

**EMPLOYERS REQUIREMENT FOR  
MECHANICAL & ELECTRICAL WORKS**

**CHAPTER 03  
GENERAL TESTING, INSPECTION, COMMISSIONING AND  
TRAINING REQUIREMENTS**

## CHAPTER 03

# GENERAL TESTING, INSPECTION, COMMISSIONING AND TRAINING REQUIREMENTS

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## **CHAPTER 03**

### **MATERIAL & WORKMAN SHIP**

### **GENERAL TESTING, INSPECTION, COMMISSIONING AND TRAINING REQUIREMENTS**

#### **3.1. Work Testing - General**

The Contractor shall offer all items of Plant for inspection examination and witness testing by the Employer. In such cases the Contractor shall give the Employer four weeks' notice that the equipment is ready for tests.

The Contractor shall carry out tests as stated in the current appropriate British Standards, performance tests and such other tests as specified or as necessary. Where witness tests are not required the test certificate and performance curves shall be forwarded to the Employer. On each test certificate and performance curves sufficient information shall be given for ready identification of the material or equipment to which the certificate refers. Inspection or passing by the Employer of the Work, Plant or materials covered by the Contract, whether carried out or supplied by the Contractor shall not release the Contractor from any of his obligations under the Contract.

The Employer reserves the right to require the Contractor to meet any extra costs which are occasioned by failure of the Contractor to comply with the above testing and inspection requirements including the provision of test certificates, curves, sub-orders, etc. or which in the opinion of the Employer are due to insufficient care having been taken by the Contractor before presenting the Plant for inspection or test. If unauthorized delivery has taken place, the Contractor may be required to arrange for the Plant to be returned to the manufacturer for inspection and/or witness testing or even replacement at the Contractor's expense.

Any equipment used in the testing of the Plant shall in all respects comply with the appropriate safety regulations and/or requirements regarding electrical apparatus for the safety of the Plant and the men working thereon.

The Contract price shall include the costs of all works, tests, including temporary erection, labour, materials, instrumentation, stores, fuel and power used, as may be required during all inspections and tests and for the provision of certified records and curves.

#### **3.2. Test instruments**

The manufacturer shall ensure the accuracy of all the instruments used for the tests and if required shall produce recent calibration tests, or otherwise have them calibrated at his own expense by an independent authority.

Kilowatt hour meter shall be checked for correct calibration and creep tests shall be carried out to ensure that the meter is in-operative with voltage alone if the secondary current transformer is left connected with the primary current interrupted.

### **3.3. Test certificates**

Test certificates shall be provided giving a detailed record of all electrical and mechanical tests carried out on the equipment and material including lifting equipment, pumps, motors, valves, cables and cabling etc. both in the manufacturer's works and at site.

Copies of certificates of all works, hydraulics tests shall be provided.

The Contractor shall submit to the Employer within two weeks of completion of any witness tests, test certificates and curves of all items certifying that they have been satisfactorily tested.

Copies of test certificates of major items shall be included in the Operating and Maintenance Manuals.

### **3.4. Hydraulic Works Tests**

All equipment subject to water pressure including pumps, pipes, fittings and valves shall be hydraulically tested to the pressure where specified or to at least 1.5 times the maximum working pressure or to 1.5 times the closed valve pressure, whichever is the highest.

### **3.5. Works Inspection, test and guarantee**

All the schedules shall be completed with the guaranteed particulars and efficiencies of the equipment offered at the duties specified and these will be binding and may not be varied.

Witness testing to the relevant standards and to prove guarantees given may be required for the following items:

- Pumps
- Valves
- Screening equipment
- Electric motors
- Control / switchgear panels
- Cranes and lifting equipment
- Control, measuring, indicating, instruments and alarms
- Electrical measuring instruments and meters
- Alarm systems

The Employer may at his discretion require witness testing of items not included in the above list.

Where items of equipment are of identical size and duty, it may be required at the discretion of the Employer that a reduced number of items be subjected to witness tests. However, this shall not relieve the Contractor from the requirement of carrying out performance tests on all items.

If after inspection, examination or testing, the Employer decides that any material or equipment is not in accordance with the Specification or performance requirement, he shall reject the said item and the Contractor shall replace and retest the item at his own cost.

As and when the Employer is satisfied that the equipment has passed the required tests he shall notify the Contractor in writing to that effect.

