



Bangalore Development Authority
T. Chowdaiah Road, Kumara Park West
Bangalore – 560 020

TENDER FOR THE WORK

Of

**“Development of Major Arterial Road, Phase -1 in Nada
Prabhu Kempegowda Layout”**

**(Through GOK e – Procurement Platform
<https://eproc.karnataka.gov.in>)**

VOLUME II

SECTION 7 A: EMPLOYERS REQUIREMENTS

(GENERAL REQUIREMENTS)

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VOLUME II

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SUB-SECTION 7A 1: PROJECT REQUIREMENTS

PROJECT REGION AND THE BDA

The project is under **Bangalore Development Authority (BDA)**

BDA Mission & Vision:

“To transform Bangalore to an ideal global destination with high quality infrastructure, better quality of life by ensuring sustainable and planned development based on effective monitoring, regulation, through participatory and innovative approach.

Plan, regulate, control, monitor and facilitate urban development in Bangalore Metropolitan Area, to ensure sustainable and orderly growth”

The Bangalore Development Authority (BDA) came into being with effect from 6th January 1976 under a separate Act of the State Legislature viz. the BDA Act 1976. This Authority combined in itself the Planning functions of the City Planning Authority and the developmental functions of the erstwhile CITB.

Organization:

The Bangalore Development Authority came into existence in 1976 as a successor to the erstwhile City Improvement Trust Board. Development of Bangalore in a planned manner, creating quality infrastructure, provision of sites and services and catering to the housing needs of the under privileged are the focus areas of the BDA.

Since inception, the BDA has allotted 76,000 sites to individuals for construction of residential dwellings. In addition, more than 800 civic amenity sites have been given for use by various public utilities, as also organizations, catering to the felt needs of the particular locality.

The employees strength in the B.D.A. as on 31.03.2004 was 925, comprising 170 deputationists and 755 employees of B.D.A.

B.D.A. Cadre and Recruitment Rules has been revised and sent to Government for approval during April 2001.

THE CURRENT COMPOSITION OF THE AUTHORITY

1. Chairman
2. Commissioner
3. Finance Member
4. Engineer Member
5. Town Planner Member
6. Secretary
7. Chief Architect, Government of Karnataka
8. Commissioner, Bangalore Mahanagara Palike
9. Principal Secretary to Government, Urban Development Dept.
10. Managing Director, Bangalore Electrical Supply Company
11. Chairman, Bangalore Water Supply & Sewerage Board
12. Managing Director, BMTCL, Bangalore
13. Sri M. Srinivas, Councillor, B.M.P.
14. Sri N. Nagaraju, Councillor, B.M.P.

CONSTITUTION OF BDA

The development to large, medium and small industries and the consequent increase in population has given rise to a number of formidable problems. The enormous growth of the area occupied by the city during all these years and the congestion of populations in many areas, inevitable growth of slums have all combined to make it extremely difficult to maintain the reputation on Bangalore as city beautiful. The growth of the vastness of the city from a mere 28.85 Km in 1901 to 174.71 Kms. in 1971 and 272.12 Kms. in 1981 would give an idea of the enormity of the problem of the maintenance of the city. The growing importance of Bangalore has led the disappearance of a number of small and large tanks in and around Bangalore and also the disappearance of the greenery in the form of abundant trees that existed, resulting in diminishing the claims of the city to be called a Garden City or the Air conditioned City. It was felt that planning and development functions should be vested with one agency. With this end in view, Bangalore Development Authority came into being with effect from 16th January 1976, under a separate Act of the State Legislature. This Authority combined in itself the planning functions of the City Planning Authority and developmental functions of C.I.T.B. The Bangalore Development Authority is the planning and development Agency for the Bangalore Metropolitan Area.

FUNCTIONS

The salient provisions of Bangalore Development Authority Act, which ensures planning, implementation as well as co-ordination, are mentioned below:

- Bangalore Development Authority as Planning Authority under the Karnataka Town and Country Planning Act is the agency for drawing up development plan and Town Planning schemes in Bangalore Metropolitan Area.
- The Authority can take up land acquisition and developmental schemes, housing schemes etc. Bangalore Development Authority has power for controlling the developments and enforcement of the plan and has also powers to implement developmental schemes.
- The Act empowers Bangalore Development Authority to issue directions to other Authorities connected with developmental activities.
- The act provides for proper co-ordination between BDA and the BCC which is the other important development agency, when development schemes are envisaged by either agency.
- The Corporation has to perform its functions in respect of land use and development with the concurrence of Bangalore Development Authority.

The Authority has the following main departments

1. Land Acquisition Department
2. Town Planning Department
3. Engineering Department
4. Allotment & General Administration Department
5. Finance Department
6. Law Department
7. Public Relations Department
8. Environment & Horticulture Department

- 1) The Land Acquisition Department works in close liaison with the Engineering Department for the purpose of acquiring lands required for executing various developmental schemes & formation of new layouts.
 - 2) The Town Planning Department is responsible for preparation and revision of the Comprehensive Development Plan for Bangalore Metropolitan Area, periodically, preparation of Layout Plans, approval of Development Plans for Layouts and Group Housing Schemes and generally assists the Authority in its function as the Planning Authority for Bangalore. It also monitors the change of land use in the CDP area.
 - 3) The Engineering Department is primarily concerned with the execution of various developmental schemes in the layouts as also infrastructural works. This department also monitors the execution of water supply and underground drainage works in BDA layouts taken up by BWSSB and electrification works executed by BESCOM and also takes of works on self-execution.
 - 4) The Allotment & Administration Department handles all matters pertaining to allotment of sites, shops and houses, assessment of property tax, leases and shop rents. The Department is also entrusted with the responsibility of all establishment and general administrative matters.
 - 5) The Finance Department renders advice to the Authority on various financial issues and is also entrusted with the responsibility of maintenance of the accounts of the Authority. This Department also oversees the demand, collection and balance of dues to the Authority.
 - 6) The Law Department advises the Authority on various legal issues, handles litigations by and against the Authority in various courts, etc.
 - 7) The Public Relations Department receives applications for various purposes from public on acknowledgement and thereafter transmits them to various departments for necessary action. Apart from the above, Public Relations office handles the media issues. These include publication of press notes, advertisements as also rejoinders and clarifications with reference to reports appearing in newspapers about the Organization.
- The Bangalore Development Authority performs planning and development functions:

I. PLANNING

The Bangalore Development Authority is designated as the Planning Authority under the Karnataka Town and Country Planning Act, 1961. The planning functions in brief involve the following:

Preparation of development plan for Bangalore.

