the equipment manufacturers.

## 6. Template Forms

1. Template forms included in Section 100, have been created for use as part of the testing procedures.

## 7. Testing Schedule

1. Testing procedures and schedules of work shall be submitted no less than two (2) weeks prior to the projected test date for the individual component. This will include specific dates for when the various test procedures are to be carried out, and the plant staff assistance required to complete the field portion of the investigation. This schedule must be approved in writing by the Regional Water Supply, Plant Manager, or designate, prior to the commencement of any field testing.
2. The consultant should allow some flexibility in his schedule to accommodate emergencies which arise for the Regional Water Supply or Plant Staff, plus unexpected findings.
3. The field equipment acceptance report must be presented one (1) week after completion in order to identify and resolve all critical issues, which affect scope, cost or schedule in a timely manner.
4. In some cases, testing should be scheduled outside normal business hours to accommodate operating issues and/or low flow conditions. This should be discussed and resolved with plant management during the planning phase.

## 8. Documentation & Reporting

1. The consultant will be required to use the following standard documentation for instrument acceptance tests:
  - a. Field Instrument Acceptance Report
  - b. Field Calibration Report, preferably in electronic documentation, transferable in standard spreadsheet format
  - c. Shop drawings, Instrument Data Sheets and calibration certificates (update as required)
  - d. "As Built" P&ID's, control schematics, and electrical drawings (update as required)
  - e. Completed Testing Report(s) - The consultant will present his findings in an electronic and printed reports which will contain, as a minimum:
    - i. The scope of the Specific Instrument Acceptance Test;
    - ii. Specific Objectives beyond the General Objectives noted above;
    - iii. Summary of Outstanding Issues, with the detailed test reports contained in an Appendix;
    - iv. Recommendations on Improvements/Upgrades to existing Instruments, Devices, Wiring, and Equipment.
    - v. Cost estimates for all recommended improvements.

## 9. Execution

1. This Section provides an outline of activities to be completed by the Consultant as part of the Instrument Acceptance Testing.
2. Instrument Acceptance – General: Inspect and document that each instrument matches the reviewed shop drawing. The inspection shall include, but not be limited to the following (as applicable):
  - a. Verifying that instrument product details match shop drawings and Contract Documents, (including Instrument Data Sheets);
  - b. Confirming soundness of instrument, i.e. without damaged parts;
  - c. Confirming completeness in all respects as specified for instrumentation;
  - d. Confirming correctness of setting, alignment, and relative arrangement

- e. Inspecting power, signal, and grounding wiring identified on the control schematics and documenting the results. All wiring to be verified for continuity.
3. Instrument Acceptance – Specific to Instruments: Instruments are also to be tested for their repeatability, accuracy and operation by varying the process and simultaneously measuring and recording the information displayed by:
  - a. An independent measuring instrument;
  - b. The local transmitter indicator;
  - c. All remote digital/mechanical indicators;
  - d. The 4-20mA (or digital value) measured at both PLC panels' and operator panels' terminal blocks and converted into engineering units.
4. Test results to be compared against the instrument calibration reports and planned PLC analog input range. As an example, flow sensors will require testing using a “draw and fill” test of a local container.
5. The final approval for budget and method will be made by the Regional Water Supply.
6. Instrument Acceptance – Specific to Switches: The instrument switches, such as pressure switches or building flood alarms, are to be tested for their accuracy and operation by varying the process conditions (for example: high then low pressure) and simultaneously measuring and recording the information displayed by:
  - a. An independent measuring instrument;
  - b. The instrument switch;
  - c. All remote lights and indicators;
  - d. The digital input status measured at both the PLC and operator panels' terminal blocks.
7. Test results are to be compared against the instrument calibration/ setting reports and planned PLC discrete input setting.

## 10. Testing Tools and Equipment

1. The Consultant, and/or respective Calibration Contractors or Equipment Manufacturers will be responsible for proper protection of instruments and devices that may be damaged by high voltage tests. If damages occur, the respective parties shall be fully responsible for replacement of damaged parts and/or components. Calibration equipment to be provided by Consultant and/or Calibration Contractor.
2. Adopt calibration method and tools that will not cause  $\pm 0.5\%$  error in any test. The accuracy of the calibration tools must be traceable to National Standards. The Consultant will review and approve all testing procedures, and tools to be used. The Regional Water Supply's preference is the use of electronic calibration equipment that will provide a form of electronic documentation, transferable in a standard spreadsheet format.
3. For all plant areas, and in particular the collection/distribution system facilities, detailed schedule coordination is required in order to organize traffic barriers, enter confined spaces, provide proper gas monitoring documentation, and other related tasks. The Contractor must supply all equipment and trained personnel.

## **311 Field Installation Acceptance Test**

### **1. General**

1. The field installation acceptance test focuses on a detailed confirmation that the field equipment and wiring is installed in accordance with the contract documents and meet the requirements of the operation. This includes verification that the units have been correctly calibrated (by qualified personnel), and verification that the equipment is available to properly receive and/or transmit information to/from the controllers.
2. In general, this test is not considered to be a full mechanical and physical installation acceptance for mechanical equipment such as pumps, blowers, etc. The procedure is intended to cover control devices, such as valves and only the control and power wiring related to other mechanical equipment.
3. Where it is identified that the original contract requirements do not achieve the operational requirements, the consultant must identify the differences, recommend solutions, and implement the necessary changes for the process control system to work properly.
4. Where it is identified that the Contract Requirements have not been met, the Contractor will be required to rectify the deficiencies for immediate re-testing.
5. Acceptance of equipment and systems installed under Divisions 13, 15, and 16 (Process Control, Mechanical, and Electrical respectively, shall follow satisfactory commissioning which comprises inspection, field testing for a specified number of consecutive days under Plant conditions, certification of correctness of installation, and placing such equipment and systems in readiness for operation.

### **2. Objectives**

1. The following identifies the general objectives of the field installation acceptance test:
  - a. Confirm and document that all new equipment meets the contract specification and drawing requirements, including functionality, reliability, and installation details.
  - b. Confirm that all discrete and analog signals (both new and existing) to be transmitted to and from the equipment are available and functioning correctly.

### **3. Completion Criteria**

1. The Installation of equipment is deemed to be accepted when all features, functions and information required in accordance with the Software Programming Requirements and P&IDs have been verified as present and functioning, and documented as accurate within the anticipated operating range for the process being monitored.
2. The Field Installation Acceptance Report to be used to identify and manage all outstanding issues, until they are resolved.

### **4. Participants and Responsibilities**

1. Consultant – With the assistance of the Contractor, the Consultant is responsible for gathering information, preparing installation acceptance reports prior to commencing, scheduling testing, requesting field assistance from plant personnel, reviewing schedule with Operator, completing testing, then presenting findings and report to Regional Water Supply and Operator.
2. All testing procedures and tools to be used will be specified by the Consultant (if possible). The Consultant will also supervise and approve all procedures and tools used.
3. Regional Water Supply and Operator – Review consultant's work plan, assign staff to assist/witness field testing, coordinate with plant operating, maintenance, and other construction activities.
4. Contractor – Provide qualified instrument or electrical technician with experience to assist in testing and quickly repairing minor deficiencies during the same test phase, for re-testing in the same test phase.

