An updated cash-flow forecast indicating previously forecast and actual, involving levels together with revised future requirements shall be submitted quarterly. A graphical display in the form of an "S-curve" of the actual vs planned payment certification (on & offshore) shall be provided by the Contractor in triplicate on a quarterly basis to supplement the basic cash flow information.

If, during execution of the Contract, the Employer considers the progress position of any section of the work to be unsatisfactory, or for any other reason relating to the Contract, he will be at liberty to call meetings, either in his Head Office or at Site. If required by the Employer, a responsible representative from the Contractor's works is to attend at the Contractor's expense such meetings with sufficient authority to issue instructions or effect an alteration in the works to the satisfaction of the Employer.

Access to the Contractor's and Sub-Contractor's works is to be granted to the Employers representative at all reasonable times for the purpose of ascertaining progress.

7.6.8 Sub-contracts and Orders

As soon as practicable after entering into Contract the Contractor may, having obtained the Engineer's consent, enter into the sub-contracts he considers necessary, for the satisfactory completion of the Contract Works. Three un priced copies of the Contractor's sub-orders shall be supplied to the Engineer.

One copy of any drawings where the sub-order shall refer shall also be submitted. Each sub-order and drawing shall contain the following reference and an instruction that the plant is subject to inspection and tests to be witnessed by the Engineer or his agent with sufficient authority to issue instructions, or effect an alternation in the Works to the satisfaction of the Engineer.

Approval by the Engineer of Contractor's sub-orders shall not relieve the Contractor of his responsibilities in meeting this specification. It is the Contractor's responsibility to ensure that a full specification based on the relevant information in the contract is passed to the sub-contractor.

The Contractor will be responsible for progressing the Sub-Contractor's works including visits to the works to ensure the work as to programme, specification, quality and drawings and to witness all necessary routine, sample and type tests. The cost of this Contract control is deemed to be included in the Contract Sum.

7.6.9 Training for Employer's Staff

The Contractor, without additional cost will train the Employer's employees in the operation and maintenance of the plant. This training is to be carried out in Khulna as formal instruction courses on each of the various types of plant being provided. The attendance of WZPDCL staff during erection and commissioning works will not be acceptable as an alternative to the formal training courses. Course notes and handbooks as appropriate are to be issued to attendees, and full reference is to be made to the Operation and Maintenance manuals issued by the Contractor.

Importance shall be emphasized on the following particulars but not limited to during training:-

Routine Operation, Maintenance and trouble shooting, Testing and Repair of:-

- Switchgear and control equipment
- Control equipment, metering and alarm equipment
- Protection equipment
- Underground cables, sheaths, etc
- Earthing

- Substation Automation System
- Building Services
- DC and LV AC systems.

In addition full instruction is required in the stripping down, repair or replacement of components, reassembly, operation testing and re-commissioning of switchgear and transformers.

The employers operational staffs are to be instructed in operational procedures, i.e., switching fault reporting, sequence of operations following fault occurrence etc. Practical demonstrations and simulated events are to be performed in the control rooms provided, and the contractor is to monitor and advise the employer's attendants during substation energization and initial commercial operation. This training is required to ensure that the Employers staffs are made fully familiar with the plant operational design, maintenance procedures, etc.

The Contractor shall arrange foreign training for (i) 12 (twelve) Employer's engineers on GIS operation & maintenance at GIS switchgear and equipment manufacturer's premises/factory for two weeks. (ii) 6 (Six) Employer's engineers on Protection Scheme as well as offered Protective devices at manufacturer's premises/factory and offered Switching station Automation System (SAS) at Automation system manufacturer's premises/factory for a period of two (two) weeks at manufacturer's premises/factory. The training shall also include the field visit during training for practical operation. The training program on Switching station Automation System (SAS) also includes the installation & configuration of automation software. The full training programme is to be approved by the employer/engineer prior to commencement.

The cost of Air Tickets (both way) from Bangladesh to Manufacturer's Country, Hotel Accommodation, fooding and lodging etc. will be borne by the contractor. Other than this the contractor will pay a standard amount of pocket money (Euro 100) per day (including journey period). All the cost of this purpose shall be deemed is included in the offered price.

If the country of origin of equipment (Manufacturer Country) is more than one, the training shall be held at prime equipment manufacturer country.

The contractor shall also to arrange a local training program on Substation Automation System and Protection Scheme as well as offered Protective devices for twenty (12) operators for fifteen (15) days. This should include training on operation & control of the automation software and protective device. The Contractor is to report on the capability and progress of each trainee at the completion of their training periods. All cost of local training including accommodation, transport and fooding will be bear by the contractor.

7.6.10 Packing and Erection Marks

Each item is to be export packed and properly protected for shipment, transport and storage in the port area and for transport to and storage on Site.

All Plant provided under this Contract shall have the packing marked in the following manner.

A green band shall be painted all around each package. The band shall be 8" wide or ¼ of the length of the packing whichever is the less. Each package should have the following information printed on it in bold letters:-

(a) Port of Loading

(b) Name of Consignee

(c) Purchase Order Number

(d) Brief description of Stores

(e) Number of Package

(f) Gross, tare and net weight

(g) Measurements

(h) Contractors Name

(i) Contract Tittle

(j) Contract Number

(k) port of Landing

All members comprising multipart assembles, e.g. steel frameworks, are to be marked with distinguishing numbers and/or letters corresponding to those ofn the approved drawings or materials lists.

Colour banding to and approved code is to be employed to identify members of similar shape or type but of differing strengths or grades.

Cases containing delicate items such as relays and instruments should carry a separate marking:

Sensitive equipment packages shall be opened in the presence of a representative of the Employer.

7.6.11 Spares

The Contractor is to propose comprehensive schedules of spare parts requirement for 5 years service of the Plant.

Those Spare Parts required for routine maintenance are to be provided under this contract.

The Contractor shall provide detailed schedules of those emergency spares he considers that it would be prudent for the Employer to purchase in price schedule: Schedule no. 7 (Recommended Spare Parts) and those will not be included in the Bid Evaluation.

The Contractor shall guarantee and provide certificate from the manufacturers that spare parts for all plant shall be available for a minimum period of 10 years from contract completion.

