

SUBSECTION 12: QUALITY ASSURANCE AND QUALITY CONTROL

12.1 GENERAL

Some of the tests and procedures related to the specific works related to this Contract are laid out here and shall be applicable for this Contract. They shall be in general as an additional stipulation to the QA/QC manual and will not reduce the requirements stipulated in the Manual. The various tests stipulated below will be conducted on the following frequencies and the test report format and other details will be followed as per the QA/QC Manual.

4.12.1 CIVIL ENGINEERING WORKS:

4.12.1.1 Supply of Material

The tests on the construction material received on site shall be carried out as follows:

Procedures for Testing Materials on Site

CEMENT			QC-M-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Normal consistency	TC-M-01-01	One for each source and when called for by the Engineer	On receipt of material at site and before using as directed by the Engineer. Test certificate to be produced to the Engineer before use.
2	Fineness	TC-M-01-01		
3	Setting time – Initial / final	TC-M-01-01		
4	Compressive strength - 72 hrs, 168 hrs, 672 hrs.	TC-M-01-01		
For sulphate resistant cement as per IS-12330 OPC 43/53 shall conform to IS 8112/ 12269 and both 56 and 90 days strength shall be tested.				

SAND			QC-M-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Sieve analysis	TC-M-02-01	One test for 15 m ³	On receipt at site and test certificate to be produced to the Engineer before use.
2	Fineness modulus	TC-M-02-01	One test for 15 m ³	
3	Deleterious constituents	TC-M-02-01	One test for 15 m ³	
4	Bulking test	TC-M-02-01	One test per Source	

WATER FOR CONSTRUCTION WORKS			QC-M-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Alkalinity and acidity as per IS-3025	TC-M-03-01	Once per source of supply and when called for by the Engineer	Before use of water from that source
2	Solids	TC-M-03-01		

BRICKS			QC-M-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength	TC-M-04-01	One test per 50,000 bricks or part thereof	On receipt at site
2	Physical properties	TC-M-04-01		
3	Water absorption test	TC-M-04-01		

SIZE STONE			QC-M-05	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Water absorption test	TC-M-05-01	One test per source and when called for	On receipt at site
2	Dimension check	Lab format	As directed by the Engineer	
3	Type of rock	Lab format		

COARSE AGGREGATE FOR CONCRETE			QC-M-06	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Aggregate Impact or Los Angeles Abrasion Value as per IS-2386 Part-IV	TC-M-06-01/1 TC-M-06-01/2	One for each source of supply and when called for by the Engineer	On receipt of material at site
2	Soundness as per IS-2386 Part-V	TC-M-06-02		
3	Alkali Aggregate Reactivity as per IS-2386 Part-IV	Lab Format		
4	Flakiness Index	TC-M-06-03		
5	Gradation by wet sieve analysis	TC-M-06-04		
6	Water Absorption	TC-M-05-01		

When required, the Contractor shall furnish the mix design along with material properties at least 15 days in advance.

SOIL/EARTH/SUB-GRADE MATERIAL			QC-M-07	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Swelling index IS 2720 part XL	TC-M-09-01	Two sets for 3000 m ³ or part thereof	On receipt at site
2	Liquid limits and plasticity index	TC-M-09-02		
3	Deleterious material IS 1498	Lab format		
4	OMC and MDD Test	TC-M-09-03		
5	Chemical properties	Lab format		
6	Grain Size Distribution Graph (by wet sieve analysis)	TC-M-09-04		
7	Void ratio gradation	Lab format		
8	Soaked CBR test (optional)	TC-M-07-01	Two sets for 3000 m ³ or part thereof and as directed by the Engineer	

GRANULAR SUB-BASE MATERIAL			QC-M-08	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	California Bearing Ratio Test	TC-M-07-01	As required	On receipt at site
2	Material combinations	Daily log		
3	Moisture content as per IS-2270	TC-M-07-02	1 test per 250 m3 or part thereof	Prior to compaction
4	Fineness value BS 812 Part III	Lab format	As required	On receipt at site
5	Soundness of material	TC-M-06-02		
6	Air voids content	Lab format		
7	Gradation by wet sieve analysis	TC-M-06-04	1 test per 200 m3 or part thereof	
8	Atterberg limits	TC-M-09-02		
9	Deleterious constituents	Lab format		
10	OMC and MDD	TC-M-09-03		
The Contractor shall furnish the GSB design mix along with material properties and test results at least 15 days before laying GSB at site.				