### **5. Documents Required Prior to Field Work**

1. The following documents are to be assembled and reviewed by the Consultant prior to conducting Installation Acceptance Testing.
  - a. Approved shop drawings, for each piece of equipment;

- b. "For Construction" P&ID's, control schematics, mechanical and electrical drawings;
- c. Results of factory performance tests, where specified in the contract documents;
- d. Equipment field test and calibration reports;
- e. Prepared equipment acceptance reports with all equipment numbers, loop numbers and relevant details entered.

## 6. Template Forms

1. Template forms included in section 100, have been created for use as part of the testing.

## 7. Testing Schedule

1. Testing procedures and schedules of work shall be submitted no less than two (2) weeks prior to the projected test date for the individual component. This will include specific dates for when the various test procedures are to be carried out, and the plant staff assistance required to complete the field portion of the investigation.
2. This schedule must be approved in writing by the Regional Water Supply, Plant Manager, or designate, prior to the commencement of any field investigations.
3. The consultant should allow some flexibility in his schedule to accommodate emergencies, which arise for the Regional Water Supply or Plant Staff, plus unexpected findings.
4. The field equipment acceptance report must be presented one (1) week after completion in order to identify and resolve all critical issues, which affect scope, cost or schedule in a timely manner.
5. In some cases, testing will be required to be scheduled outside normal business hours to accommodate operating issues and/or low flow conditions. This will be discussed and resolved with plant management during the planning phase.

## 8. Documentation & Reporting

1. The consultant will be required to use the following standard documentation for installation acceptance tests:
  - a. Field Installation Acceptance, with Criteria as per ISA, as per installation details, as per manufacturer, and as per other required authorities;
  - b. Field Calibration Report;
  - c. Shop drawings, Instrument Data Sheets and performance test/calibration reports (update as required);
  - d. "As Built" P&ID's, control schematics, mechanical and electrical drawings (update as required).
  - e. Completed Testing Report(s) - The consultant will present his findings in an electronic and printed report which contains as a minimum:
    - i. Scope of the Specific Equipment Acceptance Test;
    - ii. Specific Objectives beyond the General Objectives noted above;
    - iii. Summary of Outstanding Issues, with the Detailed Acceptance Reports contained in an Appendix;
    - iv. Recommendations on improvements/upgrades to contract scope in order to achieve operational requirements. Identify cost of installation(s).
    - v. Cost estimates for all recommended improvements.

## 9. Execution

1. This Section provides an outline of the activities to be completed by the Consultant as part of the Field Installation Acceptance Test(s).
2. Installation Acceptance – General: Inspect and document that each piece of equipment is supplied according to the Contract Specifications and matches the reviewed shop drawing. The inspection shall include, but not be limited to the following (as applicable):
  - a. Ensuring that equipment product details match both shop drawings and contract documents;
  - b. Confirming soundness of equipment, i.e. without damaged parts;
  - c. Confirming completeness in all respects as specified;
  - d. Verify correctness of setting, alignment, and relative arrangement. Confirm that adequate mounting and space is provided for maintenance and operation;
  - e. Inspecting power, signal, and grounding wiring identified on the control schematics and documenting the results. All wiring is to be tested for continuity;
  - f. Inspecting and verifying all signal cables, including shielding and grounding connections.

3. Installation Acceptance – Devices: Demonstrate that all field devices can be turned on and off from the PLC.
4. Control devices such as modulating/motorized valves are to be tested for their accuracy and operation by varying the hand switch positions, and modulating analogs from the PLC control panel terminal blocks to simulate PLC outputs, and triggering field interlocks while measuring and recording the control device operation and indications from:
  - a. Independent measuring devices and/or visual inspections;
  - b. The local indicators and lights;
  - c. All remote indicators and lights;
  - d. The analog and digital signals measured at the PLC panel terminal blocks. Where applicable convert the values into engineering units.
5. Test results are to be compared against the detailed process narrative operating description, control logic drawings, equipment shop drawings, control schematics and power drawings, and planned PLC output/input voltages and ranges.
6. Installation Acceptance – Equipment: Do not start-up any equipment, system or facility prior to issuance of a 'certificate of correctness of installation' from the manufacturers or suppliers of equipment and/or systems. Control circuits and powering wiring related to mechanical and process equipment such as pumps, blowers, and clarifier mechanism to be tested for the correct function and the associated safe operation of the equipment. Testing to be conducted by varying the hand switch positions, and modulating analogs from the PLC control panel terminal blocks to simulate PLC outputs, and triggering field interlocks while measuring and recording the control device operation and indications from:
  - a. Independent measuring devices and/or visual inspections;
  - b. The local indicators and lights;
  - c. All remote indicators and lights;
  - d. The analog and digital signals measured at the PLC panel terminal blocks. Where applicable, convert the values into engineering units.
7. All field wiring and mechanical interlocks identified on the control schematics must be individually tested to confirm the device properly stops and cannot be restarted until the condition clears.

## 10. Testing Tools and Equipment

1. The Consultant, and/or respective Calibration Contractors or Equipment Manufacturers will be responsible for proper protection of instruments and devices that may be damaged by high voltage tests. If damages occur, the respective parties shall be fully responsible for replacement of damaged parts and/or components.
2. Adopt calibration method and tools that will not cause  $\pm 0.5\%$  error in any test. The accuracy of the calibration tools must be traceable to National Standards. The Consultant will review and approve all testing procedures, and tools to be used. The Regional Water Supply's preference is the use of electronic calibration equipment that will provide a form of electronic documentation, transferable in a standard spreadsheet format.
3. For the plants and outstations, detailed schedule coordination is required in order to organize traffic barriers, enter confined spaces, provide proper gas monitoring documentation, and other related tasks. The Contractor must supply all equipment and trained personnel.

## 312 Factory Acceptance Testing

### 1. General

1. The SCADA Factory Acceptance Test (FAT) is focused on ensuring that all SCADA and controller hardware plus software is working properly and that all software configurations match the requirements identified in Software Programming Requirements document. Successful completion of the FAT is considered to be a critical project milestone. All participants attempt to test the software under all possible process conditions in order to ensure the robustness of the software. Various process conditions which will be difficult, or impossible, to test on site must be tested in FAT.
2. The goal of software testing is to ensure that the system meets the requirements of the Regional Water Supply/Operator, be error-free and not affect the operation of other systems. To achieve this goal, the SCADA FAT combines the traditional, successful methods used for both plant (facility) automation and computer software data integration.

### 2. Definitions

1. Software testing is defined as the execution of a program to find its faults, not just a process to verify its correctness. Other useful definitions are:
  - a. Verification: The process of proving the program's correctness.
  - b. Validation: An attempt to find errors by executing a program in the controllers, SCADA Nodes, Control nodes, and Monitoring (View) nodes.
  - c. Debugging: Diagnosing the precise nature of a known error then correcting it. Debugging is a
  - d. "fix" activity, not strictly a testing activity.
  - e. Errors: Human mistakes, errors in design definition or interpretation of the design by the programmer.
  - f. Defects: Improper program conditions that are generally the result of an error. Not all errors produce defects (as with incorrect program comments, for example).
  - g. Bugs: A fault that is a program defect found when the program is being tested or is in operational use. Bugs result from defects, but all defects do not necessarily produce bugs.