The local currency element shall include all handling, local transport and delivery to a store or stores nominated by the Employer. Spares shall be handed over to the Employer as soon as they arrive on site, and shall be checked in the presence of the Employer's representative. The Contractor shall obtain a receipt for the material at the time of delivery to the Employer's stores.

Any spare material so ordered shall be strictly interchangeable with the parts which it is intended to replace, packed and treated in such a manner as to be suitable for storage in the climate at the Site for an indefinite period and each part shall be clearly marked for identification purposes, outside the package where applicable.

Schedules of spare materials in triplicate shall be handed over to the Employer arranged for the easy identification and checking of materials at the time of hand over. Prior to the handing over date for Contractor spares, the Contractor shall be responsible for all security arrangements and the safe custody of the spare materials.

In addition to the contract spares listed in Schedule of Price/BOQ the Contractor shall ensure that sufficient stocks of commissioning spares are available on site to enable the rapid correction of any defect discovered during site testing.

The provision of commissioning spares is the Contractors responsibility and the cost of these is to be borne by the Contractor. Contract spares are not be utilized as commissioning spares.

The Contractor shall submit to the Employers Representative, on a monthly basis, a complete schedule of the stock of commissioning spares available on site. In addition the contractor shall provide a monthly return on all items which have required replacement from the commissioning spares stock. The Employer or his Representative may require the Contractor to return any item of defective plant to the manufacturer for a report on the cause of failure.

7.6.12 Contractor's Local Agent

The Bidder shall state in his Bid the name and address in Bangladesh of his local Agent, if any.

7.6.13 Civil Works

7.6.1.13.1 Removal, Transport and Relocation of Existing Equipment.

Where it is necessary to move, dismantle, relocate, adjust, or rehabilitate any existing equipment in order to perform the work specified, the Contractor shall be responsible for performing this work and the cost is deemed to be included in the Contract Sum.

Where existing equipment is surplus to requirements the Contractor shall be responsible for the removal, dismantling, cleaning, coating with protective material to the Engineer's approval, packing and transporting the equipment to the Employer's stores.

Terminal Points

Cables within sub Switching station

Power and Multi-core Cabling between Equipment within Switching-station i.e. 33 kV, LV, dc, etc. cabling between equipment within Switching -stations shall be included in this Contract.

33 kV Outgoing Cables

The supply of cable boxes on the switchgear complete with cable lugs shall be provided under this Contract. The outgoing feeders from the 33 kV switchgears will not form part of this Contract unless otherwise specified.

7.6.1.13.2 Civil and Building Works

The civil works on this Contract shall include all demolishing, clearing, levelling, building, building services (small power, lighting, fans, fresh and foul water etc.) indoor and outdoor plant foundations, roads, concrete cable trenches and cable ducts within the site boundary repairing at all roads trenches.

7.6.14 Drawings, Diagrams and Calculations

7.6.1.14.1 General

The term "drawing" shall also include diagrams, schedules, performance curves and calculations etc., required for the comprehensive design of the works. The Contractor shall be responsible for the provision of all drawings required for the various stages of the Contract. All drawings, apart from workshop drawings, shall be submitted to the Engineer for his approval, in accordance with an approved programme. The Contractor shall ensure that drawings are submitted for approval in good time such that they may be approved within the specified period by the Engineer prior to the manufacture or construction commencing. Further adequate time must be allowed by the Contractor to permit any comments made by the Engineer to be incorporated. Any works performed prior to approval of drawings by the Engineer will be entirely at the Contractor's own risk including any delays that may result from modifications being found to be necessary by the Engineer.

The Contractor shall be fully responsible for obtaining any drawing or data of existing plant and installations that he requires in order to carry out the works, and shall also be responsible for verifying that any drawings of existing plant and installations are accurate. The Contractor shall provide suitable drafting and other staff on site that he requires investigating and producing any drawings that he requires of existing equipment and installations in order to carry out the works. Any cost associated with these requirements is deemed to be included in the contract price.

Where existing installations have been modified or extended the Contractor shall provide complete new sets of drawings. In this respect the Contractor shall provide drawings detailing both the existing and new works and shall not limit the scope of the drawings to the new works only.

7.6.1.14.2 Format

Drawings are to be submitted for approval on paper prints, folded to A4 size with the project title block and drawing numbers fully visible.

All drawings are to be submitted on "A" series paper to ISO/5457. The maximum size of drawings shall be A1 except for site survey and layout drawings which may be submitted as A0 size sheets, if necessary, to accommodate details on a scale of 1:100. Single line diagrams and schematic drawings shall preferably be on a maximum sheet size of A2. All dimensional drawings shall be to the following scales and fully detailed.

1:1, 1:2, 1:5, 1:10 and factors of 10 thereof.

Drawings symbols shall be in accordance with IEC 117.

All drawings are to be submitted in AutoCAD format in CDR Disk.

Drawing titles shall clearly identify the specific function of the drawings and where appropriate the name of the site(s) to which the drawing applies.

7.6.1.14.3 Drawing Numbering and Revisions

The Contractor shall be responsible for adding the Engineers drawing numbers to all drawings prior to submittal. Following award of the contract the Engineer and Contractor will review the numbering system, familiarize each other with requirements, and agree on the numbering system to be applied.

Comprehensive cross-reference are to be included on drawings and the Contractor shall include the Engineer drawing number in the cross-references.

At each and every issue of a drawing the revision shall be raised, and details given in revision boxes on the drawings. Comprehensive details of revisions are to be given and phrases such as "REVISED", "UPDATED", "MODIFIED" or similar are not acceptable.

Reference to any drawing in communications shall include the Engineer's drawing number.

7.6.15 Operating and Maintenance Manuals

7.6.1.15.1 General

The Contractor shall be responsible for compiling operation and maintenance (O&M) manuals for each section of the Works.

Drafts of the manuals are to be submitted to the Engineer at least six weeks prior to the commencement of pre-energisation commissioning checks on Site. Following examination the Engineer will forward copies of his comments to the Contractor to action prior to issuing Final O&M manuals. Final O&M manuals are to be available on site prior to the issue of Taking over Certificate.

Handling, installation, storage and transit instructions, in accordance with Clause 7 of BS 4884 part 1, which shall form part of the manuals, are to be available on site prior to the arrival of the Plant.