MATERIAL FOR WBM			QC-M-09	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Aggregate Impact Value	TC-M-06-01/1	One test for 200 m ³	On receipt at site
2	Grading by wet sieve analysis	TC-M-06-04	One test for 100 m ³	
3	Flakiness Index and Elongation Index	TC-M-06-03	One test for 200 m ³ of aggregate	
4	Atterberg limits of binding material	TC-M-09-02	One test for 25m ³ of binding material	
5	Atterberg limits of portion of aggregate passing 425 micron sieve.	TC-M-09-02	One test for 100 m ³ of aggregate	
6	Water Absorption Test	TC-M-05-01	Initially one set of 3 representative specimen for each source of supply and subsequently, when warranted by changes in the quality of aggregate	
7	Soundness Test	TC-M-06-02	One for each source of supply and when called for by the Engineer	On receipt at site and when absorption value is more 2%

METAL FOR BM / DBM / BC / SURFACE DRESSING / MSS / PRE-MIX CARPET			QC-M-10	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Aggregate Impact Value	TC-M-06-01/1	One test for 50 m ³ of aggregate or part thereof	On receipt at site and before using in the hot mixing
2	Flakiness Index and Elongation Index of aggregates	TC-M-06-03		
3	Water absorption of aggregates	TC-M-06-06	Initially one set of 3 representative specimen for each source of supply and subsequently, when warranted by changes in the quality of aggregate	
4	Stripping value	TC-M-11-01		
5	Gradation by wet sieve analysis	TC-M-06-04	As directed by the Engineer for individual component and for combined coarse, fine aggregate and filler.	
6	Soundness Test	TC-M-06-02	One for each source of supply and when called for by the Engineer	On receipt at site and when absorption value is more than 2%
For DBM and BC, the Contractor shall furnish the material properties and proposed job mix formula at least 20 days in advance.				

BINDER FOR WBM			QC-M-11	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Atterberg Limit Test	TC-M-09-02	One test for 100 m ³ of binding material	On receipt at site

FINE AGGREGATE FOR DBM/BC			QC-M-12	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Passing 2.36 mm sieve and retained on 75 micron sieve	Daily log	As directed by the Engineer	Before use
2	Deleterious matter	Daily log	Visual observation of lot before use	

BITUMEN			QC-M-14	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Grade of bitumen as directed/defined (Penetration Test)	TC-M-10-01	Two samples per test subject to all or some tests as directed by the Engineer	On receipt of material at site before unloading from the truck
2	Ductility Test	TC-M-10-02		
3	Flash and Fire Point Test	Lab format		
4	Viscosity Test	Lab format		
5	Softening Test	Lab format		

4.12.1.2 General Civil Engineering Works:

The general civil engineering works will be subjected to a check frequency as follows:

Table 4.13.1: Procedures for Testing General Civil and Structural Works

Embankment Formation			QC-G-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Moisture content as per IS-2720	TC-M-09-03	One test for each 250 m ³ of soil	In-process
2	Field density test as per IS-2720	TC-M-09-03	5-10 density tests for each 1000 m ² compacted area, or as directed by Engineer	
3	Compaction	Daily log	As per required number of passes	While compacting

Excavation/Backfilling			QC-G-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Layout, slopes of excavation, benching and over-burden	Daily log	As directed by the Engineer	After excavation
2	Sub-soil water, shoring and strutting	Daily log		
3	Bottom levels and compaction	Daily log		
4	Soil classification	Daily log		
5	Backfilling and compaction	Daily log		After backfilling

Concreting			QC-G-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-516	TC-G-01-01	One test for 1-5 m ³ of concrete Two tests for 6-15 m ³ of concrete Three tests for 16-30 m ³ of concrete Four tests for 31-50 m ³ + one set every 50 m ³ of additional concrete work.	Test samples to be taken while pouring. Testing to be done as specified in Contract.
2	Slump test per IS-1199	TC-G-01-02	Random checks throughout concreting as directed by the Engineer	Before pouring concrete
3	Inspection of steel reinforcement placement and bending, and formwork	Daily log	Before pouring concrete	Before pouring concrete
4	Concrete Pour Report	TC-G-01-03	When pouring is done	Immediately after pouring

Mortar			QC-G-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-2250	TC-G-01-01	One sample for every 2 m ³ of mortar subject to a minimum of three samples for a day's work	Test samples to be taken while before mortaring. Testing to be done as specified in Contract.
2	Consistency as per IS-2250	TC-G-02-01		

4.12.1.3 Pipe Line and Water Retaining Works:

The general pipe line works and water retaining works will be tested as follows:

Table 4.13.3: Procedures for Testing Pipeline Works and Liquid Retaining Structures

Earth Bedding			QC-P-01	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Moisture content as per IS-2720	TC-M-09-03	One test for each 250 m ³ of soil	In-process
2	Field density test as per IS-2720	TC-M-09-03	One test for each 100 m ² of compacted area	