### 3. Objectives

1. The following identifies the overall objectives of the SCADA Factory Acceptance Test :
  - a. Consultant to confirm and document that the PLC I/O matches the voltage and number identified in the control schematics.
  - b. Consultant to confirm and document that the individual device logic operates all field equipment correctly and safely, as described in the detailed software design and process narrative.
  - c. Consultant to confirm and document that the control logic operates the facility correctly and safely, as described in the Software Programming Requirements document. Regional Water Supply and Operator to witness test.
  - d. Consultant to confirm and document that the data integration with other systems operates correctly as described. Regional Water Supply and Operator to witness test.

### 4. Completion Criteria

1. Testing of software is deemed complete when all features, functions and information required in accordance with the Software Programming Requirements have been verified as present and functioning, and documented as accurate within the anticipated operating range for the process being monitored.

### 5. Participants and Responsibilities

1. The roles and responsibilities for test planning and testing are summarized below.
2. Consultant – Responsible for developing the test plan and testing schedule, requesting plant staff assistance, completing all FAT sub-phases, presenting findings and reporting to the Regional Water Supply.
3. Regional Water Supply and Operator – Review work plan, and assign staff to assist/witness in FAT.
4. Review and confirm that the proposed automation matches the facility operating objectives.



## 6. Documentation

1. This Section provides an outline of the documentation to be used/produced by the Consultant as a part of the SCADA Factory Acceptance Test(s). The consultant will be required to use and/or produce the following documentation for SCADA Factory Acceptance Tests:
  - a. Up-to-date version of the Software Programming Requirements
  - b. "For Construction" P&ID's and control schematics
  - c. Completed SCADA FAT report(s) – The consultant will present his findings in electronic and printed reports which contain, as a minimum:
    - i. Test Plan
    - ii. Summary of Outstanding Issues.
    - iii. Change Request Forms.
    - iv. Change Request Action Log.
    - v. Test Sub-Phase Completion, Review and Sign-off form.

## 7. Template Forms

1. Template forms have been created for use as part of the testing, and are contained at the end of this document.

## 8. Testing Schedule

1. Testing procedures and schedules of work shall be submitted no less than two (2) weeks prior to the projected test date. This will include specific dates for when the various test procedures are to be carried out, and the plant staff assistance is required to do so. This schedule must be approved in writing by the Regional Water Supply, Plant Manager, or designate, prior to commencement.
2. The consultant should allow some flexibility in his schedule to accommodate emergencies, which arise for the Regional Water Supply or Plant Staff, plus unexpected findings.
3. The Factory Acceptance Test Report must be presented one (1) week after completion in order to identify and resolve all critical issues, which affect scope, cost or schedule in a timely manner.
4. Regional Water Supply to review and respond within one (1) week of receipt of the FAT Report.

## 9. Execution

1. This Section provides an outline of the works to be carried out by the Consultant as a part of the SCADA Factory Acceptance Test(s).
2. Test Sub-Phases: There are five types of software tests (referred to here as test sub-phases). These are:
  - a. Individual instruments, equipment, and process units: these sub-phases test/verify that devices and their larger system parts (e.g. process units and duty tables) perform as specified.
  - b. Intra-system Integration: tests/verifies the interfaces between units and the associated process logic related to multiple units, treatment processes, facility areas, and/or liquids, solids and plant-wide operating strategies.
  - c. Function: tests/verifies the functions the program is to perform as set out in the detailed requirements.
  - d. Performance/Operational: tests/verifies the system's performance under a variety of conditions (load/stress, volume, etc) and verifies these results against the specifications. Includes testing of the system's configuration, security, backup/recovery, reliability, etc. in the planned network architecture.
  - e. User Acceptance: tests/validates the system to the user's requirements.
3. Test Plan Contents: Proper testing includes thorough test planning that begins in advance of the SCADA Programming phase. Following Preliminary Design, the Preliminary Design documents to be reviewed for "testability" (e.g. flagging possible test planning/test design or test scheduling issues; identifying aspects of the design, which may prove to be very difficult to reasonably test; etc.) An initial test plan to be developed as part of the Field Detailed Design phase in order to identify any additional piping, valves, etc. which would simplify the future testing and acceptance on site. Final test plans should specify:
  - a. The test objectives.
  - b. Testing requirements, especially ones that may be specific to the project objectives and scope.
  - c. The testing approach, including an overview of the testing tasks (e.g. test case design, test data collection/compilation, priority/emphasis, and integration considerations).
  - d. A testing schedule.

- e. The participants and their responsibilities.
  - f. The test sub-phase acceptance/completion criteria.
  - g. Assumptions/key considerations.
4. The following inputs are required for successful test planning:
- a. Functional Specification.
  - b. System Requirements for system scope, priorities and sizing (from PCS Preliminary Design).
  - c. System Architecture for components and interactions (from PCS Detailed Software Design Specification).
  - d. Specialized hardware/software considerations/requirements.
  - e. Change Requests and Defect reports, as appropriate.
  - f. Assumptions/constraints/limitations.
5. Defect Handling and Management Change Requests: During testing, the need for changes to the system will be identified. This will be as a result of a test failure or as a result of an incorrectly specified requirement (test did not fail, but the requirement is incorrectly specified). It is important that there be a process for determining the nature and severity of the defect, and the nature and importance of the needed specification change.
6. For test failures, the defect must be reported using a Software Defect Report. For incorrectly specified requirements, the defect is to be reported in the form of a Change Request.
7. The following "Fault Severity Index" is suggested for handling defects:

Defect Severity Level	Defect Description
1.	Fault causes system to crash. System rendered unusable/non-functional.
2.	Fault occurs in a critical function. Whole function rendered unusable.
3.	Fault occurs in a critical function. A portion of the function rendered unusable.
4.	Fault occurs in a <u>non-critical</u> function. Whole function rendered unusable.
5.	Fault occurs in a <u>non-critical</u> function. A portion of the function rendered unusable.
6.	Cosmetic (e.g. typo) and would be unlikely to result in loss of confidence by users.

8. All defects are documented by the Consultant. Level one, two and three defects, which are NOT the result of incorrect specifications, are directed to the programmer for immediate correction.
9. Testing Cut-Off Points: Testing cut-off points also need to be established in the test plan and reflected in the testing schedule. Level 1, Level 2, and Level 3 faults must be corrected as a first priority and testing should not proceed to the next sub-phase until all Level 1, 2 and 3 faults are corrected.
10. Change Request Management: Change Requests are prepared by the Consultant. The Consultant will estimate the time and resources required to make the change, and recommend a priority to the Regional Water Supply. Possible implications of not proceeding should also be identified. The Regional Water Supply authorizes the work to be done. The Consultant schedules change request work based on these priorities. A Change Request should be maintained by the Consultant.

## 313 SCADA Site Acceptance Test (SAT)

### 1. General

1. The SCADA Site Acceptance Test (SAT) is focused on ensuring that all SCADA and controller hardware plus software is working properly and that all software configurations match the requirements identified in Software Programming Requirements. Successful completion of the SAT is considered to be a critical project milestone. All participants attempt to test the software under all possible process conditions in order to ensure the robustness of the software.
2. In general, the SAT consists of repeating the FAT using the actual field inputs/outputs once all field equipment has been installed and successfully tested. Hence, many of the procedures are identical to the activities identified in the other test procedures.
3. The objective of software testing is to ensure that the system meets the requirements of the Regional Water Supply/Operator, be error-free and not affect the operation of other systems. To achieve this goal, the SAT combines the traditional, successful methods used for both plant automation and computer software data integration.