Preparation of Scheme Plans.

Approval of Development Plans for Group Housing and Layouts.

Approval of building plans.

Other statutory functions under KTCP Act.

II. DEVELOPMENT

In addition to the planning functions, the BDA Act envisages the following development functions:

Planning and implementation of schemes to provide for Residential sites, Commercial sites, Industrial sites, Civic Amenity sites, Parks and playgrounds.

Construction of Commercial complexes.

Construction of houses for Economically Weaker Sections, Low Income Group, Middle Income Group, High Income Group.

Development of major infrastructure facilities.

The following functions are carried out by the Public Relations Wing:

1. Information Counter
2. Single Window Agency
3. Newspaper and Publications

Information about various procedures in BDA is disseminated from the Information Counter. In addition, BDA has published a guide for the allottees with a view to assist them through various procedures to be followed in matters like obtaining sale deed, transfer of site etc.

This Single Window Agency, receives applications for various purposes from public on acknowledgement and thereafter transmits them to various departments for necessary action. In the process, the applicant is also informed about the time limit within which his application will be examined and final decision given.

Apart from the above, Public Relations office handles the media issues. These include publication of press notes, advertisements as also rejoinders and clarifications with reference to reports appearing in newspapers about the Organization.

CONTACT DETAILS:

PUBLIC RELATIONS OFFICER

T. Chowdaiah Road

Kumara Park West

Bangalore-560020

Tel: 23464064, e-mail: pro@bdabangalore.org

GUIDELINES

Guidelines in following manuals and Institutions shall be generally followed for designing the project components and framing the project.

- Code of Practice for Design of Urban Roads (Part 1, 2, 3 & 4) published by Ministry of Urban Development (MoUD)
- Street Design Guidelines published by UTTIPEC, New Delhi
- Codes and Practices Issued by Indian Roads Congress

COMPLETENESS OF “THE WORKS” AND SYSTEM

The Contractor shall be fully responsible to ensure that the whole of the works and system including each individual component, is designed and constructed in a manner so that the system as a whole operates as a fully integrated system which is capable of achieving the required output in an efficient and economical manner, and include all plant, equipment and accessories required for the safe and satisfactory operation of the facilities. To achieve this, the Contractor shall ensure that each individual component performs in a manner which is complimentary to that of all other components. Any accessories which are not specifically mentioned in the specifications, but which are usual or necessary for completion of the works and successful performance of the system and facilities shall be provided by the Contractor within the tendered cost. The Contractor shall to the maximum extent practical and feasible, endeavour to standardize on the manufacture and supply of plant and equipment so as to minimize the operation and maintenance requirements. The contractor shall ensure that his designs are “maintenance-friendly” and that all items of plant and equipment are designed and installed in a manner which will facilitate routine and periodic maintenance.

The works, plant and item shall be selected, designed, manufactured, erected and commissioned to meet following essential requirements.

- Suitable for design life specified
- Energy conservation shall be of vital importance. Particularly high energy consuming equipment e.g. pumps, motors and transformer, cables etc. shall be selected such that the equipment operates at optimum efficiency level and energy consumptions are minimum
- Maintenance and repair requirement shall be minimized
- Access to all components of plant / equipment / item shall be feasible
- Adequate clear space shall be provided for staff to attend the component for maintenance of any component of plant and equipment

DESIGN LIFE

“Design life” means the period for which an item or works is designed to operate at full design output without major overhaul involving extensive dismantling, serious erosion and corrosion or necessity for substantial renewal of any anti-corrosion system, reduction of efficiency in excess of 5%, or replacement of major components essential to the functioning of the item etc. except for consumables and for any limited life components explicitly agreed at the time of contract award.

Minimum design lives shall be as follows:

a)	Road Pavement Works	-	Construction period + 15 years
b)	Structure of concrete, brick or block work	-	60 years
c)	Pipelines and valves	-	30 years
d)	Pumps, motors, electric actuators	-	15 years
e)	Lifting equipment, control panels, generating sets, transformers, switchgear, cabling, air blowers, compressors, process plant, electrical installations, building services etc.	-	20 years
f)	Instrumentation, control and automation	-	10 years
g)	Computer systems	-	5 years