### **3.6. Pumps and pump sets**

One pump of each type shall be tested in accordance with Part 2 of BS 5316. Site conditions shall be fully simulated, including the minimum site Net Positive Suction Head (NPSH) condition and site suction pipework configuration.

Pump shall be tested with the tested and certified Contract motor including intermediate shafting, as required.

Pump shall be tested at the guaranteed duty point and over its full working range from closed valve condition to 10% in excess of the minimum head. Duty head / quantity curves, power / quantity and overall efficiency/quantity and NPSHr /quantity curves shall be plotted to demonstrate that the Plant will be capable of meeting the operating conditions at Site. Efficiency of the pump and the overall pump sets wire efficiency shall be established on test.

Pump shall be dismantled after test and inspection carried out to confirm the satisfactory condition of all parts prior to dispatch to Site.

The results of the above tests on pumps, motors and drives will be used by the Employer to determine whether each pump set has achieved the performance guarantees. If a pump set fails to achieve the guaranteed performance, the Contractor shall carry out such further works as he considers necessary and shall arrange for tests to be repeated. This procedure shall be continued until the pump set performs as guaranteed or the pump is rejected.

### **3.7. Valves**

All valve bodies shall be hydraulically tested closed ended to 1.5 times the rated pressure. All isolating valve seats shall be tested to the maximum working pressure, at which pressure they shall be drop tight. Each valve shall be tested for functional operation with its own actuator.

### **3.8. Cranes and lifting equipment**

The cranes and lifting equipment shall be assembled and tested in the manufacturer's works to 50 percent above the rated load and test certificates provided.

Full functional tests of all crane motions shall be demonstrated with the crane carrying the maximum working load. All mechanical and electrical equipment shall be shown to operate smoothly within rated capacity. A deflection test in accordance with BS 4666 shall be carried out.

### **3.9. Motors**

Electric motors shall be individually tested off-Site to IEC 60034 & BS 4999: Part 143, at work test ambient temperature at the machine frame power output–rating after application of de-rating factors for Site temperatures, duty factor and Site power supplies. Verification of guaranteed efficiencies and power factor shall be carried out using the de-rated power output application on Site, which shall be nameplate rating. Motors of 5.5 kW rating and over shall each be subjected to full ‘Basic’ tests, and in addition to noise level tests to BS 4999 Part 109, except that where two or more identical motors are being provided under the Contract. One motor shall be subjected to full ‘Basic’ tests and the remainder subjected to ‘Duplicate’ tests. Motor under 5.5 kW rating shall each be subjected to ‘Duplicate’ tests providing that a Type Test Certificate for full ‘Basic’ test and noise level test to BS 4999: Part 109 of a similar motor is available. Where no such Type Test Certificate is available, testing shall be as follows for motors with rating of 5.5 kW and over.

Type test certificate shall include the following minimum information and shall be provided for all motors:

- a. Manufacture standard
- b. Class of insulation
- c. Type of cable fittings
- d. Type of bearings, sizes and lubricants
- e. Type and rating of heaters
- f. Brush sizes and maker (if fitted)

### **3.10. Low and medium voltage switching devices**

Low and medium voltage switching devices shall be subjected to Routine Tests in accordance with the following standards:

#### **a. Low voltage devices**

- (1) Low voltage circuit breakers shall be tested in accordance with IEC 60947 Part 2.
- (2) Miniature circuit breakers shall be tested in accordance with IEC 60898
- (3) Low voltage air-break switches and fuse-combination units shall be tested in accordance with IEC 60947 Part 3.
- (4) Low voltage contactors shall be tested in accordance with IEC60947 Part 1.

#### **b. Medium voltage devices**

- (1) Medium voltage circuit breakers shall be tested in accordance with IEC 62271 Part 4. Medium Voltage switches shall be tested in accordance with IEC 60265
- (2) Medium voltage contactors shall be tested in accordance with BS 775, Part 2.
- (3) Medium voltage direct-on-line starters shall be tested in accordance with IEC-60632 – 1.

- (4) All medium Voltage switching devices of current rating 100 A or greater shall be subject to measurement, at the main terminals of each pole with the contacts fully closed of dc voltage and current (at 100A or greater).

The values of resistance for any two similar examples from a particular manufacturer range shall not differ by more than 2%.

### **3.11. Switchboards and motor control centers**

Factory built assemblies of low voltage switchgear and control gear shall be subject to Routine Tests in accordance with IEC 60439.