Concreting			QC-P-02	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-516	TC-G-01-01	One test for 1-5 m ³ of concrete Two tests for 6-15 m ³ of concrete Three tests for 16-30 m ³ of concrete Four tests for 31-50 m ³ of concrete + one set every 50 m ³ of additional concrete work.	Test samples to be taken while pouring. Tests to be done as specified in the Contract.
2	Slump test per IS-1199	TC-G-01-02	Random checks throughout concreting period as directed by the Engineer	Before pouring concrete
3	Steel reinforcement placement and bending	Daily log	Before pouring concrete	Before pouring concrete
4	Concrete Pour Report	TC-G-01-03	When pouring is done	Immediately after pouring

Mortar			QC-P-03	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Compressive strength as per IS-2250	TC-G-01-01	One sample for every 2 m ³ of mortar subject to a minimum of three samples for a day's work	Test samples to be taken while placing. Tests to be done as specified in the Contract.
2	Consistency as per IS-2250	TC-G-01-02		

Completion of Pipeline Laying and Jointing			QC-P-04	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Hydrostatic test for NP pipes	TC-P-04-01	One test for defined stretch	On completion of stage
2	Hydrostatic test for pressure pipes	TC-P-04-02	One test for defined stretch	On completion of stage

Completion of Manhole/Valve Chamber			QC-P-05	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Leakage Test	TC-P-05-01	100% inspection	On completion of stage

Completion of Liquid Retaining Structures			QC-P-06	
Sl. No.	Type of Test	Test Report Format No.	Frequency of Test	Timing of Test/ Inspection
1	Water tightness for underground structures	TC-P-06-01	One test per structure	On completion of stage
2	Water tightness for elevated structures	TC-P-06-02	One test per structure	

4.12.2 MATERIALS, PLANT AND EQUIPMENT:

4.12.2.1 Extent and Procedure for Submission for Pre Construction Testing and Review Data:

All goods and materials to be incorporated into the Works shall be new, unused, of the most recent or current models, and shall incorporate all recent improvements in design and materials.

The Contractor shall place orders for the material and the equipment only after approval of the Employer's Representative. The Contractor shall submit the detailed drawings from the approved manufacturer and the procedure of submission, review and revision shall be as specified in clause 4.1.8 of Sub section 1.

4.13.1.1.1 Works Tests

These shall be as per applicable IEC/BIS standards unless otherwise detailed in the technical requirements. The results of all works tests shall be recorded and submitted to the Employer's Representative no later than the date of delivery of ex-works.

4.13.1.1.2 Scope of Inspection

The test equipment, meters, instruments, etc. used for testing shall be calibrated at recognized test laboratories at regular intervals and valid certificates shall be made available to the Employer's representative at the time of testing. The calibrating instruments used as standards shall be traceable to International standards.

All type (as applicable), routine and acceptance tests shall be conducted in the presence of Employer/ Employer's Representative / Third Party Inspector on all the equipment as per latest applicable IS/IEC at no extra cost. Any modification / revision in the equipment as required by the Inspector shall be carried out by the Contractor without any extra cost. All such costs / fees for revisions / modifications shall be deemed to be included in the prices of supply of equipment as quoted by the Contractor. Typical type test reports for other equipment shall be submitted by the Contractor for approval by Employer.

4.13.1.1.3 Dispatch

The Plant / accessories shall not be shipped / dispatched unless shipping release from Employer / Employer's Representative is issued subsequent to acceptance of test results.

4.13.1.1.4 Packing and Shipping

Any items liable to be damaged in transit shall be effectively protected and securely fixed in their cases. All cases shall be marked to show where slings should be placed.

All cases shall be clearly identified giving particulars of manufacturer's name and type of equipment. All identification marks on the outside of cases shall be waterproof and permanent. All electrical equipment shall be adequately sealed and desiccating agents shall be used where necessary to prevent damage from condensation. All equipment shall be packed and protected, bearing in mind that it will be shipped to a harsh environment, that a considerable period may elapse between its arrival on site and its unpacking and that covered storage may not always be possible.

All wood and other materials used in packing cases shall be insect free. Adequate protection and precautions shall be taken to exclude termites and other vermin, noxious insects, larvae or fungus from the packing materials or plant. All contents shall be clearly marked for easy identification against the packing list.

The Contractor shall protect all steelwork before shipment, to prevent damage. Bundles of steel sections shall be properly tied together by an

corrosion and approved met

and care shall be taken to ensure that they are robust and that they can be handled easily during shipment.

Bolts and nuts shall be double bagged and crated for shipment. Crating of dissimilar metals is not acceptable.

Packing cases where used, shall be strongly constructed and in no case shall timber less than 25 mm in thickness be used. The contents of packing cases shall be securely bolted or fastened in position with struts or cross battens. Cross battens supporting weight in any direction shall not rely for their support on nails or screws driven lengthwise into the grain of the wood, but shall be supported by cleats secured from inside.