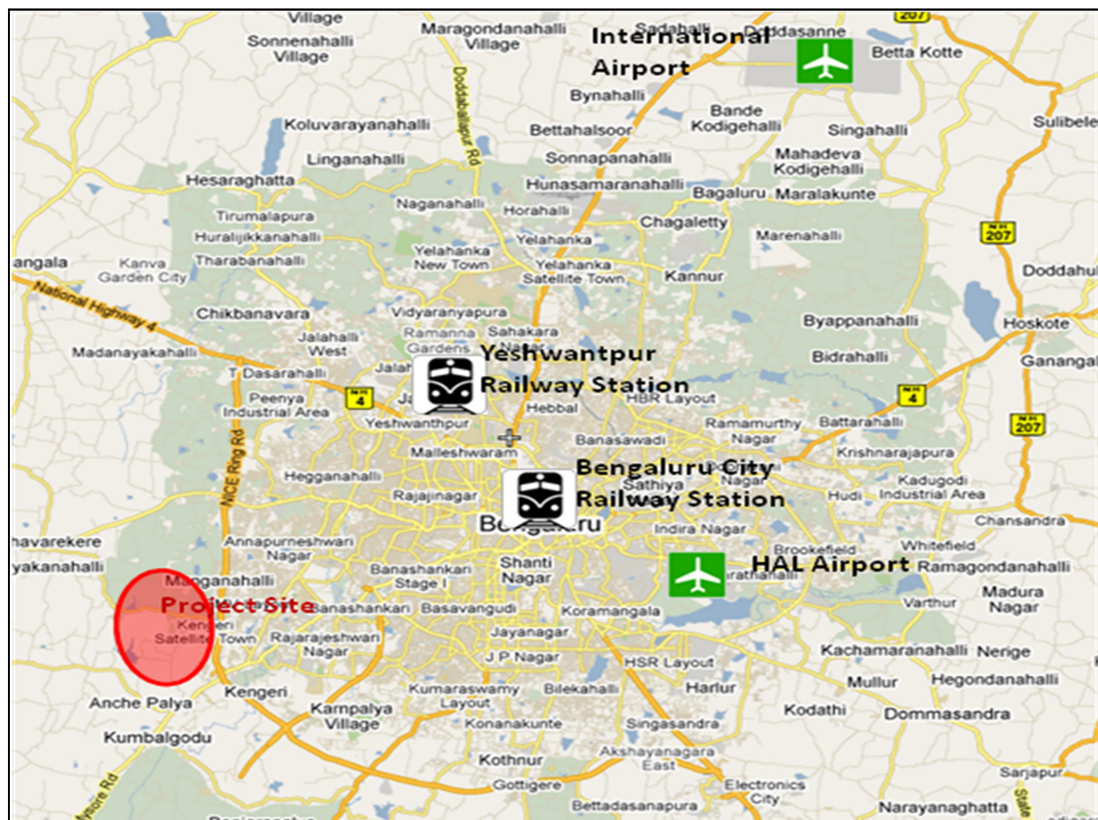
All items and systems shall be designed to allow replacement or major overhaul at the end of the design life without requiring major work or dismantling of other items which interrupt operation of independent items and systems.

1.1 Introduction

The Bangalore Development Authority is developing a township named Nadaprabhu Kempegowda Layout, located in the south western fringes of the Bangalore city, adjoining the NICE Road. Ms. Tandon Urban Solutions Pvt. Ltd has been entrusted with preparing the Development Plan for this township. The villages falling within this earmarked areas which are under the KengeriHobli, Bangalore South Taluk are Challaghatta, Bheemanakuppe, Kommaghatta-Krishnasagara, Ramasandra, Sulikere, Kenchenpura and under the YeshwantpuraHobli, Bangalore North Taluk are Manganahalli, Kanneli, Kodigehalli and Seegehalli. Geographically, it is situated between Latitudes $12^{\circ} 59' 11.28''$ N & $12^{\circ} 53' 15.71''$ N ; and Longitudes $77^{\circ} 25' 47.88''$ E & $77^{\circ} 29' 06.70''$ E . The site is bounded on the north by Magadi Road at a distance of 700 m from the site boundary. On the Eastern side the NICE road runs almost parallel to the site boundary at a distance of 300 - 500 m approximately. The Bangalore Mysore National Highway No. 275 also runs along the south of the site.

It is spread over an area of **4043 Acres - 27 Guntas**. The project aims at creating a dynamic and self-sustainable township, to relieve the pressure of the ever increasing population, on resources and infrastructure in the core city.

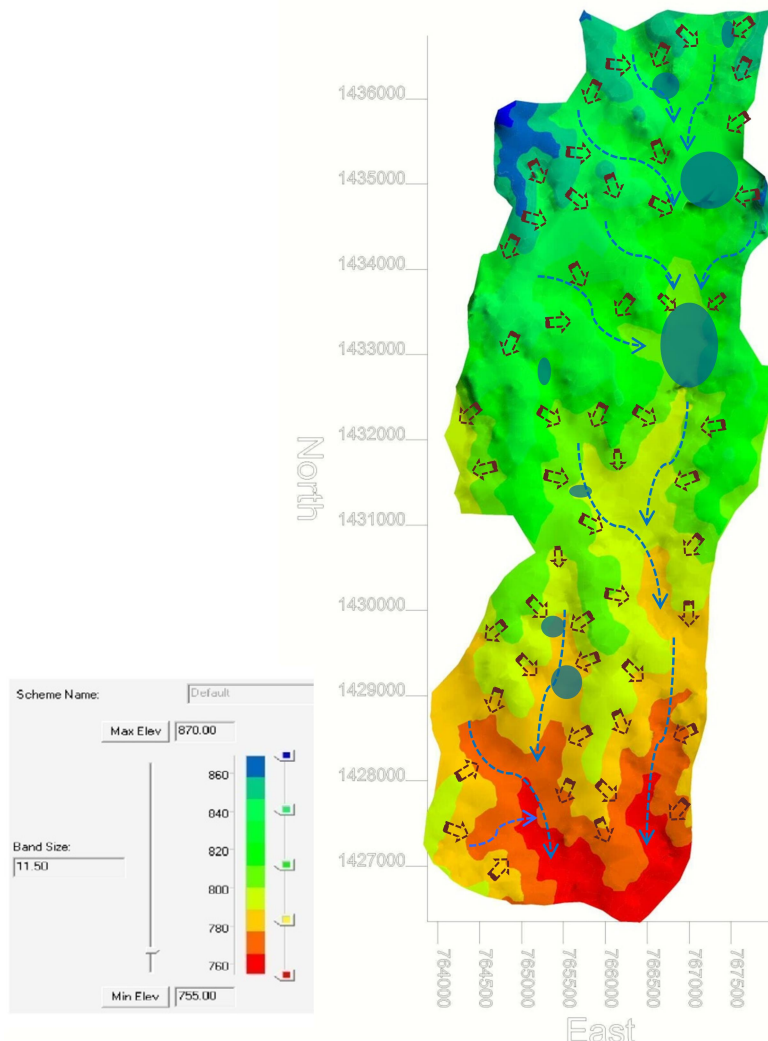
Figure 0-1:Map showing Nadaprabhu Kempegowda Layout with respect to Bangalore



1.1.1 Topography

The site has a slightly undulating profile with valleys/natural drains in between. The general direction of the slope is from North West to South East. The slope is very gradual with the highest level being +860.0 Metre at the North West and the lowest level is +765.0 Metres at the South East.