Medium voltage metal enclosed switchgear and control gear shall be subject to Routine Tests in accordance with IEC 62271

Additionally low voltage and medium voltage switchgear and control gear assemblies shall be tested for the following:

#### **a. Measurements of main circuit resistance**

The resistance of each pole of each main circuit from the cable terminal to bushes with all intervening switch contacts fully closed shall be measured and recorded. A similar measurement and record shall be taken along the length of each bus-bar with bus-section switch contacts fully closed. The tests shall comprise of the measurement of dc voltage and current (at 100A or greater) and calculation of resistance.

#### **b. Interchangeability**

All components of the same rating and construction, designated as draw-out or plug-in shall be demonstrated as being interchangeable.

#### **c. Protection and control circuits**

For all forms of current transformer protection, the following information shall be made available to the Employer before the time of Inspection:

- (1) Current transformer magnetizing curve
- (2) Recommended relay setting
- (3) Calculated primary operating current at this setting
- (4) Calculated through-fault stability values where applicable
- (5) Values of any stabilizing and setting resistors employed in the system

As far as possible, the satisfactory operation of associated control and protection circuits shall be proved by the following tests:

- (1) To ensure the correct operation of all current operated protection relays and direct acting coils at the recommended setting by primary current injection.

- (2) To ensure the correct polarity between current and voltage elements of power relays, meters and instruments.
- (3) To ensure the correct operation of dc operated auxiliary protection relays, such as Buchholz protection relays at normal operating voltage by simulated operation of associated remote relays.
- (4) To ensure the correct operation of control circuits at normal operating voltage by operation of local control switches and simulation of operation from remote control positions

**Note:** Checking the operation of all protection relays and control circuits shall be carried out with all closing and tripping circuits energized at their normal rated voltage.

#### **d. Instrument and metering equipment**

Indicating Ammeter shall be checked for calibration at 0.25, 0.5 and full scale deflection by primary current injection testing.  
Indicating voltmeters shall be checked for normal voltage readings by secondary voltage application.

Where possible, integrating kWh meters shall be tested for correct operation. Tests shall be carried out to ensure that the meter is in-operative with voltage alone, with the secondaries of current transformers connected and the primary current interrupted.

All instruments shall be subject to the manufacturers normal work tests.

### **3.12. Cables**

All cables shall be subject to routine tests in accordance with the relevant Standard Specification.

Test certificates shall be provided against each drum and / or cable length.

The tests carried out on every cable length and / or drum at manufacturer's premises shall include:

- a. High voltage DC insulation pressure test, between cores, each core to earth, metallic sheath or armor as applicable.
- b. Insulation resistance test.
- c. Core continuity and identification
- d. Conductor resistance test

### **3.13. Process, control and indicating instruments**

All flow, level and process measurement controllers, transmitters, recorder, indicators, vacuum and pressure gauges shall be subject to routine tests in accordance with BS 88, BS 1780 and BS3680.

Test certificates shall be provided against each item of equipment.



### **3.14. Electrical measuring instruments and meters**

Tests to ensure accurate operation of all meters, Voltmeters and KiloWatt hour meters shall be undertaken in accordance with BS 89 and BS 37.

### **3.15. Alarm system**

The Contractor shall test all items of equipment comprising the alarm system for correct operation and sequence action.

### **3.16. Site testing**

#### **3.16.1. Co-ordination of Site testing program**

The Contractor shall be responsible for coordinating the program of Site testing of all items and to ensure that all parties concerned are present during any tests to obligate their responsibilities.

#### **3.16.2. Cable test during installation**

During the period of Site installation, the Employer will carry out inspection of the works to ensure that the standard of workmanship meets the Specification. In the event of any part of the cabling installation failing to meet the requirements, the Contractor shall remedy the deficiency to the satisfaction of the Employer.

The Contractor shall:

- a. Inform the Employer prior to the testing of the cables and shall be responsible to liaising with any other party to whose equipment the cables may be terminated to ensure that all parties concerned are aware of the impending tests, to guarantee the safety of personnel and that the isolation of any equipment has been completed. Any special isolation or preparation required to be carried out before cable testing will be carried out by the party responsible for equipment. All tests shall be carried out by the Contractor but shall be supervised by the Employer.
- b. Provide high voltage dc test equipment and conduct the high voltage dc test (with necessary isolations and safeguards) at specified voltage in accordance with relevant standards between cores, cores and sheath & cores and armor as applicable on power cables installed on power systems.
- c. Demonstrate correct phasing out of cores in all cables throughout the works and test the insulation of all cables, both between the cores and between the cores and earth, during installation with a "Megger" 500 Volt hand generator.
- d. Conduct soil resistivity tests in the presence of the Employer to obtain the most suitable location for the earth electrode system.
- e. Demonstrate to the Employer that the resistance of the earth electrodes to earth conductor continuity and earth installation is in accordance with the specified requirements.