In addition to the compiled manuals, the contractor shall submit copies of brochures and other explanatory literature with drawings of the plant, which will assist the Engineer in approval of the drawings.

7.6.1.15.2 Contents

Operation and Maintenance manuals shall be prepared for the equipment supplied for substation. The content and presentation of the manuals shall conform in full with BS 4884 parts 1 and 2.

The O&M manuals are also to contain a complete drawing list appropriate to the individual section of the works. The drawing list shall include the Engineer's drawing numbers.

Maintenance instructions for all plant shall cover preventive and corrective maintenance procedures. For electronic or solid state control, protection equipment etc. details shall be provided to enable individual circuit cards to be checked for correct operation and faults to be traced, and repaired.

The Contractor shall provide proformas of the required maintenance record sheets for all plant, which shall include cross-reference to the appropriate section of the O&M manuals which detail how to perform the tasks required. Any other record sheets suitable for the monitoring of the plant shall also be designed and provided.

7.6.1.15.3 Binders, Presentation

The information will be provided on A4 pages, with diagrams on throw-clear pages where required to enable the text and diagrams to be refereed to simultaneously.

The front cover and spine of the manuals shall give the following information:

- Project Title
- Employer's name
- Contract number
- Identification of the Section of the Works
- Volume number and total number of volumes applicable
- (e.g. volume 3 of 5 volumes)
- Contractor's company logo and name

The above shall also be provided on a flysheet inside the front cover of each volume. Draft O&M manuals may be presented in unprinted covers.

Four copies of draft O&M manuals are to be provided to the Engineer; following approval 8 copies are to be provided to the Engineer or Engineer's site Representative for each section of the works.

7.6.16 Site Storage Facilities

The Contractor shall provide lockable cabinets in each of the individual substations, which are to contain the following:

(a) One set of paper prints of the complete record drawings for the section of the work. These shall be arranged in a logical sequence in accordance with the drawing list contained in the O&M manuals. Record drawings are to be grouped into labeled pockets or binders to minimize disturbance in locating specific drawings. As-built drawings are to be stored in these locations prior to the issue of record drawings.

(b) Two complete sets of O&M manuals

(c) Volumes of factory and site test reports/certificates

(d) Copies of maintenance log sheets, record sheets etc.

(e) Space for stationery an operators' log books

These cabinets shall match other furnishings being provided in the substation and the location as such items is to be included in the design of the substation layout.

7.6.17 Test Carried after erection

7.6.17.1 Electrical Equipment

7.6.17.1.1 General

A general check of all the main switchgear and ancillary equipment shall be made and shall include a cheek of the completeness, correctness and condition of earth connections, labeling, arcing ring and horn gaps, clearances, painted surfaces, cables, wiring, pipe work, valves, blanking plates and all other auxiliary and ancillary items. Checks shall be made for oil and gas leaks and that insulators are clean and free from external damage. A check shall be made that loose items which are to be handed over to the employer e.g. blanking plates, tools, spares, are in order and are correctly stored or handed over.

The following general tests are to be carried out on electrical equipment **after erection at site:-**

- Routine high voltage tests to the appropriate IEC Standard. Where no relevant standard exists, tests shall be agreed with the Engineer.
- Insulation resistance tests on all electrical equipment.
- Continuity and conductivity resistance tests.
- Test operation of alarm and tripping, devices to local and remote.
- Rotational tests on all motors.
- Polarity tests on CTs and VTs.
- Oil tests.
- Grounding system and electrode tests.
- Ratio, Vector Grouping and magnetizing current tests on each transformer.
- Calibration of winding and oil temperature devices.
- Vector group and phasing tests on VT Circuits.

- Magnetization current/voltage tests and winding resistance tests on all current transformers.
- Primary and secondary injection tests on relays, protection devices and equipment.

7.6.17.1.2 Circuit-Breakers

Circuit-breakers shall be given a visual inspection.

In the case of gas type circuit-breakers testing will be required on the gas system to prove the gas pressure, quantity, dryness and dielectric strength.

Contact resistance tests shall be carried out. In the case of multi-interrupter circuit-breakers resistance tests will be required at each interrupter or pair of interrupters as well as through the series of interrupters on each pole.

Operational tests shall include local and remote trip/close. Timing tests shall be carried out on all circuit-breakers, except those which are below 66kV and which are neither assembled at Site a nor have mechanically ganged pole operation.

Local air components associated with pneumatic operation, including air compressors, shall be tested and air loss measurements and pressure and alarm settings checked. Tests shall be made also on mechanical and hydraulic operation systems.

7.6.17.1.3 Disconnectors and Earth Switches

Manual operation of disconnectors and earth switches shall be subject to operational tests to confirm contact pressures, contact resistances, simultaneous operation of all phases and the ease of operation.

Motorised operation of disconnectors and earth switches shall be tested to prove the motor operation, including local and remote operation, and timing tests shall also be carried out. Motor protection shall be tested.

Checks shall be made on interlocks, local and remote indications and operation of auxiliary contacts.

Earth switches shall be tested to confirm the opening and closing sequences and checks shall be made on interlocks, indications and manual locking devices.

7.6.17.1.4 Busbars and Connections

Flexible busbars and connections shall be tested to ensure that the correct tensions, sags and clearances will be maintained over the range of environmental conditions and loads without stress to other equipment. If dynamometers are used to check the sags and tensions, they shall be checked both before and after use.

Rigid busbars and connections shall be tested to ensure that the busbars will not cause overloading of the supporting insulators under load conditions and under the range of climatic variations applicable to the site and that expansion and contraction of the equipment is fully accommodated by flexible connections.

Conductivity tests shall be carried out on all connections and joints which are made on site, without exception.

7.6.17.1.5 Earthing System

Tests shall be made on the effectiveness of the bonding and earthing which will include conductivity tests on selected joints, on the main earthing system, and at the connections to equipment and structures. Checks shall also be made on precautions taken to avoid corrosion attack on the earthing system.

Test probes at approximately 300 and 600 meters separation will normally be required to effectively test the earthing system. The use of transmission line conductors may be arranged to simplify test testing procedures.