### 2. Definitions

1. Software testing is defined as the execution of a program to find its faults, not just a process to verify its correctness. That is, check for appropriate alarms and contingent action is implemented (For example, power failure in middle of ramping VFD down or up and CSD. Is an alarm set? Are all programs still intact? Etc.)
2. Other useful definitions are:
  - a. Verification: The process of proving the program's correctness.
  - b. Validation: An attempt to find errors by executing a program in the controllers, SCADA Servers, Control nodes, and Monitoring nodes.
  - c. Debugging: Diagnosing the precise nature of a known error then correcting it. Debugging is a "fix" activity, not strictly a testing activity.
  - d. Errors: Human mistakes, errors in design definition or interpretation of the design by the programmer.
  - e. Defects: Improper program conditions that are generally the result of an error. Not all errors produce defects (as with incorrect program comments, for example).
  - f. Bugs: A fault that is a program defect found when the program is being tested or is in operational use. Bugs result from defects, but all defects do not necessarily produce bugs.

### 3. Objectives

1. The following identifies the overall objectives of the SCADA Site Acceptance Test:
  - a. Confirm and document that the PLC I/O matches the voltage and number installed on site.
  - b. Confirm and document that the individual device logic operates all field equipment correctly and safely, as described in the detailed software design and process narrative.
  - c. Confirm and document that the control logic operates the facility correctly and safely, as determined in the FAT and also described in the detailed software design and process narrative.
  - d. Confirm and document that the data integration with the other systems operates correctly as tested in the FAT and described in the Software Programming Requirements.

### 4. Completion Criteria

1. Testing of software is deemed to be complete when all features, functions and information required in accordance with the Software Programming Requirements, Logic Flow Charts, Software Programming Requirements have been verified as present and functioning, and documented as accurate within the anticipated operating range for the process being monitored.

### 5. Participants and Responsibilities

1. The roles and responsibilities for test planning and testing are summarized below.
2. Consultant – Responsible for developing the test plan and testing schedule, requesting plant staff assistance, completing all SAT sub-phases, presenting findings and reporting to the Regional Water Supply.
3. Regional Water Supply and Operator – Review work plan, and assign staff to assist/witness in SAT.

4. Review and confirm that the proposed automation matches the facility operating and maintenance requirements.

## 6. Documentation

1. This Section provides an outline of the documentation to be used/produced by the Consultant as a part of the SCADA Site Acceptance Test(s). The consultant will be required to use and/or produce the following documentation for SCADA Site Acceptance Tests:
  - a. Up-to-date version of Software Programming Requirements
  - b. "For Construction" P&ID's and control schematics
  - c. Completed SCADA SAT report(s) – The consultant will present his findings in electronic and printed reports which contain, as a minimum:
    - i. Test Plan, which includes section to be specified in section.
    - ii. Summary of Outstanding Issues.
    - iii. Change Request Forms.
    - iv. Change Request Action Log.
    - v. Test Sub-Phase Completion, Review and Sign-off form.

## 7. Template Forms

1. Template forms have been created for use as part of the testing. These sample forms should be modified to reflect the specifics of the particular site. For example, all field I/O points to be listed individually. The forms should allow Regional Water Supply/Operator to simply check each point tested.

## 8. Testing Schedule

1. Testing procedures and schedules of work shall be submitted no less than two (2) weeks prior to the projected test date. This will include specific dates for when the various test procedures are to be carried out, and the plant staff assistance. This schedule must be approved in writing by the Regional Water Supply, Plant Manager, or designate, prior to commencement.
2. The consultant should allow some flexibility in his schedule to accommodate emergencies which arise for the Regional Water Supply or Plant Staff, plus unexpected findings.
3. The Site Acceptance Test Report must be presented one (1) week after completion in order to identify and resolve all critical issues which affect scope, cost or schedule in a timely manner.

## 9. Execution

1. This Section provides an outline of the works to be carried out by the Consultant as a part of the SCADA Site Acceptance Test(s).
2. Test Sub-Phase: There are seven types of software tests (referred to here as test sub-phases). These are:
  - a. Individual instruments, equipment, and process units: these sub-phases test/verify that devices and their larger system parts (e.g. process units and duty tables) perform as specified.
  - b. Intra-system Integration: tests/verifies the interfaces between units and the associated process logic related to multiple units, treatment processes, facility areas, and/or liquids, solids and plant-wide operating strategies.
  - c. Function: tests/verifies the functions the program is to perform as set out in the detailed requirements.
  - d. Performance/Operational: tests/verifies the system's performance under a variety of conditions (load/stress, volume, etc) and verifies these results against the specifications. Includes testing of the system's configuration, security, backup/recovery, reliability, etc. in the planned network architecture.
  - e. Inter-system Integration: tests/verifies the interfaces between systems, and between systems and different technology environments.
  - f. Regional Water Supply/Operator Acceptance: tests/validates the system to the user's requirements.
  - g. Installation: tests/validates the install ability and operability of the system in the facilities.
3. Test Plan Contents: Proper testing includes thorough test planning that begins in advance of the SCADA Programming phase. Following Preliminary Design, the Preliminary Design documents to be reviewed for "testability" (e.g. flagging possible test planning/test design or test scheduling issues; identifying aspects of the design which may prove to be very difficult to reasonably test; etc.) An initial test plan to be developed as part of the Field Detailed Design phase in order to identify any additional piping, valves, etc. which would simplify the future testing and acceptance on site. Final test plans should specify:
  - a. the test objectives (normal and special situations);

- b. testing requirements, especially ones that may be specific to the project objectives and scope;
  - c. the testing approach, including an overview of the testing tasks (e.g. test case design, test data collection/compilation; priority/emphasis, integration considerations );
  - d. a testing schedule;
  - e. the participants and their responsibilities;
  - f. the test sub-phase acceptance/completion criteria; and
  - g. assumptions / key considerations.
4. The following inputs are required for successful test planning:
    - a. Functional Specification
    - b. Specialized hardware/software considerations/requirements
    - c. Change Requests and Defect logs, as appropriate
    - d. Assumptions/constraints/limitations
  5. Defect Handling and Management Change Requests: During testing, the need for changes to the system will be identified. This will be as a result of a test failure or as a result of an incorrectly specified requirement (test did not fail, but the requirement is incorrectly specified). It is important that there be a process for determining the nature and severity of the defect, and the nature and importance of the needed specification change.
  6. For test failures, the defect must be reported using a Defect Report /Defect Log.
  7. For incorrectly specified requirements, the defect is to be reported in the form of a Change Request.
  8. The following “Fault Severity Index” is suggested for handling defects:

<b>Defect Severity Level</b>	<b>Defect Description</b>
1.	Fault causes system to crash. System rendered unusable/non-functional.
2.	Fault occurs in a critical function (according to the definition in Section 4.4). Whole function rendered unusable.
3.	Fault occurs in a critical function. A portion of the function rendered unusable.
4.	Fault occurs in a <u>non-critical</u> function. Whole function rendered unusable.
5.	Fault occurs in a <u>non-critical</u> function. A portion of the function rendered unusable.
6.	Cosmetic (e.g. typo) and would be unlikely to result in loss of confidence by users

9. All defects are documented by the Consultant. Level1, 2 and 3 defects, which are NOT the result of incorrect specifications, are directed to the programmer for immediate correction.
10. Testing Cut-Off Points” Testing cut-off points also need to be established in the test plan and reflected in the testing schedule. Level 1, Level 2, and Level 3 faults must be corrected as a first priority and testing should not proceed to the next sub-phase until all Level 1, 2 and 3 faults are corrected.
11. Change Request Management: Change Requests are prepared by the Consultant. The Consultant will estimate the time and resources required to make the change, and recommend a priority to the Regional Water Supply. Possible implications of not proceeding should also be identified. The Regional Water Supply authorizes the work to be done. The Consultant schedules change request work based on these priorities. A Change Request should be maintained by the Consultant.