4.13.1.1.5 Labels

All equipment / components / parts shall be provided with labels or name plates, giving a description of the equipment, together with information regarding the rating, nominal voltage, nominal current and the like under which the item of plant in question has been designed to operate. The labels shall be permanently attached in a conspicuous position. Where this is not practicable, such labeling shall be provided on packaging to the Employer's Representative approval.

Labels shall be made of non-rusting metal. Labels shall have white letters on black or dark blue background. The lettering size shall be 6 mm for panel designation and minimum 3 mm for device labels. The label inscriptions shall be subject to the Employer's approval.

Each item shall be clearly and permanently labeled on the outside of its container with its description and purpose. When several items are packed in one case, a general description of the contents shall be given on the outside of the case. Spare parts shall not be shipped in the same cases as components, which are used for erection. The cases shall be clearly labeled to indicate that they contain spare parts or tools and each spare part tool or appliance shall be clearly marked with its size and purpose.

4.13.1.2 Quality Assurance

The Bidder shall submit in the bid an outline of the quality assurance practices that will be applied to all aspects of the manufacturing, installation and commissioning process.

The Contractor shall submit a detailed Quality Assurance Manual, which conforms generally to the requirements of ISO 9002. Approval to proceed with manufacture of equipment within this Contract will not be given until this Quality Assurance Manual and drawings of the equipment / systems has been received and approved by the Employer's Representative. Delays to the Contract completion date due to non-compliance with this requirement will be the Contractor's responsibility.

Major features of the Quality Assurance Scheme practiced by the Contractor and detailed in his Quality Assurance Manual shall include:

- a) The Contractor has defined all staff responsibilities and the QA systems operating within the organization for the purpose of ensuring adequate quality of the end product.
- b) Regular and systematic programs of testing are carried out for all incoming raw materials.
- c) Regular calibration checks are carried out on all measuring equipment used in the manufacturing operations.
- d) All production operations and test functions are properly documented and available to any relevant member of the Contractor's workforce.
- e) All checking activities, test results, etc. are recorded on appropriate standardized forms and these are verified, certified, recorded and filed in a systematic manner.
- f) A detailed inspection and test plan is prepared for the whole manufacturing operation.
- g) Statistical analyses are carried out regularly on appropriate test results to confirm that all processes are performing within the specified tolerances.
- h) Adequate procedures are planned for corrective action in the event that quality checks show that performance is not satisfactory.
- i) The Contractor has a senior officer with the authority to resolve matters of quality to the satisfaction of the Employer's Representative.

- j) The Contractor has adequate facilities under the control of properly trained staff to perform the quality control duties.

The Contractor shall inform the Employer's Representative about the likely dates of manufacturing, testing, and dispatching of any material and equipment to be incorporated into the Permanent Works. The Contractor shall notify the Employer's Representative for inspection and testing, at least twenty-eight (28) days prior to packing and shipping and shall supply the manufacturer's test results and quality control certificates. The Employer's Representative will decide whether he or his representative will inspect and test the material / equipment or whether he will approve it on the basis of the manufacture's certificate.

The following inspection and test categories shall be applied prior to delivery of the equipment, of various categories as indicated in the technical specifications for each type of the equipment:

Category A: -The drawing has to be approved by the Employer's Representative before manufacture and testing. The material has to be inspected by the Employer's Representative or a third party inspecting agency approved by the Employer's Representative at the manufacturer's premise before packing and dispatching. The inspection charges of the agency will be borne by the Employer. Initially the Contractor will deposit the inspection charges and same shall be reimbursed by the Employer's Representative. The Contractor shall provide the necessary equipment and facilities for tests and the cost thereof shall be borne by the Contractor.

Category B: - The drawings of the equipment have to be submitted and approved by the Employer's Representative prior to manufacture. The material has to be tested by the manufacturer and the manufacturer's test certificates are to be submitted and approved by the Employer's Representative before dispatching of the equipment. Notwithstanding the above, the Employer's Representative, after examination of the test certificates, reserves the right to instruct the Contractor for retesting, if required, in the presence of the Contractor's representative.

Category C: - Samples of the materials and/or equipment shall be submitted to the Employer's Representative for pre-construction review and approval in accordance with the provisions of Sub-Clause 5.5, Section 2. Following approval by the Employer's Representative, the material may be manufactured as per the approved standards and delivered to the Site.

4.12.2.2 Conditions for Supply and Inspections:

For material/equipment under Category "A" and "B", the Employer's Representative will provide an authorization for packing and shipping after inspection.

The testing and approval for dispatching shall not absolve the Contractor from his obligations for satisfactory performance of the System.