The earth resistance shall be measured during the installation and on completion as follows:-

- Of each earth rod after driving
- Of the earth grid after completion and back-filling of the trenches

- Of each group of earth rods or earth point after completion of the connection from the test link terminal.
- Of the completed installation without any connections outside the substation

The tests shall be carried out by a method and with equipment approved by the Engineer. All tests are to be witnessed and the equipment and method used recorded with the test results.

The Contractor may also be called upon to provide assistance in the measurement of earth resistance after earth connections to the system have been completed.

7.6.17.1.6 Control Relays and metering Panels, Instruments and Protective Devices

(a) Wiring

After complete erection and cabling, all circuits shall be subjected to the high voltage test specified in the relevant IEC or approved standard.

The insulation resistance of all circuits shall be measured before and after any high voltage tests.

For AC secondary injection tests a substantially sinusoidal test supply shall be used.

The operation and resetting level (current and/or voltage) and timing of all relays shall be measured over an agreed range of settings for all relays.

For directional relays phase-shifting transformers shall be used to determine the maximum torque angle and the boundaries of operation/restraint.

Other relays shall be fully tested in accordance with the manufacturer's recommendations.

All DC elements of protection relays shall be tested for operation at 70% rated voltage.

All d/c supplies shall be checked for severity of current inrush when energized by switching on or inserting fuses or links.

(b) Mechanical Inspection

All panel equipment is to be examined to ensure that it is in proper working condition and correctly adjusted, correctly labeled and that cases, covers, glass and gaskets are in good order and properly fitting.

(c) General

Sufficient tests shall be performed on the relays and protection schemes to:

- Establish that the equipment has not suffered damage during transit.
- Establish that the correct equipment has been supplied and installed.
- Confirm that the various items of equipment have been correctly interconnected.

- Confirm performance of schemes designed on the bases of calculation e.g. differential protection.
- To provide a set of figures for comparison with future maintenance values allowing the condition of the equipment to be determined.

(d) Secondary Injection

Secondary infection shall be carried out on all AC relays, using voltage and current of sinusoidal wave form and rated power frequency to confirm satisfactory operation and range adjustment.

The polar characteristic of all distance protections shall be recorded at a minimum of 30 degree intervals.

For circulating current protection employing high impedance voltage operated relays, the points of injection for relay voltage setting tests shall be across the relay and stabilizing resistance.

The fault setting for the type of protection is to be established by secondary injection, where it is implacable to ascertain this value by primary injection. Injection is to be made across the appropriate relay bus wires with all associated relays, setting resistors, and CT's connected

(e) Primary Injection

All current operated relays shall be tested by injection of primary current to record the actual relay setting and as a final proof of the integrity of all secondary connections.

The stability of all differential schemes shall be checked by injection of primary current.

Primary current injection tests are to be carried out by the contractor and the methods employed for a particular installation are to be agreed with the Engineer.

Tests are to be carried out as follows :

Local primary injection to establish the ratio and polarity of current transformers as a group, care being taken to prove the identity of current transformers of similar ratio.

Overall primary injection to prove correct interconnection between current transformer groups and associated relays.

Fault setting tests, where possible, to establish the value of current necessary to produce operation of the relays.

(f) DC Operations

Tests are to be carried out to prove the correctness of all DC polarities, the operating levels of DC relays and the correct functioning of DC relay schemes, selection and control switching, indications and alarms. The correct functioning of all isolation links and fuses shall also be checked.

(g) Tests on Load

Tests on load shall also be done to demonstrate stability and operation of protection relays as required by the Engineer.

All tripping, control, alarm and interlocking circuits shall be functionally tested to prove satisfactory and full proof operation and/or resetting. The functional and safety aspects of all shorting and/ or isolation links, fuses and switches devices shall be proved.

The total burdens connected to all voltage transformer circuits shall be measured and recorded.

The total capacitance of all wiring and apparatus connected to the negative pole of each main tripping battery shall be measured and recorded; the value shall not exceed 10 microfarad.

The continuous current drain of all trip circuit supervision relays shall be measured and shall not be greater than half the minimum current required for tripping. The supervision current shall be measured with the circuit-breaker (or other device) both open and closed.

7.6.17.1.7 Batteries and Chargers

Tests shall be carried out on the batteries and chargers to confirm the charger ratings and adjustment, the battery and charger alarm systems and battery capacity.

The open-circuit cell voltages of the batteries when fully charged shall be recorded.

The insulation to earth of the complete DC installation shall be tested.

7.6.17.1.8 Power Cables

Each completed circuit shall be tested for continuity and insulation resistance.

7.6.17.1.9 Current Transformers

A Magnetization curve shall be obtained for each current transformer in order to:-

Detect damage in transit or installation

Prove that the correct cores have been wired out to the relevant terminals

For high impedance relay schemes, to confirm that correct relay settings have been calculated.

The DC resistance of each current transformer secondary winding shall be measured and also the transformers and connection leads, each item being recorded separately.

The insulation resistance of all secondary circuits shall be measured at 1000 volt and recorded.

Primary current injection tests shall be conducted on all current transformers using adequate primary current to prove correct ratio, polarity and, for differential protection schemes, to prove the correct relative polarities of all current transformers of each scheme.

7.6.17.1.10 Voltage Transformers

The transformer ratio and polarity shall be checked using a primary voltage high enough to give a clearly measurable secondary voltage or by using rated primary voltage and comparison with an already proven voltage transformer. The phasing and phase rotation shall be checked. For three phase voltage transformers a test shall be conducted to show that energizing each primary winding produces an output from only the correct phase secondary winding. The residual voltage of any open delta or broken delta winding shall be measured with rated primary voltage applied.

7.6.17.1.11 Control and Instrumentation Equipment

The following general tests shall be performed on control and instrumentation equipment at site.

High voltage testing of all circuits, as specified in the relevant IEC or approved standard.

Insulation resistance testing of all circuits.

Functional tests for all tripping, control, alarm and interlocking circuits.

The testing of all equipment in accordance with the manufacturer's instructions or as advised by the Engineer.

7.6.17.1.12 Transformers and Ancillary Equipment

The following tests shall be performed.