## **314 SCADA 15-Day Commissioning Test**

### **1. Commissioning Phase**

1. The 15 day commissioning should be deemed successful if the SCADA System downtime, caused by hardware or software faults, is less than one hour over the 15 x 24 hour period.
2. Each time an error occurs, the downtime is added to the previous downtime total. If this total reaches 60 minutes before the test is completed, the entire test must be restarted at the next morning, or after the problems have been corrected.
3. The commissioning phase may only be terminated upon successful completion of all the verification/checkout and commissioning of equipment, system and sub-system, processes, etc. that enables the facility to operate in the manner as designed and intended per the contract specifications and drawings prepared by the Consultant.

## 315 Project Documentation

### 1. Project Documentation Summary

1. The following table summarizes the SCADA documentation that must be provided by the Engineer or Contractor at the end of construction.

Document Name	Number of Copies
<b><u>Engineer</u></b>	
SCADA Testing Reports	
Process Narratives	4
Software Development Design Manual	4
Process and Instrumentation Drawings (P&IDs)	3
Control Schematics and Electrical Drawings	3
SCADA Network Drawings	3
Plant Operations Manual	3
<b><u>Contractor</u></b>	
SCADA Operations Manual	4
SCADA Maintenance Manual	3
SCADA Purchased Hardware & Software Manual	3
Control Panel Drawings	3
Field Equipment and Instrument Manual	3

2. As well as printed copies, all information must be provided on CD(s) in both Adobe and the native format.

### 2. SCADA Testing Reports

1. Testing reports shall be supplied in both printed and electronic format as part of the final documentation.
2. Organize the testing reports according to the following categories, for each related PLC.
  - Field Instrument Tests
  - Network and PLC I/O Wiring Tests
  - Control Panel Tests
  - Factory Acceptance Test
  - Site Acceptance Tests
  - Software Trial Period Report

### 3. Process Narratives

1. The initial version of the Process Narratives is to be developed during Pre design. It should then be updated during Detailed Design and included as one of the first sections of the Software Development Design Manual. At the end of construction, an "As Recorded" version must be created and submitted.

### 4. Software Development Design Manual

1. The Software Development Design Manual is initially created as part of the SCADA tender documents. It describes the software development/programming that must be done by the Contractor, including references to the SCADA standards. Some of the content to be included is listed below.
  - a. Listing of Relevant SCADA Standards.
  - b. General Programming Requirements
  - c. Detailed Process Control Strategies
  - d. Field & Field bus I/O Listings
  - e. Analog Range and Alarms Table
  - f. Alarm Paging
  - g. SCADA Historical Data Collection
  - h. InSQL Historical Data Collection
  - i. SQL Historical Data Collection

2. The Field and Fieldbus I/O table should include:
  - a. Description
  - b. Tag
  - c. Signal Type (DI,DO,AI,AO,FDI,FAO,FAI,FAO)
  - d. Point Termination
    - i. Rack
    - ii. Slot
    - iii. Point
  - e. Software Address (to be added by programmer)
  - f. Ranges for AI and AO
  - g. Voltage for DI & DO
3. The PLC I/O table should define the I/O configuration requirements within the PLC and should include:
  - a. Description
  - b. Tag
  - c. Software
  - d. Configuration Requirements for Analogs, within PLC Logic.
    - i. 100% value in Eng units
    - ii. 0% value in Eng units
    - iii. LOLO Alarm in Eng units
    - iv. LO Alarm in Eng units
    - v. HI Alarm in Eng units
    - vi. HHI Alarm in Eng units
    - vii. ROC Alarm in Eng units
    - viii. Out-of-Range Alarm in Eng units
4. The SCADA I/O table should define the I/O requirements within the SCADA software and should include:
  - a. Description
  - b. Tag
  - c. Signal Type (SDI,SDO,SAI,SAO)
  - d. Configuration Requirements for Analogs, within SCADA Logic.
    - i. 100% value in Eng units
    - ii. 0% value in Eng units
    - iii. LOLO Alarm in Eng units
    - iv. LO Alarm in Eng units
    - v. HI Alarm in Eng units
    - vi. HHI Alarm in Eng units
    - vii. ROC Alarm in Eng units
    - viii. Out-of-Range Alarm in Eng units
5. Paging Requirements (Yes/No) should specify which alarms are to be paged.
6. SCADA Historical Collect (Yes/No) should specify which values are to be corrected
7. In SQL Historical Collect should specify which values are to be collected
8. SQL Historical Collect should specify which values are to be collected
  - a. Hourly Avg
  - b. Daily Avg
  - c. Hourly Max
  - d. Hourly Min
  - e. Monthly Avg
  - f. Daily Max
  - g. Daily Min
  - h. Yearly Avg

## 5. Process & Instrumentation Drawings

1. All P&IDs are to be initially created during Predesign, and then updated during Detailed Design. A final "As Recorded" set to be produced at the end of construction.



2. The drawing style and content to comply with the MOE requirements for P&IDs.
3. All P&IDs must be developed using the Regional Water Supply's standards for symbols, line types, and drawing style.

## **6. Control Schematics & Electrical Drawings**

1. All control schematic and related electrical drawings are to be initially created during Detailed Design. A final "As Recorded" set to be produced at the end of construction.

## **7. SCADA Network Drawings**

1. All SCADA Network Drawings and related electrical drawings are to be initially created during Detailed Design. A final "As Recorded" set to be produced at the end of construction.
2. Plant Operations Manual
3. Prepare or update the Operations Manual as required by the Regional Water Supply staff and as mandated by the MOE Certificate of Approval for Water and Sewage. Ensure that the manual is clear, comprehensive, complete, and complies with MOE requirements. The manual shall include, but not be limited, to the following:
  - a. General plant description and plant treatment processes
  - b. A detailed description of the expansion/upgrade work and its operational details
  - c. A detailed description of how the expansion/upgrade work is integrated to the existing facility
  - d. Details of new individual unit processes, including any special characteristics and special considerations
  - e. Detailed technical description, and operation requirements of the expansion/upgrade works
  - f. Maintenance of equipment, linking to the Operations and Maintenance Manual supplied under the construction contract by the Contractor
  - g. Special observations and unique operating characteristics.
4. Manuals must be submitted to the Regional Water Supply staff prior to substantial performance and/or prior to the equipment/system being turned over to the Regional Water Supply.