Figure 0-2: Map showing slope analysis for the site



The slope analysis diagram shown above is self-explanatory. The highest levels are represented by Blue colour and the lowest levels are depicted by Red Colour. The brown arrows show local flow direction from the ridges and the blue arrow show the general scheme of flow representing the valleys. The advantage of this natural gradient has been optimally utilised in designing the Utilities for this layout.

1.3 Brief about Major Arterial Road

Proposed Major Arterial Road is considered as Arterial, which is primarily for through traffic, usually on a continuous route. This shall carry significant intra-urban travel such as between central business district and outlying residential areas or between major suburban centres.

Suggestive geometric design standards and design elements for the project road under consideration are referred from following list of IRC codes, Code of Practice for Design of Urban Roads (Part 1, 2, 3 & 4) published by Ministry of Urban Development (MoUD) and Street Design Guidelines published by UTTIPEC, New Delhi and presented below.

1)	Classification of Road	:	Arterial
2)	Design Speed	:	80 Kmph (Main Carriageways)
		:	40 Kmph (Service Roads)
3)	Land Width	:	45m
4)	Cross Sectional Elements	:	
	Carriageway width		
	Main Carriageway (MCW)	:	2 x 10.0m
	Service Roads (SR)	:	2 x 7.00m
	Median	:	1 x 3.00m
	Space between MCW & SR	:	2 x 28.00m
	Cycle Track	:	2 x 2.00m
	Footpath	:	2 x 2.00m
5)	Kerb	:	Barrier type
6)	Camber		
	Carriageway	:	2.0%
	Paved footpath	:	2.5%
7)	Safe stopping sight distance	:	120m
8)	Horizontal Alignment:		

Super elevation	:	$e = \frac{v^2}{225R}$ subject to maximum of 4%
Transition Curve	:	Larger value obtained amongst consideration of rate of change of centrifugal acceleration & rate of change of super-elevation
Set-back distance	:	4m (for combination of design speed of 100 Kmph, radius of horizontal curve more than 500m and safe stopping sight distance of 120m).

9) Vertical Alignment:

Minimum gradient	:	0.5% (to facilitate drainage)
Maximum gradient	:	4% (for flyovers)
	:	8% (for service / slip roads)
Minimum length of curve	:	50m

- 10) Co-ordination of Horizontal Curve & Vertical Alignments: The vertical and horizontal curves shall coincide as far as possible and their length more or less equal. It not feasible, the horizontal curve may be longer than the vertical curve. Sharp horizontal curves at or near the apex of pronounced vertical curves shall be avoided.
- 11) Intersection design: The at-grade intersections shall be designed to enable efficiency of operation, safety, speed, cost of operation and capacity. Junctions where the traffic volume is heavy and the delays and loss caused justifies a grade separator, such proposal shall be made.
- 12) Railway Crossing: It is proposed to build railway over bridge (ROB) at 1 railway crossing.
- 13) Additional Features

Acceleration & Deceleration lane	:	
Width	:	3.0m minimum
Length	:	50.0m minimum
Taper	:	1 in 15 beyond design length

Pedestrian / Cattle Underpasses :	
Width	: 6.0m minimum
Vertical Clearance	: 3.0m minimum
At grade Intersection	: As per IRC: SP: 41
Rotary Intersection	: With ICD as 27.8m and width of weaving and non-weaving section as 10.0m.
Grade Separated Intersection	: As per IRC: 92 & IRC: SP: 90
14) Utilities	: To be accommodated in utility ducts running both side of carriageway with intermediate connections. Whereas sewer lines shall be laid separately underneath service roads.
15) Traffic control devices	: As per relevant code of practice.

SUB-SECTION 7A.2

CONTRACT ADMINISTRATION

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SUB-SECTION 7A.2: CONTRACT ADMINISTRATION

2.1 General

The Contractor shall be responsible for administration of the Contract from award of Contract through design, manufacture, manufacturer's works testing, and delivery of Plant to Site, installation, commissioning, testing and performance proving to final take over.

The employer lays great importance on all aspects of contract administration including setting up design and field offices deployment of Contractor's key staff, their qualifications and experience, duties, responsibilities and authorities defined and delegated to them, and all aspects of works management including finalization of vendors and subcontractors, placement of work orders and purchase orders, pre-delivery inspection and testing, storage, erection and commissioning.

The Contractor shall submit to the Employer's representative a diagram showing the structure of the organization for administration of the Contract. This structure shall include a project managing organization as part of the Contractor's organization.

The structure diagram shall state the names of the firms to be employed to carry out the following portions of the works:

- Process plant;
- Mechanical plant;
- Electrical plant;
- Instrumentation, control and automation systems;
- Civil works

Designs, drawings and documents that are required to be submitted to the Employer's representative for approval shall be considered as bonafide by the him only if they have been submitted by the Contractor's representative. Prior to submission, the Contractor's representative shall have reviewed the design, drawing or document. Each item submitted shall be stamped "checked by name and designation", dated and shall be clearly identified as to its final location and function.