- Insulation resistance tests on bushings.
- Insulation resistance test at 500V between core and core clamping structure.
- Voltage withstand tests on insulation oil to BS 148.
- Ratio.
- Phase relationship
- Magnetization characteristics of current transformers of winding temperature devices.
- Calibration of winding temperature devices.
- Tap Selector and Diverter Switch alignment.
- Calibration of automatic voltage control equipment.
- Proving tests as necessary on control schemes.
- Measurement of winding resistance on all taps and phases.
- Where applicable the above tests shall also be carried out on Earthing Transformers.

7.6.18 Inspection Plan and Procedures

7.6.18.1 Measuring and Testing Equipment's

At prescribed intervals, or prior to each use, all measuring and testing equipment used in inspection shall be calibrated and adjusted against certified equipment having a known valid relationship to nationally recognized standards. Where no national standards exist, the basis employed for calibration shall be approved by the Engineer.

The manufacturer shall prepare a calibration schedule showing equipment type, identification number, location, frequency of checks, method of checking and action to take when results are unsatisfactory.

Each piece of equipment shall be labeled with its identification and current calibration status.

Calibration records for each piece of equipment shall be maintained at least for life of that piece of equipment and shall be available for examination by the Engineer.

7.6.18.2 Re-inspection Following Non-Conformance

If a non-conformance report is issued as Clause above or plant rejected Clause as in below, the Contractor shall reimburse the Engineer for all costs (including time costs, travel, accommodation etc.) for both attending discussions on remedial matters and any re-inspection that the Engineer may deem to be necessary.

7.6.19 Plant Performance

7.6.19.1 Guarantees

Bidders shall state and guarantee the technical particulars listed in the Schedules of Technical Particulars and Guarantees. These guarantees and particulars shall be binding and shall not be departed from without the written permission of the Engineer.

The Bidder shall further guarantee that all equipment supplied complies with the Contract Documents.

The tolerances permitted in the IEC or other Standard shall apply unless otherwise stated.

7.6.19.2 Rejection

If the guarantees are not met and/or if any items fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or during the maintenance period, the Engineer may reject the item, or defective component thereof, whichever he considers necessary, and after adjustment or modification as directed by the Engineer, the Contractor shall submit the item for further inspection and/or test. The repair procedure shall be to the Engineer's approval. In the event of a defect on any item being of such a nature that the requirements of this Specification cannot be fulfilled by adjustment or modification, such item shall be replaced by the Contractor, at his own expense to the entire satisfaction of the Engineer. Any item of plant repaired to an approved procedure shall not be accepted as a part of the Works as a permanent solution or replacement unless the Contractor guarantees in writing that the repaired plant or component shall have the same service life and efficiency as the component originally manufactured.

7.6.20 Site Pre-commissioning Checks and Commissioning Procedures.

7.6.20.1 General

The Contractor shall be responsible for the safe and efficient setting to work of the whole of the plant and equipment. The methods adopted shall be to the approval of the Engineer or his representative on Site, and shall be in accordance with any safety and permit regulations in force by the Employer on the Site.

At least two months before commencing the commissioning of any plant or equipment, the Contractor shall submit for approval fully comprehensive schedules of pre-commissioning checks as applicable to each item of the plant and equipment provided. These schedules shall then be used during pre-commissioning as a guide to the methods to be followed and to record the actual activities carried out with the appropriate date, together with details of all work yet to be completed, variations and modifications to design conditions.

In addition the Contractor is to submit with the schedules to the Engineer's representative proforma test sheets (to be used by the Contractor during testing and commissioning) for all tests he proposes to carry out and those required by the Engineer's Representative.

Each activity on the schedules, when completed to the satisfaction of the Engineer's Representative, shall be signed and dated by the Contractor. The schedules shall be countersigned by the Engineer's Representative as necessary. If during the performance of the pre-commissioning checks the Engineers representative considers that additional tests are necessary to prove the system or plant the Contractor shall perform such additional tests to the Engineer's satisfaction.

The Contractor shall also submit for approval schedules of commissioning procedures that the proposes to follow when bringing into service groups of plant items during the commissioning period. These schedules shall detail the tests necessary to ensure the complete and satisfactory commissioning of each section of plant and shall detail all operational limitations. The schedules shall be used during commissioning which shall only commence when the relevant pre-commissioning check schedules have been completed.

Each activity on the commissioning procedure schedules when completed to the satisfaction of the Engineer's Representative, shall be signed and dated by the Contractor and shall be countersigned by the Engineer's Representative as necessary.

The commissioning procedures shall ensure that the commissioning of any section of the Works does not interrupt the normal commercial operation of any previously commissioned section(s).

21 days prior to commencing commissioning checks the Contractor is to agree with the Engineer's Representative the method and sequence of performing the commissioning tests. Following agreement the Contractor shall submit a detailed program indicating the testing

sequence to permit advance notice to be given to the Employer in order that the Employer's Representatives may also witness testing if so desired.

When the commissioning of each section of the Works is complete the Contractor shall carry out such preliminary tests as are necessary to establish that the plant is functioning correctly and efficiently, and shall make any adjustments required.

The Contractor is to supply all test equipment, tools chemicals, lubricating oils and greases and other materials required for the aforementioned operations.

For the purposes of this Contract, the provisions of this section will apply to plant supplied from nominated subcontractors.

7.6.20.2 Contractor's Site Supervisory Staff

During the commissioning and subsequent testing of any item of plant the Contractor is to provide for the services of any special supervisory staff necessary for the purpose of ensuring proper commissioning and the satisfactory completion of all tests. The cost of such services is deemed to be part of the Bided price for Erection of Plant.

7.6.20.3 Commissioning of Modified Circuits

Where the scope of works has included the diversion, relocation or variation of any existing circuit the Contractor is deemed to have included for all pre-commissioning checks on existing equipment. Where this work includes overhead line or cable circuits the Contractor is responsible for carrying out full pre-commissioning and on-load checks at the remote end of the circuit including the injection testing and re-setting of relays if required.

All and any such work associated with the re-commissioning of existing equipment is deemed to be included in the contract price.

Test Equipment

The Contractor is responsible for providing all equipment, power, etc. necessary to carry out all tests on site. Following award of contract the successful Contractor shall submit a detailed schedule of the test equipment etc., he intends to provide for carrying out this portion of the Works. Should the Engineer require additional or alternative test equipment to be provided to enable full site testing to be performed in accordance with the requirements of the Specification the Contractor shall supply such equipment at no extra cost.