Tests shall be performed for each major item of plant, by using an "Earth Megger" and auxiliary return conductor.

If any portion of the work fails to pass the tests, another test of the failed portion shall be repeated within a reasonable time.

### **3.17. Tests before completion**

Tests before completion shall be undertaken by the Contractor in line with the following general requirements.

In general these tests may be undertaken without supervision or witnessing by the Employer but the Employer shall be kept informed of the program of these tests and given the opportunity to supervise and witness the tests where he considers this appropriate.

Tests before Completion shall as a minimum comprise of:

- a. Pressure test to check tightness of joints, coupling etc.
- b. Continuity test on power and control cabling including armoring
- c. Visual inspection and tests for insulation resistance, earth loop impedance, polarity and phase rotation. The test shall be carried out between phases and phase to earth. All circuit breakers, switches and contactors shall be in their circuit position and closed. All secondary small wiring circuits shall be similarly tested.
- d. Satisfactory operation of all current operated protection circuits over their whole operating range shall be checked by primary current injection. Where primary injection tests have been previously performed at the manufacturer's premises, secondary current injection testing may be used subject to approval by the Employer.
- e. Correct operation of control circuits, indications and alarms shall be demonstrated.
- f. Correct operation of current and voltage operated indicating instruments and meters.
- g. Electrical pressure test on high voltage equipment.
- h. Earth continuity and resistivity test.
- i. Off-load operation / function test of all mechanical plant and electrical switchgear.
- j. Rotational check on all motor drives.
- k. All remedial work required is satisfactorily completed.

### **3.18. Tests on completion**

After erection is completed and the equipment is running satisfactorily after preliminary setting to work the Contractor shall notify the Employer that he is ready to demonstrate the performance of the Plant. Such demonstration referred to herein as Tests on Completion, shall be witnessed by the Employer. The

Contractor shall then test fully all items of equipment and shall include provision and arrangement of:-

- Provision and disposal of all services, lubricants and electricity.
- All skilled and qualified operating and test staff for the testing of all equipment
- All measuring and testing instruments to demonstrate that the equipment operated to the fulfillment of the work tests.

All tests shall be carried out by the Contractor under the supervision of and to the satisfaction of the Employer as follows:

#### **3.18.1. Pump sets**

Tests in accordance with Part-1 of BS 5316 to demonstrate that each pump set is reliable in operation and is able to cover the whole working range. Each pump shall be tested at the minimum guaranteed and maximum duty points. The values obtained will be compared with the values obtained during the tests on the manufacturer's premises and any discrepancies shall be rectified by the Contractor. Pump in combination with other duty pumps shall be similarly tested.

Temporary facilities, including flow measurement, instrumentation and throttling valves shall be provided at the pumping installation for recycling the test flow from any single pump back to the suction conduit if possible. This may be through permanent pumping station by pass pipework, if provided.

Pumps in combination of 2, 3 or 4 pumps shall be tested after being installed to ensure smooth, vibration free suction and delivery and the manifold and to certify delivery by each pump singularly and in combination of full and guaranteed delivery requirements.

#### **3.18.2. Cranes and lifting equipment**

The Crane inclusive of rails and beams shall be tested at site with test loads provided by the Contractor to prove that the whole is capable of satisfactorily lifting 50 percent above its rated load (lift in centre of gantry).

Cranes shall be tested after erection. A vertical deflection test shall be carried out with the "safe working load" suspended from the hook with the crab in the centre of the span. Workshop functional tests shall be repeated.

A further condition assessment and functional check shall be carried out prior to taking over. Any deterioration resulting from the Contractor's use of the crane during Plant erection shall be rectified by the Contractor.

#### **3.18.3. Ancillary equipment**

The Contractor shall demonstrate the satisfactory operation of the Plant and associated control equipment.

#### **3.18.4. Pipework**

Following completion of installation, all station pipework shall be water tested for leakage at appropriate test pressures. In the case of delivery pipework, and such other pipework on the suction side as may be vulnerable to full delivery pressure, the test pressure shall be the same as the Site test pressure for the associated delivery pipeline.