2.2 Contractor's Design Office in Project Area

The Employer requires a high level of input for the initial investigation and design phase and requires the Contractor to be prepared with all necessary inputs so as to not lose time at the beginning of the Contract in these activities including approval of various designs and drawings. It is expected that the Contractor shall mobilize the necessary Design engineers as stipulated in these documents and equipment and base them at a location approved by the employer immediately after receipt of the Letter of Acceptance issued. The Contractor shall make the office functional within two weeks. The office will have required furniture, computer hardware required Design software packages with valid licenses, printers, plotters, projection system with screen and other office requirements. It shall have design team of qualified personnel for preparing and submitting the necessary design and drawings for all activities. The office shall also have a conference room of not less than 50 sq.m. with seating arrangement for 20 persons, for discussions and reviews.

2.3 Project Management Team

2.3.1 Contractor's Representative

The Contractor shall appoint the Contractor's Representative and shall request the Employer in writing to approve the person so appointed.

The Contractor's Representative shall represent and act for the Contractor at all times during the performance of the Contract and shall give to the Engineer all the Contractor's notices, instructions, information and all other communications under the Contract.

All notices, instructions, information and all other communications given by the Employer or the Engineer to the Contractor under the Contract shall be given to the Contractor's Representative or, in its absence, its deputy, except as herein otherwise provided.

The Contractor shall not revoke the appointment of the Contractor's Representative without the Employer's prior written consent, which shall not be unreasonably withheld. If the Employer consents thereto, the Contractor shall appoint some other person as the Contractor's Representative,

The Employer may by notice to the Contractor object to any representative or

person employed by the Contractor in the execution of the Contract who, in the reasonable opinion of the Employer, may behave inappropriately, may be incompetent or negligent, or may commit a serious breach of the Site regulations. The Employer shall provide evidence of the same, whereupon the Contractor shall remove such person from the Facilities.

If any representative or person employed by the Contractor is removed, the Contractor shall, where required, promptly appoint a replacement.

The Contractor's representative shall be minimum a graduate in engineering with at least 20 years of experience in contract management in the similar field.

Specific responsibilities of the Contractor's Representative shall be:

- (a) The sole representative on behalf of the Contractor in all discussion, correspondence and matters relating to the Works.
- (b) He shall be delegated with power of attorney to sign on behalf of contractor on all issues related to contract and payments.
- (c) The co-ordination and monitoring of Contract progress, which shall include the preparation of the Contract programme, monitoring of progress and submission of monthly progress reports. At the discretion of the Employer's representative, regular meetings shall be called at which the Contractor's Representative shall give a full account of the Contract progress and programme.
- (d) The Contractor's Representative shall be responsible for co-ordinating the design, technical information and data between sub-contractors. All calculations, drawings and information submitted to the Employer's representative shall be checked by the Contractor's Representative and certified as having been checked before submission.
- (e) The Contractor's Representative shall attend all meetings involving the Contractor and the Employer's representative
- (f) The co-ordination and programming of inspection and testing at manufacturer's works and the submission of test certificates.

- (g) The co-ordination and programming of Plant delivery.
- (h) The co-ordination and programming of the installation of Plant on the Site, all tests and commissioning.
- (i) The Contractor's Representative shall be responsible for the various sub-contractors. At the discretion of the Employer's representative regular site meetings will be held during which the Contractor's Representative shall give full account of site progress and programme.
- (j) The Contractor's Representative shall also be responsible for producing in advance of the work being undertaken, detailed method statements of any work, which involves or affects the performance of existing equipment, processes, or disruption to existing water supplies.
- (k) The co-ordination and preparation of As-Built Drawings and operating and maintenance manuals.
- (l) The preparation and co-ordination of training.
- (m) The submission of applications for payment.

The Contractor at his discretion may delegate some duties and authority to the Project Manager with prior approval of the Employer.

CONTRACTOR'S RESPONSIBILITIES

The Contractor shall design, manufacture including associated purchases and install and complete the Facilities in accordance with the Contract. When completed, the Facilities should be fit for the purposes for which they are intended as defined in the Contract.

The Contractor confirms that it has entered into this Contract on the basis of a proper examination of the data relating to the Facilities provided by the Employer, and on the basis of information that the Contractor could have obtained from a visual inspection of the Site if access thereto was available and of other data readily available to it relating to the Facilities as of the date

twenty-eight (28) days prior to bid submission. The Contractor acknowledges that any failure to acquaint itself with all such data and information shall not relieve its responsibility for properly estimating the difficulty or cost of successfully performing the Facilities.

The Contractor shall acquire and pay for all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the Site is located which such authorities or undertakings require the Contractor to obtain in its name and which are necessary for the performance of the Contract, including, without limitation, visas for the Contractor's and entry permits for all imported Contractor's Equipment. The Contractor shall acquire all other permits, approvals and/or licenses that are not the responsibility of the Employer under SCC Sub-Clause 5.4.2 hereof and that are necessary for the performance of the Contract. However, Contractor shall assist Employer & liaison with the line departments for obtaining all the other permits, approvals and/or licenses that are not the responsibility of the Contractor.

The Contractor shall comply with all laws in force in the country where the Facilities are to be implemented. The laws will include all local, state, national or other laws that affect the performance of the Contract and bind upon the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any and all liabilities, damages, claims, fines, penalties and expenses of whatever nature arising or resulting from the violation of such laws by the Contractor or its personnel.

The Contractor shall, with due care and diligence, design, engineer, procure, execute test and commission, including defect liability period, remedy any defects therein accordance with the provisions of the Contract. The Contractor shall provide all superintendence, labour, materials, Plant, Contractor's Equipment and all other things, whether of a temporary or permanent nature, required in and for such design, execution, completion and remedying of any defects, so far as the necessity for providing the same is specified in or is reasonably to be inferred from the Contract.

The Contractor shall promptly notify the Employer, of any error, omission, fault or other defect in the design of or Specification for the Works (prepared

by the contractor and approved by the Engineer earlier), but which he discovers when reviewing the designs or executing the Works.