7.6.21 Civil and Building Works

Where items of mechanical plant are mounted on foundations, which are part of the civil engineering works, the Contractor shall carry out suitable leveling and adjustment of the plant on the foundations, before the plant is secured in position. The Contractor shall check the alignment, leveling or positioning of the mechanical plant in question, before and after grooving. The Contractor shall make records of the alignment, leveling or positional measurement and shall maintain such records until his activities at site are concluded.

The building steel work shall be designed to carry the loads/forces imposed by pipe work, cables and associated fittings which also form part of the works, and all necessary supports and fixing shall be shown on the relevant drawings.

Such supports and fixings may be secured to the steel work by bolting welding or clamping.

No other supports or fixings shall be subsequently attached to the steel work nor may any other drilling, cutting or welding be carried out without the prior permission of the Engineer.

7.6.22 Design and Construction Requirements and Interchangeability

7.6.22.1 General Requirements

- The Works shall be designed to operate safely, reliably and efficiently in accordance with the Design and Operating Requirements stated in this Specification.
- No departure from the Specification shall be made subsequent to the Contract without the written approval of the Employer.
- The design shall conform to the best current engineering practice. Each of the several parts of the Plant shall be of the maker's standard design, provided that this design is in general accordance with the Specification.
- The design, dimensions and materials of all parts shall be such that they will not suffer damage as a result of stresses under the most severe service conditions. The materials used in the construction of the Plant shall be of the highest quality and selected particularly to meet the duties required of them. The plant shall be designed and constructed to minimize correction. Workmanship and general finish shall be of the highest class throughout.
- All plant items and corresponding parts forming similar duties shall be interchangeable in order to minimize the stock of spare parts.
- All equipment shall be designed to minimize the risk of fire and damage which may be caused in the event of fire.

7.6.22.2 Specific Requirements

- The choice of plant and design of the installation is to meet the following criteria.
- Switching -station layouts are to utilize the minimum of land area.
- All equipment is to facilitate the installation of all circuits indicated as "future" with the minimum of disruption. All cabling schemes, D.C. and A.C. equipment etc. shall be designed to accommodate all such future circuits, loads, etc.
- The plant and installation shall be designed for a minimum service life of 25 years.
- All plant is to have a minimum of 2 years satisfactory and proven service record of high durability and reliability in a similar environment. Documentary evidence in support of the choice of any item of plant will be provided by the Contractor if requested by the Engineer.
- Each Switching -station is to be designed such that the failure or removal of any one item of plant for maintenance or repair shall not impair the operational integrity of the sub-station.
- The design and layout of the sub-stations shall ensure the safety of personnel concerned with the operation and maintenance of the plant.

7.6.23 Units of Measurement

The Contract shall be conducted in the Systems International 'Units (SI) system of units in accordance with the provisions of ISO 31 and ISO 1000.

7.6.24 Plant and Equipment Indentification

7.6.24.1 Identification on Drawings

The Contractor shall prepare comprehensive Plant or Equipment identification Schedules. The Schedules shall include the respective flow sheet or Drawing/Diagram identification Numbers.

7.6.24.2 Labels and Nameplates

- The Contractor shall supply and install all labels, ratings, instruction and warning plates necessary for the identification and safe operation of the Works.
- Nameplates of labels shall be non-hygroscopic material with engraved lettering of a contrasting colour or, alternatively in the case of indoor circuit-breakers, starters, etc. of plastic material with suitably coloured lettering engraved thereon.
- All the above labels and plates shall be securely fixed to items of plant and equipment with stainless steel rivets, plated self tapping screws or other approved means. The use of adhesives will not be permitted.
- The language of labels, plates and notices shall comply with the requirements of the Contract.
- Individual plant items and all relevant areas within the contract works where a danger to personnel exists shall be provided with plentiful, prominent and clear warning notices.
- These warning notices shall draw attention to the danger or risk with words which attract attention and summarize the type of risk or danger. The notices shall also carry a large symbol which graphically depicts the type of risk.
- All equipment within panels and desks shall be individually identified. The identification shall correspond to that used in schematic and wiring diagrams.
- Each circuit breaker panel, electrical control panel, relay panel etc., shall have circuit designation label mounted on the front and rear. Corridor type panels shall additionally have circuit designation labels within the panels.
- All equipment and apparatus mounted there on shall be clearly labeled in an approved manner. The function of each relay, control switch, indicating lamp, MCB, link etc. shall be separately labeled.
- The Contractor shall be responsible for the relocation, or replacement of all labels on existing plant, which became inaccurate as a consequence of the contract works.

7.6.25 Safety and Security

7.6.25.1 Interlocks

- A complete system of interlocks and safety devices shall be provided so that the following requirements and any other condition necessary for the safe and continuous operation of the plant are provided:
- Safety of personnel engaged on operational and maintenance work on the plant.
- Correct sequence of operation of the plant during starting up and shutting down periods.
- Safety of the plant when operating under normal or emergency conditions.
- Interlocks shall be preventive, as distinct from corrective in operation.

- Where plant supplied under this Contract forms the whole or a part of a system for which one of more interlocking schemes are required, the Contractor shall be responsible for all interlocking schemes for the Engineer's approval. General descriptions of interlocking requirements are given in the Specifications but the Contractor shall include for any other interlocks he considers necessary.

7.6.25.2 Locks, Padlocks, and Key Cabinets

- The Contractor shall provide padlocks, locks, chains or other locking devices for the locking of all equipment cubicles, electrical isolating switches, selector switches, valves, etc. to the approval of the Engineer.
- All locking devices and chains shall be manufactured from corrosion resistant material. All mechanisms shall be provided with a cover to minimize entry of water or dust.
- Locks shall conform to a master keying feature system to be agreed with the Engineer for groups of equipment.
- All locks shall have individual high integrity locks and shall be provided with (two) keys.
- Each key shall be provided with a label as specified.
- The Contractor will supply and fit key cabinets equipped with labelled hooks, each Identified with its appropriate key. Every cabinet shall be provided with a nameplate identifying the cabinet with its respective item or items of plant. Sufficient cabinets will be provided to store all keys supplied under this Contract and cater for future extensions.
- The Contractor shall provide comprehensive lock and key schedules to readily permit identification with equipment and doors. Such schedules are not required for loose padlocks.
- Where modifications are performed to existing sites the Contractor shall provide a system identical to that existing.