The Employer or his duly authorized representative shall have access to the Contractor/Manufacturer's premises at suitable time to inspect and examine inspections (including testing for chemical analysis and physical properties) the material and workmanship of the material, plant and equipment during manufacture. The Contractor will be responsible for obtaining permission for such at the manufacture's premise if he is himself not the manufacturer as if he was himself the manufacturer. The testing will be carried out by the Contractor/Manufacturer and certificates submitted to the Employer's Representative, who will have the right to witness or inspect the above mentioned inspection/testing at any stage desired by him. The Contractor shall forward to the Employer 3 Nos. duly certified copies of the Test Certificates and Characteristics Performance Curves for all Equipment.

If any material or any part of the works fails to pass any inspection/test, the Contractor shall either rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice. Any fault or short coming found during any inspection or test shall be rectified to the satisfaction of the Employer's Representative without any extra cost before proceeding with further inspection or wiring of that item. Any circuit previously tested, which may have been affected by the rectifications work shall be retested.

Where the Plant and Equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit at the Maker's works.

Neither the Inspection / Testing of the material or any part of the works, nor the attendance by the Employer's Representative(s), nor the issue of any Inspection Test Certificate shall relieve the Contractor from the responsibilities under the Contract.

The Test Equipment, Meters, Instruments etc., used for testing shall be calibrated at Recognized Test Laboratories at regular intervals and valid certificates shall be made available to the Employer's

Representative at the time of testing. The calibration instruments used as Standard shall be traceable to National/International Standards. The calibration certificates for the test instruments shall be produced for Employer's Representative consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test.

4.12.2.3 Category of Inspection

The categorization of the various material, equipment and plant for purpose of inspections is as below. However this list can be altered and additions or subtractions done or categories changed in due course during the implementation of the Contract by the Employer's Representative.

4.12.2.3.1 Mechanical and Instrumentation Work

Sr. No.	Items	Category of Inspection
A)	Mechanical Works	
1.	Sewage pumps	Category A
2.	Sluice Valves with / without Actuators	Category A
3.	Butterfly valve with the actuator	Category A
4.	Non-Return Valves	Category A
5.	Pipe work above 300mm	Category A
6.	Sluice gates	Category A
7.	E.O.T Crane	Category A
8.	Air vessel and Pressure Filter	Category A
9.	Air compressor	Category A
10.	Chlorinator	Category A
11.	Motor above 90kW	Category A
12.	Motor below 90kW	Category B
13.	Cooling water pumps	Category B
14.	Lubricating water pumps	Category B
15.	M.O.T Crane	Category B
16.	Blower	Category B
17.	Metallic bellows, Expansion Joints and Dismantling joints	Category A
18.	Air washers	Category B
19.	Air Valves	Category B
20.	Drain and dewatering Pump sets	Category B
21.	Pipe Work 300mm and below	Category B
22.	Exhaust Fans	Category B
23.	Portable Fire Extinguisher	Category B
24.	Air Conditioners	Category B
B)	Instrumentation Works	
1.	Instrument Control Panel for RWPS comprising of PLC system, digital indicators, digital flow indicator and integrator, alarm annunciator, pushbuttons etc.	Category A
2.	Instrument Control Panel for CWPS comprising of PLC system, digital indicator, alarm annunciator, pushbuttons etc.	Category A

Sr. No.	Items	Category of Inspection
3.	Instrument Control Panel for Water Treatment Plant along with PLC System.	Category A
4.	Local SCADA Systems (Integrated testing with PLC system) for RWPS and for CWPS.	Category A
5.	Temperature scanners	Category A
6.	Flow switches	Category A
7.	Digital panel meters	Category A
8.	Conductivity level switches	Category A
9.	Control panel for surge protection system	Category A
10.	Filter consoles	Category A
11.	Full Bore Electromagnetic Flow meters	Category A
12.	Clarifier and dosing control panel	Category A
13.	Pressure Switches	Category B
14.	Differential pressure switches	Category B
15.	Ultrasonic type level measuring systems	Category B
16.	Ultrasonic flow meter	Category B
17.	Float type Level Switches	Category B
18.	Instrumentation and Control cables	Category B
19.	Battery and Battery Charger Panel	Category B
20.	Surge Protection Devices	Category B
21.	Radar type level meter	Category B
22.	Pressure transmitter	Category B
23.	Flow indicator and integrator	Category B
24.	Alarm Annunciator	Category B
25.	Motorised Actuators for valves	Category B
26.	Chlorine dosing control panel	Category B
27.	Open channel flow meter	Category B
28.	Turbidity meters	Category B
29.	Residual chlorine meter	Category B
30.	PH meter	Category B
31.	Laboratory instruments and equipment	Category B
32.	Pressure Gauges	Category B
33.	Portable temperature monitor	Category B
34.	Portable sound level meter	Category B
35.	Portable vibration meter	Category B