The Contractor shall take full responsibility for the adequacy, stability and safety of all Site operations and methods of construction. Since the Contract expressly provides that all items of plant shall be designed by the Contractor, he shall be fully responsible for all components of the plant, notwithstanding any approval by the Employer.

The Contractor shall provide all necessary superintendence during the execution of the Plant and as long as thereafter as the Project Engineer may consider necessary for the proper fulfilling of the Contractor's obligations under the Contract. The Contractor, or a competent and authorized representative approved of by the Engineer, which approval may at any time be withdrawn, shall give his whole time to the superintendence of the construction of plant. Such authorized representative shall receive, on behalf of the Contractor, instructions from the Engineer. If the approval of the representative is withdrawn by the Engineer, the Contractor shall, as soon as is practicable, having regard to the requirement of replacing him as hereinafter mentioned, after receiving notice of such withdrawal, remove the representative from the construction of plant and shall not thereafter employ him again on the assignment in any capacity and shall replace him by another representative approved by the Engineer.

The Contractor shall be responsible for:

- (a) the accurate setting-out of the various components of the plant in relation to original points, lines and levels of reference as designed by the contractor and approved by the Engineer.
- (b) the correctness, subject as above mentioned, of the position, levels, dimensions and alignment of all parts of the plant, and
- (c) the provision of all necessary instruments, appliances and labour in connection with the foregoing responsibilities.

If, any time during the execution of the plant, any error appears in the position, levels, dimensions or alignment of any part of the plant, the Contractor, on being required so to do by the Engineer, shall, at his own cost, rectify such error to the satisfaction of the Engineer, unless such error is based on incorrect instructions in writing by the Engineer, in which case the

Engineer shall determine an addition to the Contract Price as per the relevant provisions of the contract and shall notify the Contractor accordingly.

The checking of any setting-out or of any line by the Engineer shall not in any way relieve the Contractor of his responsibility for the accuracy thereof and the Contractor shall carefully protect and preserve all bench-marks, sight-rails, pegs and other things used in setting-out the Works.

The Contractor shall comply with all applicable environmental laws and regulations in India. The contractor shall (a) establish an operational system for managing environmental impacts, (b) carry out all of the monitoring and mitigation measures required and implement the Environmental Management Plan (EMP). The Contractor shall submit to the Employer monthly reports on the carrying out of such measures.”

License for Explosives: The Contractor should take necessary licenses under the current explosive rules to enable him to manufacture and process the quantity of gunpowder / explosive and perform the blasting as necessary according to prevailing rules.

All personnel, raw material, utilities, lubricants, chemicals catalysts and other material and facilities and works and required to properly carry out the Pre-Commissioning and Guarantee Tests, all in accordance with the Contract Agreement shall be arranged and provided by the Contractor.

The contractor shall be responsible for the continued operation and maintenance of the facilities during defect liability period after completion and shall be responsible for conducting the Guarantee Tests(s) for the facilities.

2.3.2 Clause not used.

2.3.3 Key Staff of Contractor

a) Project Manager

Project Manager shall be a person deployed by the JV/Consortium/Contractor as an overall in-charge for the works and shall be deployed at project office. He should be a senior level staff member of the Lead firm of the consortium. He shall be minimum graduate in engineering with at least 15 years of experience in execution of works in water supply sector.

He shall be responsible for day to day progress of works at site and all matters related to site works.

He may perform some of duties and responsibilities of the Contractor's representative with prior approval of the Employer.

2.4 Programme

In accordance with Conditions of Contract, the Contractor shall within a time specified in the ITB of Tender, submit a detailed contract programme for approval, which shall include details of survey and geotechnical investigation works, all temporary and permanent works, construction procedures and methodologies.

In addition to the requirements set down in the Conditions of Contract, the programme shall include the following details:

- (a) Contractor's organisational structures for the Contract including details of all key staff and their responsibilities;
- (b) A statement giving the numbers and categories of supervisory staff and skilled and unskilled labour to be employed on the Works;
- (c) A list and type details of major constructional plant (including vehicles) which the Contractor proposes to employ on the Works, including programmed dates for order and delivery;
- (d) Details of the Contractor's methods of working for all operations;
- (e) A statement giving the proposals for location or locations and sizes of offices, workshops and stores at the Site, pipe manufacturing units and labour camps;
- (f) A complete resource allocation showing the number of units and allotted times for each unit of constructional plant, materials and labour allocated to each part of the Works;
- (g) Particulars to be shown on the programme shall include:
 - Submission of designs, drawings and documents
 - Employer's representative's approval procedures / review procedures
 - Re-submission of drawings etc. as necessary and review
 - Civil construction of each major structure

- Placing of orders for Plant
- Plant manufacture
- Plant tests at place of manufacture
- Plant deliveries to site
- Plant erection
- Plant tests at site
- Tests on completion (commissioning tests)

The programme shall be co-ordinated to take into account the requirements of climatic, groundwater and other conditions to provide for the completion of the Works in accordance with the Contract.

The programme shall be prepared using MS Project software such as primavera or equivalent and shall be submitted in both soft (editable and PDF) and hard copies.

The programme shall be updated every month and as and when requested by the Employer's representative to show actual progress and required revisions.

2.5 Milestones

Consistent prorata progress on all components of the Contract during the entire Contract period shall be achieved. The key milestones set out in Table 2.3, or such other Milestones as may be proposed by the Contractor and agreed by the Employer at the time of bidding, are proposed to be adopted for periodic review of the progress of various components. These milestones will be the stages when the decisions regarding any delay in the implementation will be taken with a view towards the application of the provisions of the Conditions of Contract.

2.6 Monitoring of Progress, Progress Reports and Meetings

Each month the Contractor shall submit to the Employer's representative six copies of a written detailed progress report and showing the stage reached in the execution of the Works. The report shall show progress to the end of the preceding month with respect to the approved Contract programme and output of project management software. The reports shall be accompanied by such additional information in approved form as may be required by the Employer's representative. The reports shall be forwarded promptly so that

on receipt the content is not more than seven days out of date.