7.6.26 Spare Parts

7.6.26.1 Commissioning Spares

In addition to the spare parts being provided for the Employer, the Contractor is responsible for ensuring that he has access to a stock of commissioning spares. Spares provided for the Employer are not to be utilized as commissioning spares, without written approval, in which case the Contractor shall immediately replace the contract spare at his own expense.

All commissioning spares are considered as Contractors equipment.

7.6.27 Consumable Items

7.6.27.1 Chemicals and other Consumable

The Contract includes for the provision of all chemicals, resins, and other consumables required for testing, commissioning and setting to work of each section of the works.

Unless otherwise stated, the Contractor shall provide all such chemicals and other consumables required for the efficient operation and maintenance of the plant at full load 24 hours per day for a period of 12 months for each section of the works from the date of the final certificate.

The Contractor shall prepare a list of these consumables giving quantities necessary for each section of the works and the recommended suppliers.

7.6.28 Painting and Cleaning

- Immediately following the award of a Contract, the Contractor shall submit the names of the proposed paint supplier and applicator together with a quality assurance program for approval. All paints for a contract shall be provided by one manufacturer and preferably shall be manufactured in one country to ensure compatibility
- The painting of the plant shall be carried out in accordance with the appropriate schedule. The work is generally covered by the schedules but where particular items are not referred to specifically, they shall be treated in a manner similar to other comparable items as agreed with the Engineer.
- The schedule indicate standards of surface preparation and painting which is intended to give a minimum service life of 10 years in a coastal industrial environment, with need for minor remedial work only during the intervening period.
- Steel sections and plate shall be free from surface flaws and laminations prior to blast cleaning and shall not be in worse condition than Pictorial Standard B, Swedish Standard SIS 05 5900.
- The Engineer is prepared to consider alternative paint schemes to meet the requirements of fabrication using modern automated materials handling systems, provided they offer the same standards of surface protection and service life as those intended by the schedules.
- All paints shall be applied by brush or spray in accordance with the schedule, except for priming coats for steel floors, galleries and stairways where dipping is permitted.
- Where paint is to be applied by spray, the applicator shall demonstrate that the spray technique employed does not produce paint films containing vacuoles.
- Where paint coatings are proposed for the protection of surfaces of equipment exposed to corrosive conditions, such as plant items exposed to brines or sea water immersion in liquid, or wet gases, the coatings shall be formulated to the suitably corrosion resistant and shall be high voltage spark tested at works and/or at Site prior to commissioning. The test procedure shall be based on the use of a high voltage direct current. The voltage used shall be 75% of the breakdown voltage of the coating. This breakdown voltage shall first be separately determined using test plates coated with the specified coating formulation and thickness. The coating on the test plate shall also be micro-sectioned by the applicator to show that it is free from vacuoles and other defects likely to invalidate the test procedure.
- If the defects revealed by the above test procedure do not exceed one per 5 m^2 of coating surface, the coating need not be re-tested after the defects have been repaired. If the defects exceed one per 5 m^2 of coating surface, the repairs shall be resettled after any curing is completed, and this procedure shall be repeated until the defects are less than one per 5 m^2 of coating surface. After repair of these defects, the equipment can be placed in service without further testing.

- All coating proposed for the internal protection of domestic water storage tanks and WZPDCL lination plants shall be certified by an approved independent Authority as suitable for use in potable water installations and shall meet the non-painting requirements of BS 3416.
- All plainshed and bright parts shall be coated with grease, oil or other approved rust preventive before dispatch and during erection and this coating shall be cleaned off and the parts polished before being handed over.
- Where lapped or butted joints form part of an assembly which is assembled or part assembled prior to final painting, the jointed surfaces shall be cleaned free from all scales, loose rust, dirt and grease and given one brush applied coat of zinc phosphate primer before assembly.
- Paint shall not be applied to surfaces which are superficially or structurally damp and condensation must be absent before the application of each coat.
- Painting shall not be carried out under adverse weather conditions, such as low temperature (below 4^0C) or above 90% relative humidity or during rain or fog, or when the surfaces are less than 3^0C above dew point, except to the approval of the Engineer or his duly appointed representative.
- Priming coats of paint should not be applied until the surfaces have been inspected and preparatory work has been approved by the Engineer or his duly appointed representative.
- No consecutive coats of paint, except in the case of white, should be of the same shade. Thinners shall not be used except with the written agreement of the Engineer.
- On sheltered or unventilated horizontal surfaces on which dew may linger more protection is needed and to achieve this additional top coat of paint shall be applied.
- The schedules differentiate between 'Treatment at Maker's Works' and 'Treatment at Site after Completion of Erection' but the locations at which different stages of the treatments are carried out may be modified always providing that each change is specifically agreed to by the Engineer and the painting is finished at Site to the Engineer's satisfaction.
- All paint film thickness quoted are minimum and refer to the dry film condition. All thickness shall be determined by the correct use of approved commercial paint film thickness measuring meters.
- The Contractor shall ensure that precautions are taken in packing and crating to avoid damage to the protective treatment applied before shipment, during transport to the site.
- Structural bolts shall be galvanized, sheradised or cadmium plated and painted as for adjacent steelwork.
- All structural timber that does not require to be painted (timber joists, flooring, etc) shall be treated with two coats exterior grade approved timber preservative.
- The requirements of this clause and the schedules shall be interpreted in accordance with the requirements and recommendations of BS 5493 and CP 231, 3012 and the paint manufacturer's special instructions where applicable.
- Colour shall be in accordance with BS 1710 and BS 4800 or equivalent material standards.

7.6.29 Galvanized Work

All galvanizing shall be carried out by the hot dip process (and unless otherwise specified, shall conform in all respects with IEC's).

Attention shall be paid to the detail of members, (in accordance with IEC's). Adequate provision for filling venting and draining shall be made for assemblies fabricated form hollow sections. Vent holes shall be suitably plugged after galvanizing.