4.12.2.3.2 Electrical Works

Sr. No.	Items	Category of Inspection
1.	HV Outdoor Current Transformer	Category A
2.	HV Outdoor Switch Disconnecter/ Isolator	Category A
3.	/HV Outdoor Lightning Arrester	Category A
4.	Gantry/ Structure for Switchyard/ Transmission Line	Category A
5.	Transformer (including OLTC, RTCC panel)	Category A
6.	MV and LV Capacitors and APFC Panel	Category A
7.	HV, MV and LV switchboards	Category A
8.	LV Variable Frequency Drive	Category A
9.	Reactance Starter for MV motors	Category A
10.	Battery and Battery Charger and DCDB	Category A
11.	EPABX System	Category A
12.	Cathodic protection- Transformer/ Rectifier (T/ R) units	Category A
13.	Outdoor 33kV accessories for substation (i.e. Fuse, ACSR Conductor, Clamps and connectors, hardware,	Category B
14.	Cathodic Protection equipment other than T/ R units	Category B
15.	Neutral Grounding Resistor	Category B
16.	Sub-Distribution Boards, Lighting Panels	Category B
17.	Lighting System	Category B
18.	VHF Communication System	Category B
19.	UPS System	Category B
20.	HV, MV and LV Power and Control Cables	Category B
21.	MV/LV Cable Termination	Category B
22.	Laptop Computers	Category B
23.	Printers	Category B
24.	Earthing System	Category B
25.	Local Push Buttons	Category C
26.	Cable tray and accessories	Category B

4.12.3 ELECTRO MECHANICAL (INDICATIVE QA/QC PLAN)

Sr. No.	Material/ Equipment	Tests/ Frequency of test	Size of Sample	Authority to conduct test	Witness to test	Location of conducting test- manufacturer's place/ Site/ laboratory	Remarks
1	Raw water/ Clear water / Back wash pumps	Material test certificate	100%	Manufacturer	Record verification	Manufacturers works/ Laboratory	
		Dynamic balancing	100%	Manufacturer	Record verification	Manufacturers works	

Sr. No.	Material/ Equipment	Tests/ Frequency of test	Size of Sample	Authority to conduct test	Witness to test	Location of conducting test- manufacturer's place/ Site/ laboratory	Remarks
		NDT/ Surface finish on shaft and impeller	100%	Manufacturer	RUIDP	Manufacturers works/ Laboratory	
		Hydro test of casing	100%	Manufacturer	Record verification	Manufacturers works	
		Performance test	100%	Manufacturer	RUIDP	Manufacturers works	BS 5316 Part 2
2	Valves- Sluice/ Butterfly/ Non return	Material test certificate	100%	Manufacturer	Record verification	Manufacturers works/ Laboratory	
		Hydro test	100%	Manufacturer	RUIDP	Manufacturers works	BS 5150/ BS EN 593/ API 594
3	EOT Crane	Material test certificate	100%	Manufacturer	Record verification	Manufacturers works/ Laboratory	
		Load test	100%	Manufacturer	RUIDP	Manufacturers works	IS 3177
4	Surge vessels / Pressure filters	Material test certificate	100%	Manufacturer	Record verification	Manufacturers works/ Laboratory	
		Welding qualification		Manufacturer	Record verification	Manufacturers works	
		Heat treatment	100%	Manufacturer	Record verification	Manufacturers works	
		Hydro test	100%	Manufacturer	RUIDP	Manufacturers works	IS 2825
5	Piping above 300mm	Material test certificate	100%	Manufacturer	Record verification	Manufacturers works/ Laboratory	
		Hydro test	100%	Manufacturer	RUIDP	Manufacturers works	IS 3589
6	Expansion bellow/ Dismantling joint	Material test certificate	100%	Manufacturer	Record verification	Manufacturers works	
		Hydro test	100%	Manufacturer	RUIDP	Manufacturers works	
ELECTRICAL							
1	Transformers	Temp. rise test	100%	Manufacturer	RUIDP	Manufacturers works	
		One minute power frequency withstand voltage	100%	Manufacturer	RUIDP	Manufacturers works	
		Impulse voltage withstand	100%	Manufacturer	RUIDP	Manufacturers works	
		Measurement of resistance of windings	100%	Manufacturer	RUIDP	Manufacturers works	
		Measurement of no load current, losses	100%	Manufacturer	RUIDP	Manufacturers works	