All pipework erected at Site shall be hydraulically tested, following erection, to at least 1.5 times the maximum working pressure, The Contractor shall provide the necessary equipment including any temporary blank flanges, which may be required to isolate the equipment.

The Contractor shall be responsible for testing of the welds and inspecting and testing of welded joints together with the responsibility of making good of any welding defect. Faulty welds shall be rectified in accordance with the requirements of BS 2971.

The Contractor shall provide all the necessary facilities, labour and equipment for the proper execution of the inspections and bend testing included in BS 2971. Two sets of bend tests shall be allowed for by the Contractor.

Fittings required for temporarily closing the openings in the pipelines to be tested shall be properly designed for the purpose and shall be adequately strutted to withstand the pressure applied.

Where bursting disks are installed, one disk shall be tested to demonstrate satisfactory operation.

### **3.18.5. Valves**

All valves on completion of erection shall be fully functionally tested in association with their actuators, controls and bypass system where provided. Each installation shall be checked for water tightness and the valves for any leakage. Valves shall be subject to the system test pressure and shall be demonstrated to function satisfactorily under maximum site differential head conditions. Where appropriate, valves may be internally inspected after functional tests to verify that seals remain in a satisfactory condition.

### **3.18.6. Surge protection system**

The Contractor is required to survey and check the data supplied with the detailed plan and profile of steel pumping main to enable him to compute and meet the requirements of surge protection system in different case studies with adequate safety margin. The Contractor shall ensure that protective devices are provided for all possible cases of origin of surge in the system and its damaging effects and adequate safety devices are provided in the installation to avoid damage to the Plant and pipe line system.

Following completion of pumping installations and associated delivery pipelines, the Contractor shall demonstrate, to the satisfaction of the Employer that the surge protection systems installed including surge bypass systems or surge vessels are sufficient to provide the degree of protection required.

Transient pressures shall be monitored and recorded at various points along the pipeline during the tests to verify the surge predictions and the adequacy of the surge protection equipment.

Any equipment supplied under the Contract that requires readjustment during the above tests shall after readjustment again be demonstrated by the Contractor to the satisfaction of the Employer.

### **3.18.7. Screens**

All screens on completion of erection shall be fully functionally tested to meet the performance schedule and specifications. Tests on all electrical items and control gear shall be carried out as specified under electrical plant and power systems.

### **3.18.8. Electrical plant and power systems**

For electrical plant and power systems the tests on Completion shall comprise pre-commissioning test "as detailed below, prior to energisation from the power supply source followed by energisation and demonstration of the operation of the Plant and associated protection and control systems to the specified performance requirements and maximum operating and load duties.

All tests shall be carried out by the Contractor under the supervision of and to the approval of the Employer.

### **3.18.9. Switchgear and Motor Control Centers**

#### **i. Insulation testing**

Power, frequency and pressure tests shall be carried out on all equipment for operation on MV system.

For LV systems equipment insulation tests shall be carried out at 500 volt using an approved test instrument.

These tests shall be carried out with all circuit breaker- contactor panels closed in the circuit position, between phases and phase to earth. All secondary small wiring circuits shall be similarly tested.

#### **ii. Mechanical tests**

All mechanical tests specified for conducting on manufacturer's premises are to be rechecked to ensure satisfactory operation in the final erected state.

#### **iii. Protection and control circuits**

The satisfactory operation of all current operated protection circuits over their whole operating range shall be tested by secondary current injection, where primary injection tests have been previously carried out on manufacturer's premises.

Primary injection tests shall be carried out on restricted earth fault circuits after

pilot circuits have been completed for stability and fault conditions. On transformer differential protection circuits where primary injection was not possible at the place of manufacture, the completed relay circuits are to be fully tested by secondary injection with simulated fault conditions. Stability tests are to be carried out using normal load conditions after the system has been completed and energized.

#### **3.18.10. Instruments and metering equipment**

Tests shall be carried out to ensure the correct operation of current and voltage operated indication instruments when energized by the actual supply system.

#### **3.18.11. Continuity of earth conductors**

Continuity tests shall be carried out on the earth conductor within the switchboard, such tests being done by current injection.

#### **3.18.12. Rotating machines (motors)**

Before the application of electric power on the machine windings, the insulation resistance shall be tested with a suitable insulation resistance tester, which shall be greater than the manufacturer's minimum recommended figure when corrected for Site winding temperature. Any necessary drying out of the windings on Site shall be in accordance with the manufacturer's recommendations.