All surface defects in the steel, including cracks, surface laminations, laps and folds shall be removed (in accordance with IEC's). All drilling cutting, welding, forming and final fabrications of unit members and assemblies shall be completed before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from welding slag, paint, oil, grease and similar contaminants.

The coating shall be as specified in BS 720 or equivalent National standard. Structural steel items shall initially grit blasted to BS 4232, second quality (SA2.5) and the minimum average coating weight on steel sections 5 mm thick and over shall be as specified in the table below:

THICKNESS OF STEEL SECTION WEIGHT (mm)	THICKNESS OF SIZE AVERAGE COATING (microns)	MINIMUM COATING (g/m^2)
5	80 – 90	600
10	100 – 120	750
20	120 – 150	900

With intermediate values on a pro rata basis.

On removal from the galvanizing bath the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare stops, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be jointed by high strength friction grip bolts shall be roughened before assembly so that the required slip factor (defined in BS 3294. Part BS 4606 part 1 and I) is achieved, care shall be taken to ensure that the roughening is confined to the area of the faying surface.

Bolts, nuts and washers, including general grade high strength friction grip bolts (referred to in BS 3139 and BS 4395 part 1) shall be hot dip galvanized and subsequently centrifuged (according to BS 729). Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of a galvanized high strength friction grip bolt after the bolt has been inserted through the steelwork shall be allowed to come into contact with the faying surfaces.

During off-loading and erection, nylon slings shall be used. Galvanized work which is to be stored in works on site shall be stacked so as to provided adequate ventilation to all surfaces to avoid wet storage staining (with rust).

Small areas of the galvanized coating damaged in any way shall be brought to the attention of the Engineer who shall authorize repair by:

Cleaning the area of any weld slug and though wire brushing to give a clean surface.

The application of two coats of zinc rich paint or the application of low melting point zinc alloy repair rod or power to the damage area, which is heated to 300° C.

After fixing, bolt heads, washes and nuts shall receive two coats zinc rich paint.

7.6.30 Mechanical Items

All screw threads shall be of the ISO metric form and the diameters and pitch of thread for all bolts studs and nuts shall conform to the ISO Standards as stated in BS 3692 or BS 4190 or equivalent National Standard.

It is recognized that in a number of applications such as instrument, machine components and pipe, other thread forms may be used.

7.6.30.1 Pipe work

All piping shall be designed, manufactured and tested in accordance with British Standards or equivalent Nationals Standards approved by the Engineer. In particular, pipework should meet the requirements of the following standards or their equivalents. Dimensions shall comply with Table 1 of BS 1600. The minimum wall thickness of carbon steel pipes excluding any allowance for corrosion shall be as shown in British Standards:

DIAMETER	MINIMUM WAL THICKNESS
0 - 100 mm	Table 2 BS 1387:1967
150 - 200 mm	4.87 mm
250 - 600 mm	6.35mm

Drains and air vents shall be provided as required by the physical arrangement of the pipe work and shall be via valves with the drain and vent pipe work led to drain points to the approval of the Engineer.

Screwed pipe work systems shall be provided with adequate unions to enable valves and fittings to be removed if required with minimum disturbance to the rest of the pipe system.

7.6.30.2 Bolts, Studs, Nuts and Washers

All bolts, and nuts shall conform dimensionally to the requirements of BS 3092 or BS 4190 or equivalent National Standard.

The Material of all bolts, studs and nuts for piping systems shall conform to the requirements of BS 4505 or equivalent National Standard.

The threaded portion of any bolt or stud shall not protrude more than 1.5 threads above the surface of its mating nut.

When fitted bolts are used they shall be adequately marked to ensure correct assembly.

Bolts, nuts, studs and washers in contact with sea water or used on pipe work systems containing sea water shall be of the same material as flanges etc.

The use of slotted screws shall be avoided; hexagon socket screws or recessed type heads being preferred.

7.6.31 Metal Clad Bus-Bars and Connections

Bus-bars and connections shall comply with BS 159 and shall be electrolytic copper, unless otherwise agreed with the Engineer.

The bus-bars, assembles and connections of equipment for services up to 33 kV shall be of a type which does not rely solely on air for insulation purposes. The covering material shall be non-deteriorating at the rated short-time maximum temperature of the bus-bars and shall have such thickness as is required to withstand rated line to line voltage between bus-bar and a conducting object on the exterior of the covering material for a period of not less than 60 seconds.

The bus-bars and their connections, and insulation materials as appropriate shall be capable of withstanding, without damage, the thermal and mechanical effects of a through fault current equivalent to the short-time rating of the switchgear.

Facilities to the approval of the Engineer shall be provided to accommodate thermal extension of the bus-bars and associated components including the insulating medium if appropriate.

Bus-bars shall be contained in a separate compartment within the general casing of switchgear. Bus-bars barriers shall be provided between switchgear equipment to prevent the spreading of ionized gases in the event of a fault.

Access to bus-bars and the connections directly connected thereto shall be gained only by the removal of covers secured by bolts or screws. Such covers shall be clearly and indelibly marked "DANGER-BUSBARS".

Bus-bars shall be extensible at both ends, such extension shall entail the minimum disturbances to bus-bar compartments.

Bus-bars shall be of uniform cross-sectional area throughout their length.

7.6.32 Insulators and Bushings

Porcelain or glass insulators and bushings shall comply with the requirements of IEC 168, IEC 137, IEC 305, IEC 273, IEC 433 and IEC 815.

Porcelain for insulating purposes shall comply with the requirements of BS 1598 Each porcelain insulator shall bear the manufacturers mark and batch identification, which shall be applied before firing. The clamping surfaces of all porcelain insulators shall be accurately grounded and shall be free of glaze.

Insulators and bushings shall satisfy the test requirements of IEC 168-Post, IEC 233-Hollow, IEC 383-Overhead Line. The design of insulators shall be such as to minimize radio interference (RFI), and tests will be required as proposed in IEC 437 or equivalent to limit RFI to CISPR or CCITT recommended limits, or equivalent National Standards or Regulations.

Insulators and bushings of organic moulded or resin-bonded material shall comply with the requirements of IEC 660 as appropriate. They shall have a durable non-hygroscope surface finish with a high anti-tracking index. Precautions shall be taken during manufacture and assembly of insulators of this type to exclude all moisture.