Sr. No.	Material/ Equipment	Tests/ Frequency of test	Size of Sample	Authority to conduct test	Witness to test	Location of conducting test- manufacturer's place/ Site/ laboratory	Remarks
		Measurement of load losses	100%	Manufacturer	RUIDP	Manufacturers works	
		Measurement of efficiency and regulation	100%	Manufacturer	RUIDP	Manufacturers works	
		Magnetic balance test	100%	Manufacturer	RUIDP	Manufacturers works	
		Separate source voltage withstand	100%	Manufacturer	RUIDP	Manufacturers works	
		Test on OLTC	100%	Manufacturer	RUIDP	Manufacturers works	
		Test on RTCC	100%	Manufacturer	RUIDP	Manufacturers works	
2	Switchboards HV/ MV/ LV	One minute power frequency voltage on main and aux. circuits	100%	Manufacturer	RUIDP	Manufacturers works	
		HV pressure test for CB	100%	Manufacturer	RUIDP	Manufacturers works	
		Milli-volt drop test for CB	100%	Manufacturer	RUIDP	Manufacturers works	
		Operation of closing and trip coils	100%	Manufacturer	RUIDP	Manufacturers works	
		Functionality checks	100%	Manufacturer	RUIDP	Manufacturers works	
		Primary injection test for CTs/ VTs	100%	Manufacturer	RUIDP	Manufacturers works	
3	MV Motors and LV Motors > 90kW	HV test	100%	Manufacturer	RUIDP	Manufacturers works	
		No load/ Full load test for efficiency, power factor and slip	100%	Manufacturer	RUIDP	Manufacturers works	
		Momentary overload	100%	Manufacturer	RUIDP	Manufacturers works	
		Over speed test	100%	Manufacturer	RUIDP	Manufacturers works	
		Locked rotor readings at reduced voltage	100%	Manufacturer	RUIDP	Manufacturers works	
		Test for vibration severity of motor	100%	Manufacturer	RUIDP	Manufacturers works	
4	MV/ LV Capacitors	Load test at 110% rated voltage	100%	Manufacturer	RUIDP	Manufacturers works	
		Leak proof ness test	100%	Manufacturer	RUIDP	Manufacturers works	
		Capacitor losses	100%	Manufacturer	RUIDP	Manufacturers works	
5	LV variable frequency drives	Efficiencies at various loads at different frequency	100%	Manufacturer	RUIDP	Manufacturers works	

Sr. No.	Material/ Equipment	Tests/ Frequency of test	Size of Sample	Authority to conduct test	Witness to test	Location of conducting test- manufacturer's place/ Site/ laboratory	Remarks
		levels					
6	Battery, Battery Charger	Capacity test	100%	Manufacturer	RUIDP	Manufacturers works	
		Test for voltage charging and discharging	100%	Manufacturer	RUIDP	Manufacturers works	
		Ampere- hour and watt- hour efficiency test	100%	Manufacturer	RUIDP	Manufacturers works	
7	Starters for MV Motors	Characteristics during starting and acceleration	100%	Manufacturer	RUIDP	Manufacturers works	
8	Transformer/ Rectifier Unit	Efficiencies at 25%, 50%, 75% and 100% loads for Transformer/ Rectifier units and 100% rated current for transformer after isolating rectifier unit.	100%	Manufacturer	RUIDP	Manufacturers works	
		Ratio and polarity test at 25%, 50%, 75% and 100% rated for all T/ R units.	100%	Manufacturer	RUIDP	Manufacturers works	
		Insulation resistance test at 2kV between primary and secondary, primary and earth and secondary and earth	100%	Manufacturer	RUIDP	Manufacturers works	
		Electronic current control for supply voltage variation and load resistance from 25% to 100%	100%	Manufacturer	RUIDP	Manufacturers works	
		Electronic current limiting feature.	100%	Manufacturer	RUIDP	Manufacturers works	

4.12.3.1 Manufacturer's Works Acceptance Tests

The Contractor shall carry out further specified tests of Equipment as indicated in corresponding sub sections. Visual Inspection for all equipments shall cover:

- Material Certificates for all the specified material.
- Welding Qualifications
- Dimension Checking
- Stage Inspections (in process inspection)
- Dynamic balancing for all rotating parts
- Hydrostatic / Leak testing for all pressure parts, Pneumatic Leak Test wherever applicable
- Operation check

- Liquid penetrant tests or magnetic particle tests for all machined surfaces of pressure parts.
 - Ultrasonic test for forging materials viz.,
 - Plates of thickness 20mm and above for pressed / formed parts such as heads, etc.
 - Plates, flanges and bars of thickness / dia 40mm and above used for fabrication of pressure and load bearing members and rotating parts.
 - Radiographic testing for all but welded parts, as per applicable codes.
 - Hardness tests for all Hardened surfaces.
 - Type, routine and acceptance test, as applicable

The Contractor shall maintain proper identification of all materials used, along with reports for all internal / stage inspection work carried out, based on the specific job requirement and or based on the datasheets / drawings / specifications.

Works Testing and Inspection shall be carried out at the manufacturer's works in accordance with the Specification. The Contractor shall in addition to any obligations under the Conditions of Contract inform the Engineer's duly appointed designated representative of the date when the Plant and Equipment will be ready for inspection and witness testing.