The report shall show status of all activities required by the Contract such as design, drawings, procurement, manufacture, works tests, delivery, erection, testing and commissioning of all items of plant, pipe line and all other works.

Delays shall be detailed by the Contractor, with the proposed action to overcome it.

The Contractor should implement the Building Information Modeling System for entire “the works” during the Construction phase.

The Employer or Employer’s representative may call meetings in his office, at the Contractor’s office, or at the Site, to review the progress of the Contract. The Contractor’s representative shall attend such meetings.

In addition to the above, the Employer shall Engineer convene periodical meetings with Contractor and Employer’s representative for reviewing progress and for necessary co-ordination among all parties for smooth construction implementation and maintain the time schedule.

2.7 Photographs / Videography

The Contractor shall arrange to take photographs and video films of all important activities. These will include (but not be restricted to) virgin sites and levels, existing trees and other buildings, obstacles and utilities across / along the alignment and /or plant structures of this project. The video films shall be submitted for record in duplicate to the Owner’s designated representative.

In accordance with the requirements of the Conditions of Contract the Contractor shall submit negatives of photographs and unmounted positive colour prints not less than 250 x 200 mm of such portions of the Works, in progress and completed, as may be directed by the Employer’s representative and specified herein. The negatives and prints shall not be retouched. The negative of each photograph shall be the property of the Employer and shall be delivered to the Employer’s representative with the prints. No prints of these negatives shall be supplied to any other person without the written permission of the Employer’s representative.

The photographs shall be of two categories:

- progress photographs
- record photographs

Both categories of photographs shall be properly referenced to the approval of the Employer's representative and on the back of each print shall be recorded the date and time of the photograph, an identifying description of the subject and the reference.

Photographs taken for record purposes as ordered by the Employer's representative or as specified herein shall be supplied with three prints, having the reverse of one subscribed with the signatures of the Contractor and the Employer's representative (or their authorised representatives) for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.

The Contractor shall supply one negative and three prints of each progress photograph ordered by the Employer's representative. The Contractor shall supply two additional prints of progress photographs selected by the Employer's representative for incorporation in albums. The Contractor shall supply two sets of albums, mount the prints, and title the prints and albums all to the approval of the Employer's representative.

Preparation of Visualization of the project based on 3D animation of the proposed project superimposed in Ariel and ground videography using latest augmented reality of the project master plan and the features proposed thereof complete as per the instructions of project in charge.

The Contractor shall also conduct video recording of important activity at least once in a month and shall furnish the same.

The taking of photographs of the Works by the Contractor for any other purpose whether for use in India or in any other country shall not be carried out without written approval from the Employer's representative.

2.8 Details and Data by the Employer

The Employer has the following data and used these in formulation of the design and bid elements. They are listed below and shall be used only as guideline. The Employer does not, however, guarantee either the sufficiency or accuracy of the data provided. Contractor shall carry out fresh survey, investigation and particular testing/and all other details necessary for proper planning and detailed design. The Contractor will be required to provide full details of the investigations and analysis for approval of the Employer's representative. It is expected that the surveys will be carried out with Total

Stations and necessary software will be used for creating the required drawings.

The employer's details and data are as below;

- Tender drawings

2.9 Sub-letting

The Contractor shall not sub-let the whole of the Works. Where any design or manufacture is sub-let, the Contractor shall not be relieved of his obligation under the Contract. The Contractor shall be responsible for the acts, defaults and neglect in manufacture or design of any sub-contractor, as if they were his own.

Where the Employer's representative has consented to supply of Plant or execution of work by manufacturers or sub-contractors proposed by the Contractor, such manufacturers or sub-contractors shall not be changed without the prior approval in writing of the Employer's representative.

A copy of every order shall be sent to the Employer's representative at the time the order is placed each clearly marked with the title of the Contract and the Contract number.

2.10 Minimum Construction Equipment to be brought by Contractor on Site

The Contractor is required to assign minimum equipment on site for ensuring quality and timely progress of works. The minimum equipment in adequate numbers, including but not limited to the equipment described in this Subsection, shall be mobilized by the Contractor on site in working condition. The Contractor should submit the equipment mobilization program in the bid schedules.

Table 2.4: Minimum Equipment to be mobilized by Contractor on Site

Sl. No.	Type of Equipment	Minimum Required Equipment Numbers
1	Crusher 250 TPH	1
2	Batch Type Hot Mix Plant 120 TPH	1
3	Concrete Batching plant 30 Cum/Hr	2
4	Concrete pump	2

5	Tipper	20
6	Motor Grader	4
7	Excavator 0.90 Cum Bucket Capacity	15
8	Smooth Wheeled Roller	2
9	Vibratory Roller	4
10	Sensor paver finisher	2
11	Water Tanker	10
12	Concrete mixer with hopper	20
13	Needle vibrator	20
14	Ajax concrete mixer	4
15	Wet mix plant	2
16	Generator 50 KVA	2
17	Total station	2

2.11 Field Laboratories

The Contractor shall be responsible for all on-site and off-site testing and for all in-situ testing. All appropriate laboratory tests shall be carried out in the Contractors laboratory, unless otherwise permitted or required by the Engineer. Where the laboratory is not appropriately equipped and/or staffed for some tests, or it agreed to by the Engineer, tests may be carried out in other laboratories provided that:

They are accredited for the relevant work to standard acceptable to the Engineer; and

Particulars of the proposed laboratory are submitted to the Engineer for his consent.

- (ii) In-situ tests shall be done in the presence of the Engineer/its representative.
- (iii) Equipment, apparatus and materials for in-situ tests and laboratory compliance tests carried out by the Contractor shall be provided by the Contractor. The equipment and apparatus shall be maintained by the Contractor and shall be calibrated before the testing starts and at regular intervals as permitted by the Engineer. The equipment, apparatus and materials for in-situ tests shall be

removed by the Contractor as soon as practicable after the testing is complete.