## **8. SCADA Operations Manual**

1. SCADA Operations Manuals should include, but not be limited to:
  - a. General overview of the system, including Central & Remote Hardware, and Central & Remote Software;
  - b. Instructions on the use of the Operating Software (e.g. Windows XP), the use of Application Software Packages (e.g. MSOffice, RS View SE, etc.), as well as basic troubleshooting procedures;
  - c. Information on defining and using the Plant and Process Displays;
  - d. Instructions on the use of MMI (Man-Machine Interface) Buttons or similar interactive features;
  - e. Information outlining specific Equipment Control Displays.
2. The SCADA Operations Manual to include the following sections, as a minimum. The content should be appropriate for a plant operator who uses the SCADA system daily.
  - a. Overview of Automation – System Architecture
  - b. Description of hardware components
  - c. Description of software components
  - d. Process displays symbol standards
  - e. Modes of control
  - f. Using the HMI control buttons
  - g. Review of individual process area graphics and related monitoring and control
  - h. List of available trends, and how to access
  - i. Historical data collection overview
  - j. Alarms which are paged
  - k. Operations of paging system
  - l. List of available reports, and how to access

## **9. SCADA Maintenance Manual**

1. The SCADA Maintenance Manual must focus on the information required by the SCADA Maintenance staff to respond to hardware and software problems, as well as to perform system upgrades.
2. The manual to include, as a minimum, the following sections:

- a. Detailed description of automation system architecture and topology
  - b. Detailed description of PLC hardware configuration, network configuration, and computer hardware
  - c. Detailed description of software programming standards and modules utilized
  - d. VLAN configuration and data flow architecture
  - e. Time synchronization methodology
  - f. Alarm management
  - g. Alarm Paging System
  - h. Historical data collection
  - i. Hardware and software fault responses
  - j. Individual PLC I/O listings
  - k. Listing of PLC programs, with documentation
  - l. Listing of network switches, with documentation
  - m. Listing of SCADA computers, with documentation
  - n. Recommend hardware maintenance practices
  - o. Recommend software maintenance practices
3. For devices containing dip switches, jumpers or programming keypads provide an updated version of the documentation provided as a shop drawing submission. This version shall reflect all modifications that occurred as part of the site acceptance testing. Also, provide the following.
    - a. Printed copy of the application program
  4. For devices that require a downloaded software program, provide an updated version of the documentation provided as a shop drawing submission. This version shall reflect all modifications that occurred as part of the site acceptance testing. Also provided the following.
    - a. One printed copy of the application program, including documentation to explain the program.
    - b. One electronic copy of the application program, and application documentation, on a compact disc.
  5. The final documentation shall include all documentation on the software programs and settings, without hidden sections or password protection, in order that the Regional Water Supply can fully troubleshoot problems and download the backup copy of the program when needed. Providing the complete documentation by the contractor shall not reduce the contractor's warranty obligations.

## **10. SCADA Purchased Hardware & Software Manual**

1. For all automation hardware supplied, such as PLC components, network components, and computer hardware, provide a consolidated manual of all available vendor hardware manuals.
2. For all purchased software supplied, such as the PLC programming tools, network management tools, SCADA software, paging software, and databases, provide a consolidated manual of all available vendor manuals.
3. All documentation to be organized into 8 ½" x 11 binders sized with 1/3 space capacity. No binders to be larger than 3". If a larger binder is required, the System Integrator to organize the information into multiple binders.
4. The associated CD to include all information in the native format, and Adobe. Organize the electronic files into directories that match the binder organization.

## **11. Control Panel Drawings**

1. Supply a separate set of drawings for each individual panel. Final drawing must be an updated version of the shop drawing submission.
2. Print one set (11 x 17) of drawings and store in each panel. All other copies to be provided to the Engineer.
3. Provide electronic versions in AutoCAD 2000, or later version, as well as all drawings in Adobe format, on a Cd.

## **12. Field Equipment and Instrument Manual**

1. Provide equipment and instrument descriptions, with the following information for each model piece of equipment and instrument:
  - a. Manufacturer's design and performance specification data and descriptive literature.

- b. Equipment dimensions, installation requirements, typical mounting details showing methods and materials required for installation and recommendations.
  - c. Required and optional accessories list.
  - d. List of recommended spare parts and spare parts provided.
  - e. Electrical/pneumatic signal and power connection diagrams.
  - f. Operation and maintenance manuals.
2. Provide a written narrative describing the operating parameters, product maintenance requirements, performance limitations, warranty requirements, and recommended inspection requirements.
  3. Provide As-Built Instrument Data Sheets
    - a. Each instrument will be listed and pertinent information recorded including: tag number and description, complete model number, ranges, setpoints, materials and special mounting details for non-typical applications.
    - b. The data sheets will be based on ISA Standard – S20: *Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves*.
  4. Provide calibration certifications from the manufacturer for each instrument calibrated prior to installation.
  5. Provide updated shop drawings for all mounting fixtures.
  6. As final documentation for devices containing dip switches, jumpers or programming keypads provide an updated version of the documentation provided as a shop drawing submission. This version shall reflect all modifications that occurred as part of the site acceptance testing. Also, provide the following.
    - a. Printed copy of the application program
  7. As final documentation for devices that require a downloaded software program, provide an updated version of the documentation provided as a shop drawing submission. This version shall reflect all modifications that occurred as part of the site acceptance testing. Also, provide the following.
    - a. One printed copy of the application program, including documentation to explain the program.
    - b. One electronic copy of the application program, and application documentation, on a compact disc.
  8. The final documentation shall include all documentation on the software programs and settings, without hidden sections or password protection, in order that the Regional Water Supply can fully troubleshoot problems and download the backup copy of the program when needed. Providing the complete documentation by the contractor shall not reduce the contractor's warranty obligations.

## 316 Training

### 1. General Training Requirements

1. Training sessions will have to be conducted in stages to accommodate the execution of work. Co-ordinate the training schedules with the Regional Water Supply.
2. Submit the Training Manual text for review and approval by the Regional Water Supply. Modify and resubmit the manual until it is accepted by the Regional Water Supply. The material to be presented in each training course must be reviewed by the Regional Water Supply. The material shall be modified as recommended until approved by the Regional Water Supply.
3. All courses shall be on site unless an alternate site is approved by the Regional Water Supply.
4. Training is to be provided to all levels of staff, with the appropriate content. It shall match the following staff assignments:
  - a. Operator-normally monitors the process, adjusts process setpoints and responds to process alarms.
  - b. Maintenance technician – normally troubleshoots, tunes and repairs instruments and control equipment. The technician does not normally configure application software. The technician has primary support responsibility.
  - c. Systems support – normally performs system administration and application modification. The systems analyst has secondary support responsibility.
  - d. Manager – normally review process performance
5. Training Courses are to be provided to the staff groups as indicated below.

Course	Operator	Maintenance Technician	Systems Support	Manager
Process Operations Training	•	•	•	
Maintenance Training		•	•	
Applications Training			•	
Management Seminar			•	•

6. Number of Course Sessions – The Regional Water Supply requires that the courses be held multiple times to accommodate the availability of the Regional Water Supply staff and Operations staff. The minimum number of sessions is defined below. Prior to finalizing the course content, course duration, and number of sessions, the course planner is to discuss their approach with the Regional Water Supply. The process Operations Training to be arranged over a four day period.