4.12.4 LABORATORY

The Contractor is required to establish a field laboratory for ensuring the timely inspection of the material and works. The laboratory will be equipped with testing facilities sufficient to cope with the requirements of the tests to be conducted on site. It should have at least the following equipment which may be supplemented with additional equipment as may be found necessary by the Employer's Representative/Contractor.

The Test Equipment, meters, instruments etc., used for testing shall be calibrated at Recognized Test Laboratories at regular intervals and valid certificates shall be made available to the Employer's Representative. The calibration certificates should be produced in advance for the approval of the Employer's Representative and if necessary they shall be got recalibrated or substituted before commencement of the tests.

List of Minimum Laboratory Equipment

S.No.	General
1.	Oven -Electrically operated, thermostatically controlled, range upto 2000 °C sensitivity 1 °C
2.	Platform balance 300 kg capacity
3.	Balance 20 kg capacity-self indicating type
4.	Electronic Balance 5 kg capacity accuracy 0.5 gm
5.	Water bath-electrically operated and thermostatically controlled with adjustable shelves, sensitivity 1 °C
6.	Thermometers: Mercury-in-glass thermometer range 0° to 250 °C Mercury-in-steel thermometer with 30 cm stem, range upto 300 °C
7.	Kerosene or gas stove or electric hot plate
8.	Glasswares, spatulas, wire gauzes, steel scales, measuring tape, casseroles, karahis, enamelled trays of assorted sizes, pestle-mortar, porcelain dishes, gunny bags, plastic bags, chemicals, digging tools like pickaxes, shovels etc.
9.	Set of IS sieves with lid and pan: 450 mm diameter: 63 mm, 53 mm, 37.5 mm, 26.5 mm, 13.2 mm, 9.5 .mm, 6.7 mm and 4.75 mm size
10.	200 mm diameter: 2.36' mm, 2.0 mm, 1.18 mm, 600 micron, 425 micron, 300 micron, 150 micron, and 75 micron

S.No.	General
11.	Water testing kit
12.	Hydrometer
13.	Gauges to measure diameter of pipe
14.	Total station equipment
15.	Measuring tape, vernier scale, die for concrete cubes, vibrating platform, tools and tackles
16.	Core drilling equipment
17.	First aid box
	For soils and aggregates
1.	Riffle Box
2.	Atterberg Limits (liquid and plastic limits) determination apparatus
3.	Compaction Test Equipment both 2.5 kg and 4.5 kg rammers (Light and Heavy compactive efforts)
4.	Dry Bulk Density Test apparatus (sand pouring cylinder, tray, can etc.) complete
5.	Speedy Moisture Meter complete with chemicals
6.	Post -hole Auger with extensions
7.	Core cutter apparatus 10 cm dia, 10/15 cm height, complete with dolly, rammer etc.
8.	Aggregate Impact Value Test apparatus/Los Angeles Abrasion Test apparatus
9.	Flakiness and Elongation Test Gauges
10.	Standard measures of 30, 15 and 3 liters capacity along with standard tamping rod
11.	California Bearing Ratio test apparatus
12.	Unconfined compression test apparatus
	For Cement and cement concrete
1.	Vicat apparatus for testing setting times
2.	Slump testing apparatus
3.	Compression and Flexural strength testing machine of 200 tonne capacity with additional dial for flexural testing
4.	Needle Vibrator and plate vibrators
5.	Air Meter
6.	Vibrating hammer for vibrating dry mix as for Dry Lean Cement concrete sub-base
	For M.S. Pipe
1.	Ultrasonic Test Equipment
2.	Radiographic Test Equipment
3.	Coating, Lining Thickness Checking Equipment
4.	Holiday Checking Equipment
5.	Ultra sonic gauges for thickness measurement of coating, lining and MS Plate – 4 Nos.
6.	Hydraulic Testing Equipments calibrated pressure gauge
	For Pumps

S.No.	General
1.	Portable Temperature Measuring Equipment
2.	Portable Sound Measuring Equipment
3.	Portable Vibration Measuring Equipment
4.	Illumination Measuring Equipment
5.	Portable Tachometer
	For Electrical Works
1.	----- Volt Megger (hand driven)
2.	----- KV Megger (Motorised)
3.	Earth Megger (Electrically Operated)
4.	Digital Multimeter
5.	Tongue Tester (with current and voltage measurement provisions)
6.	Insulating Oil tester
7.	Electronic Stop Watch
	For bitumen and bituminous mixes
1.	Penetrometer with standard needles
2.	Centrifuge type bitumen extractor, hand operated, complete with petrol/commercial benzene
3.	Marshall stability test apparatus, complete with all accessories
4.	Field density bottle along with cutting tray, chisel, hammer and standard sand
5.	3 m straight edge
6.	Camber board
7.	Core cutting machine with 10 cm dia diamond cutting edge
8.	Vacuum pump and 3 specific gravity bottles