Before rotating any machine under power, the mechanical alignment of the drive shaft with the driven load shall be checked (and adjusted if necessary) and shall be in accordance with the manufacturer's recommendation.

Before mechanically coupling any machine to the driven load, the direction of rotation shall be checked.

Before running any machine on-load, all heavy current connections shall be checked for correctness of make-up and tightness.

#### **3.18.13. Earthing systems**

The Contractor shall test that the resistance of the earthing network and electrodes are within the specified limits and in compliance with the Supply Authority's Regulations.

#### **3.18.14. Electrical equipment and installations**

The Contractor will in addition be responsible for arranging and carrying out such witnessed or un-witnessed tests and inspections as may be required by the Electric Supply Authority and obtain and hand over to the Employer their certificate of approval of the complete electrical installation.

#### **3.18.15. Building and site services**

The Contractor shall demonstrate that the building services and installations conform to the Specification and applicable local regulations.

The tests shall include but not limited to:

- a. For lighting installations to demonstrate that the illumination levels conform to the specified values.

- b. For ventilation and air-conditioning installations to conduct all operational tests for all plants.

The measurement of air ventilation and air volumes at test points shall demonstrate:

- a. The specified performance duties of all installed fans.
- b. The correct balancing of air duct systems, if applicable.
- c. The satisfactory regulation of all air grills and diffusers to achieve the specified air flow rates at all points in the system.
- d. The measurement and recording of noise levels to demonstrate compliance with the Specification.

### **3.18.16. Transformers**

Routine and type tests shall be carried out on transformers to IEC 60076, IEC 60137, IEC 60296 & IEC 60060 or equivalent. Routine tests shall include:

- i. Insulation resistance
- ii. Ratio, polarity and phase relationship
- iii. Measurements of winding resistance on all tap positions and phase
- iv. Impedance voltage
- v. Over voltage withstand
- vi. Load loss
- vii. Noise level

## **3.19. Training of Employees O & M staff**

### **3.19.1. General**

The Contractor shall impart training to the Employees staff on all aspects of plant operation for a period of 01 month. This will be in house on-the-job training after completion of testing and commissioning works. The Contractor shall submit his staffing proposal to the Employer which will be for three shift operation per day and for the day maintenance staff. The staffing schedule shall be forwarded to the Employer 12 months before the commencement of commissioning and Reliability Trials period to enable the Employer to appoint /depute the required staff.

The staff will remain under the supervision and control of the Contractor for evaluating their capabilities and performance. The Contractor shall ensure that the staff is fully conversant with all aspects of plant operations and are capable to take over the plant after completion of their training.

### **3.19.2. Familiarization Programs**

These programs shall be theoretical as well as practical. Theoretical programs shall cover all aspects of plant operation and maintenance through lectures and audio/video devices. As a minimum these shall comprise of:

- (1) Day to day operation and maintenance procedures
- (2) Proper procedures for carrying out repair and replacement works
- (3) Trouble shooting
- (4) Material procurement and storage
- (5) Maintenance and janitorial services of the Plant
- (6) Security
- (7) Actions required under emergencies viz fire, earthquake and rains etc.
- (8) Job description of all positions.
- (9) Printed hand-outs in Urdu / English for each position holder for carrying out responsibilities described therein.

### **3.19.3. Practical training**

This shall comprise of:

- (1) Visits to similar installations in Karachi
- (2) Visits to selected manufacturing works in Karachi

### **3.20. 01 Month On-the-Job training**

This will be an in house Training on the Contract Works as and when completed and commissioned. The Contractor shall continue plant operations and shall provide all services, staff and materials at his cost. After completion of this training the Employees staff should be fully conversant with the operation and maintenance of the Contract Work and capable to take over the operation and maintenance responsibilities independently.

### **3.21. Taking over**

After satisfactory completion of all mechanical, electrical and civil works as per Contract provisions and on completion of One month training period, the Work shall be taken over by the Employer as per provisions of Civil Works of the Contract.

### **3.22. Defect Liability Period**

After issue of taking over certificate by the Employer, the Defect Liability Period of minimum 12 month shall commence. The Contractor's responsibility at no additional cost in the Contract shall include but not limited to:



Construction of New 65 MGD Pump House(Equipped with M&E Pumping Machineries)  
at Gharo, Karachi. Package # 2

- a. Providing skilled maintenance staff in each discipline for the whole period
- b. Monitoring performance of the Work
- c. Investigation fault in similar equipment under similar conditions
- d. Rectifying fault at his cost