Course	Number of Students per Session	Course Length	Number of Course Sessions
Process Operations Training	6	½ day	4
Maintenance Training	4	2 days	2
Applications Training	3	1 day	1
Management Seminar	3	½ day	2

## 2. Process Operations Training

1. Process Operations training is to focus on monitoring and controlling the facility using the SCADA graphics. It shall include the following components.
  - a. Review of all sections within the Process Narrative
  - b. Review of all sections within the Software Development Design Manual
  - c. Review of all sections within the SCADA Operations Manual
  - d. Review of the new hardware and software components installed under the project and how this impacts the previous configuration, from an operator perspective
  - e. Demonstrate all user interface functions available to the operator including power up of station, alarm response, display types, information and operator functions presented on each display type and operator changes to display information
  - f. Review in depth each of the areas that can be controlled from each location. Cover specific control strategy details including alarm limits, alarm reset procedures, start-up, shutdown, changing from local to remote, manual to automatic and reverse, etc.
  - g. Explain the operation and use of programs and procedures including, but not limited to: trend display generation, other user display generation, operating report generation, data entry functions, backup, reload and restart and system error messages
  - h. Care taking procedures such as monitor screen cleaning, paper reloading, ribbon or toner changing and similar day-to-day activities.

## 3. Maintenance Training

1. Maintenance training is to focus on the field instruments and control equipment. It shall provide instruction and experience to enable the student to quickly diagnose and correct faulty conditions and perform routine maintenance work of equipment supplied on this Contract. It shall include the following components.
  - a. Review of all sections within Field Equipment and Instrument Manual
  - b. Review of all P&ID, control schematic, networking, and field wiring record drawings
  - c. Review of the new hardware and software components installed under the project and how this impacts the previous configuration, from a maintenance perspective
  - d. Training on all supplied maintenance tools, such a calibrators, including how to use the tools to test and diagnose for faults and problems.
  - e. Programming routines and procedures used with on-line or standby equipment for maintenance and performance verification.
2. For devices containing dip switches, jumpers or programming keypads provide one ½ hr training session for each type of device.
3. For devices that require a downloaded software program, provide a 2 hr training session for each type of device.

## 4. Application Training

1. Applications training is to focus on the configuration of the network, operator interface programs, PLC programs, and other software applications. It shall include the following components.
  - a. Review of all sections within the SCDADA Maintenance Manual
  - b. System summary including the detailed system design, configuration and purpose.
  - c. System hardware including the specific hardware elements and specific configurations.
  - d. Complete system administration procedures. Include back up and reload procedures, program enable/disable and user set-up and access.
  - e. Adjustment of loop tuning parameters, timers, scaling factors and alarm limits.
  - f. Configuration software elements, their use and capabilities. Address how to adjust program parameters and how to add, delete and modify program elements. Include the following topics:
    - g. Process control program configuration
    - h. Operator-process interface configuration
    - i. Scan database configuration
    - j. Communication network configuration
    - k. Alarm configuration.

## **5. Management Training**

1. Management training is to focus on a general overview of the new SCADA system expansion. It shall include the following components.
  - a. Overview of all sections within the SCADA Users Manual
  - b. Overview of all sections within the Process Narrative
  - c. Overview of the new hardware and software components installed under the project and how this impacts the previous configuration, from an operator perspective
  - d. Presentation on the field data being collected and what consolidated data is being calculated and transferred to the Regional Water Supply's historical data management system

## **317 Assumption of Facilities**

### **1. General Requirements**

1. The Regional Water Supply will NOT assume any responsibility for the proper functioning of contractual work during the construction of the facility. Assumption of the new facility by the Regional Water Supply will be made on a formal basis as detailed.
2. All required documents as described must be completely delivered to the Plant Operation Staff and Regional Water Supply Project Manager. This includes the following.
  - a. SCADA Operations Manual
  - b. SCADA Maintenance Manual
  - c. (As-Constructed) Record Drawings
  - d. Additional documentation as defined in the standards
3. Formal Acceptance by the Regional Water Supply will occur when the following is completed.
  - a. The formal handing over of the facility to Plant Operation Staff should normally coincide with the date of the issuance of the Certificate of Substantial Completion to the contractor.
  - b. On that date, the Consultant will convene a meeting with the contractor, Plant Operations Staff, and the Regional Water Supply Project Manager. If the contractor has performed as required by the contract, issue the Certificate of Substantial Completion and turn the facility over to Plant Operation Staff.
4. Notwithstanding the fact that Plant Operation Staff will be operating the facility, all operation problems with be forwarded to the Consultant for resolution in accordance with the contract requirements.
  - a. SCADA Operations Manual
  - b. SCADA Maintenance Manual
  - c. (As-constructed) Record Drawings
  - d. Additional documentation as defined in the standards

## **318 Post Construction Services**

### **1. General Requirements**

1. At the end of the warranty period, two year from the date of completion, re-issue any "Record" drawings and CAD disk to reflect any changes made during the warranty period.
2. Any materials and equipment supplied for the contract, construction completed, or part thereof that were found to be defective, or inadequate within the guarantee/warranty period instruct the Contractor/Installer/Supplier to replace/correct the deficiencies without cost to the Regional Water Supply.
3. Develop and maintain records of warranty on all installed components, and update the Regional Water Supply of its status every six months in a written report. The report shall include the performance of equipment, and if the equipment is not performing as per specification, notify the Contractor/Supplier/Installer to correct the deficiencies without cost to the Regional Water Supply.
  - a. During the two years warranty period ensure that:
  - b. The inspection shall be carried out every six (6) months;
  - c. The inspection, where required, is carried out by all parties concerned, that is Consultant, Contractor, Regional Water Supply Project Manager, Operating Staff and Operating Support Staff;
  - d. A list of warranty deficiencies identified during this period is send to the contractor within five working days;
  - e. Provide deficiency resolution services
  - f. The contractor shall notify the Consultant and the Regional Water Supply prior to carrying out the rectification work so that any work performed can be inspected
  - g. Upon completion of satisfactory rectification work by the contractor, notify the Contractor and the Regional Water Supply in writing stating that all of its contractual obligations under the terms of the warranty have been fulfilled, upon expiration of the two year warranty period.



## **319 Facility Documentation Updating**

### **1. General**

1. One of the goals of the Regional Water Supply is to maintain a consolidated set of SCADA Facility documentation. Therefore, at the end of the construction phase, the Engineer is responsible for providing two documentation packages. The first package consists of the project-centric documentation. The second package is the facility-centric documentation.
2. The project-centric documentation includes all documentation provided by the Engineer as well as the Contracts, as per the contract requirements. This typically includes the following.
  - a. Engineer's Record drawings
  - b. Engineer's SCADA Operations Manual
  - c. SCADA Construction drawing such as panel drawings
  - d. SCADA Maintenance Manuals

### **2. Facility-Centric SCADA Documentation**

1. After submitting the project-centric documentation, the Engineer must update the following facility-centric SCADA documentation.
  - a. Facility SCADA Operations Manual
  - b. Facility Process Narrative and Software Programming Requirements documents
  - c. Facility SCADA Maintenance Manuals

### **3. Updating SCADA Preventative Maintenance Program**

1. At the end of construction, the Engineer to provide an Excel spreadsheet containing the data required, on each item, for implementing the device preventative maintenance program. This includes approximately 20 fields per device that must be extracted from the contractor's SCADA Maintenance Manuals.
2. For all types of items not previously entered within the maintenance software, the Engineer is also responsible for recommending the appropriate P.M. tasks and schedule. This information should be within the Contractor's Maintenance Manuals, as specified by the Engineer. This data to be organized in Excel spreadsheet, for uploading into the maintenance software.
3. The Excel spreadsheets to be provided to the Regional Water Supply. After proper review, the Operating Authority will upload the data into the maintenance software.

## 320 Software Programming Requirements Document

### 1. General

1. The objective of the Software Programming Requirements document is to provide the software programming team with a comprehensive, consolidated, and detailed document that describes all of the required programming plus the relationship(s) with the Section 500 Software Programming Guidelines.
  - a. The following components must all be described in this document
  - b. Smart Field Devices
  - c. Network Switches and Routers
  - d. Wireless Routers
  - e. Network Management Software
  - f. Network Performance Monitoring Software
  - g. PLC/FEC Programming
  - h. SCADA Server Configurations
  - i. In SQL
  - j. SQL Programming
  - k. Report Generation
  - l. Historical Data Queries
  - m. SCADA Web Site
  - n. Alarm Paging
  - o. Software Programming Tools
  - p. Software Version Control

### 2. Smart Field Devices

1. Smart Field devices include power monitors, VFDs, UPSs, level transmitters, and similar items.
2. Describe the specific requirements for software configuration of these devices.
3. Reference the Regional Water Supply, Section 500 standards where applicable.
4. Specify what information the Contractor must provide as part of their shop drawing submission.
5. For devices containing dip switches, jumpers or programming keypads request the following as a shop drawing submission.
  - a. Functional description
  - b. Physical, electrical and environmental requirements
  - c. Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.
  - d. Interconnection Diagrams including wiring, cables, jacks between internal and external components, power supplies, processors, communications modules, racks, I/O modules and peripherals. Label terminals, jacks and pins.
  - e. Related field tag numbers and wire numbers, module tag assignment, rack module assignment, terminal and terminal strip numbers.
  - f. Proposed configuration/Parameter Sheets including switch settings and addresses.
  - g. For hardware, items include description, make, model, part number and serial number.
  - h. For software, items include publisher, title, version, part number, serial number, media type and size, and information contained on label.
  - i. For documentation include title and publisher for each item
6. For devices that require a downloaded software program, request the following as a shop drawing submission.
  - a. Functional description of software program and control settings, including fault responses
  - b. Physical, electrical and environmental requirements
  - c. Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.
  - d. Interconnection Diagrams including wiring, cables, jacks between internal and external components, power supplies, processors, communications modules, racks, I/O modules and peripherals. Label terminals, jacks and pins.
  - e. Related field tag numbers and wire numbers, module tag assignment, rack module assignment, terminal and terminal strip numbers.

- f. Communication interface description including organization of software registers to be read/written to by the plant automation system
- g. For hardware, items include description, make, model, part number and serial number.
- h. For software, items include publisher, title, version, part number, serial number, media type and size, and information contained on label.
- i. For documentation include title and publisher for each item

### **3. Network Switches and Routers**

1. For the network switches, specify the details on how to program all network equipment to enable the required 10 VLANS, 10 layers of Quality of Service, and network redundancy. For the head end, provide a table of the following parameters – VLAN, QoS, speed per port, plus other key values.
2. For the switches, provide a table of the following parameters
  - a. Connected device name and description
  - b. Interface / Port
  - c. Speed (10 vs. 100)
  - d. Duplex (half vs. full)
  - e. Media (FX vs. OTP)
  - f. VLAN(s)
  - g. Pruned VLAN(s)
  - h. Quality of Service Priority
3. For the routers, specify the routing requirements.

### **4. Wireless Routers**

1. For the wireless routers, specify the routing requirements, security settings, plus other key parameters.

### **5. Network Management Software**

1. The network management software is used to upload/download/back-up network configurations. All new devices must be integrated into this system.
2. Specify the quantity of new items to be integrated as well as the implementation requirements.

### **6. Network Performance Monitoring Software**

1. The network performance monitoring software provides real time monitoring of the network through put, speed, and reliability. All new equipment must be integrated and added to the monitoring system.
2. Specify the quantity of new items as well as the configuration requirements.

### **7. PLC/FEC Programming**

1. Specify the general PLC/FEC programming requirements indicated in Section 500.
2. Review, finalize and include the Predesign Process Narratives within this section.
3. Expand the Process Narratives into Control Logic Descriptions.
4. Include the I/O listings and alarm setpoints.
5. Specify any required calculated values such as equipment run times, flow totalizers, and key Performance Indicators.
6. Specify the field I/O filtering requirements, in accordance with Section 500.
7. Describe the relevant equipment failure scenarios and how the PLC Logic should respond.

### **8. SCADA Server Configurations**

1. Specify and review the general requirements indicated in Section 500.
2. Specify the I/O data collection requirements.

3. Specify the general number and content of the HMI graphics.
4. Specify the general number, data points, and content of the HMI trends.
5. Specify the alarm management data points.

## **9. InSQL Programming**

1. Specify and review the general requirements indicated in Section 500.
2. Provide the list of data points, and related algorithms, for transfers to InSQL.

## **10. SQL Programming**

1. Specify and review the general requirements indicated in Section 500.
2. Provide the list of data points, and related algorithms, for transfers to In SQL.

## **11. Report Generation**

1. Specify and review the general requirements indicated in Section 500.
2. Create and include mock ups of the required reports/modifications to existing reports.
3. Specify the required upgrades to the existing reporting algorithm.

## **12. Historical Data Queries**

1. Specify and review the general requirements indicated in Section 500.
2. Create and include mock ups of the required, new data queries.
3. Specify the required modifications to the existing system.

## **13. SCADA Web Site Development**

1. Specify and review the general requirements indicated in Section 500. The Regional Water Supply web site includes different privileges for different users.
2. Create and include mock ups of the required, new data queries.
3. Specify the required modifications to the existing system.

## **14. Alarm Paging**

1. Specify and review the general requirements indicated in Section 500.
2. Provide a comprehensive list of the new points to be paged, including the paging configuration details.

## **15. Software Programming Tools**

1. For the efficient ongoing software maintenance, ensure that the versions specified match the tools currently used by the maintenance staff.
2. Specify and review the general requirements indicated in Section 500.

## **16. Software Version Control**

1. The programmers must supply the Regional Water Supply with copies of the software at the project milestones – FAT, SAT, and Post Commissioning, plus updated versions as they repair problems on site.
2. Specify and review the general requirements indicated in Section 500.
3. The version control software to be used, as a minimum, for the following requirements.
  - a. Keeps historical revisions of custom programs
  - b. Automatic version numbering

- c. Able to easily restore a previous version
- d. Automated check-out / check-in process
- e. User ID/password based security, using user groups
- f. Multi level security permissions
- g. Automated audit trail to track changes / events
- h. Audit records include who, what, when, where, and why
- i. Standard database options (Oracle, SQL, Access)
- j. Integrated report generator
- k. Client/Server based system
- l. Automated docking mode, so programmers can work off site
- m. Automated scheduler for network wide PLC and SCADA Server backups
- n. Automated software version comparison tool for PLCs and SCADA software
- o. HTML interface for clients
- p. Built in scripting engine for development of custom scripts
- q. Administrative features for setting up projects, users, security, reports etc.
- r. Able to support multiple server configuration
- s. Capable of e-signatures
- t. Project specific permissions