- (iv) The Contractor shall be entitled in all cases to attend the testing carried out in the Employer's or other laboratories, to inspect the calibration certificates of the testing machines and to undertake the testing on counterpart samples. Testing of such samples shall be undertaken in laboratories and particulars of the laboratory proposed shall be submitted to the Engineer for consent prior to the testing.

Attendance on tests, including that by the Engineer, Contractor and Designer, shall be as laid down in the Quality Assurance procedures.

Records of in-situ tests and laboratory compliance tests carried out by the Contractor shall be kept by the Contractor on the Site and report shall be submitted to the Engineer within seven (7) days or such other time stated in the Contract or in the Quality Assurance Programs, after completion of each test. In addition to any other requirements, the report shall contain the following details:

1. Material or part of works tested.
2. Location of the batch from which the samples were taken or location of the part of the Works.
3. Place of testing.
4. Date and time of tests.
5. Weather conditions in the case of in-situ tests.
6. Technical personnel supervising or carrying out the tests.
7. Size and description of samples and specimens.
8. Method of sampling.
9. Properties tested.
10. Method of testing.
11. Readings and measurements taken during the tests.
12. Test results, including any calculations and graphs.
13. Specified acceptance criteria; and
14. Other details stated in the contract.

Reports of tests shall be signed by the QA/QC engineer or his assistant, or by another representative authorized by the contractor.

If required, records of tests carried out by the Employer's staff or by the engineer shall be given to the contractor.

2.12 Clause Deleted

2.13 Materials: General Requirements and Manufacturer's Experience

The term materials shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for parts of the Works in Employer's requirements / particular specifications, the provision of the Standard Specifications shall apply to materials general requirements for any part of the Works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

The Contractor shall as far as possible use materials available in India for the completion of the Works, subject to compliance with the Specification.

Materials shall be transported, handled and stored so as to prevent deterioration, damage or contamination.

The Contractor shall procure pipes, specials, pumps and other electrical equipments from approved manufacturers specified in tender document with proven experience in the supply of similar items for atleast 10years. Employer reserves the right to demand an additional security upto 5% of the supply and construction value for considering experience in manufacturing of less than 10 years.

2.14 Substances and Products

Substances and products used in the Works which may be applied to or introduced into water supplied for drinking, washing or cooking shall not contain any matter which could impart taste, odour, colour or toxicity to the water or otherwise be objectionable on health grounds. Only substances and products which have been approved by a national or international regulatory body shall be used.

After award of Contract, from time to time, the Contractor shall submit for the approval of the Employer's representative a schedule of substances and products he proposes to use in the Works giving the following information as applicable:

- Item of plant;
- Substance/product in contact with water;
- Manufacturer of plant/substance/product;
- Point of use in the Works;
- Name of the regulatory body if applicable, which has approved the substance/product;

2.15 Delivery and Storage of Plant

2.15.1 Packing and Protection

Before any plant is dispatched from a manufacturer's factory it shall be adequately protected and packed to ensure that it will arrive on the site in an undamaged condition. The methods employed for protection and packing must be suitable for rough handling and withstanding the conditions which may be experienced during shipment, delivery to the site and prolonged periods of storage in the open, whether the items are shipped in packing cases, crates or only partially protected according to their nature. Packages containing dangerous or breakable goods shall be packed and marked in accordance with any statutory rules and orders applicable.

Bright parts and bearing surfaces shall be protected from corrosion by applying a rust preventive lacquer, high melting point grease or similar temporary protection. A sufficient quantity of solvent shall be supplied with the plant to enable this coating to be removed on the site.

Electrical equipment shall be suitably protected against corrosion and incidental damage to the satisfaction of the Employer's representative. Temporary leads shall be fitted to electrical equipment to enable anti-condensation heaters to be energized when the plant is in store. The heaters shall be energized by the Contractor when conditions require.

All machined flanges and other mating surfaces shall be protected by means

of wood templates. The bolts for securing these templates shall not be reused in the final installation.

No crate or package shall contain items of plant intended for incorporation in more than one part of the works.

All items of plant shall be clearly marked for identification against the packing list, which shall be placed in a waterproof envelope inside every packing case or crate. Every packing case and crate shall be indelibly marked to show its weight, serial number, top and bottom, shipping marks and handling instructions or sling marks.

2.15.2 Delivery to Site

The Contractor shall be responsible for the transporting and handling of all the Plant.

The storage of all equipment and construction items at the Site shall be the Contractor's responsibility.

The Contractor shall check all items against packing lists immediately on delivery to the Site and shall also inspect for damage and shortages. Damages and shortages shall be remedied with the minimum of delay.

The Contractor may, with the prior approval of the Employer's representative and at no extra cost to the Employer, make arrangements for any other contractor or agent to take delivery of, unload and store the Plant on the Site on behalf of the Contractor.

All deliveries shall take place during the Contractor's normal working hours.

2.15.3 Storage

An area and/or building on the Site for use by the Contractor for storage of Plant prior to erection will be subject to the approval of the Employer's representative.

The Contractor shall provide all other facilities for the safe and proper storage of Plant, as recommended by the manufacturers, with particular consideration being given to temperature, rain, sunlight, wind and ground conditions. All electrical equipment for indoor installation shall be kept in store building and dry condition shall be maintained.

The Contractor shall remain responsible to the Employer for the care and insurance of the Plant and the provisions of this Clause shall not relieve the

Contractor of any of his liabilities under the Contract.

Stored Plant items shall be laid out by the Contractor to facilitate their retrieval for use in the programmed order.

Stacked Plant items shall be protected from damage by spacers on load distributing supports and shall be safely arranged. No metalwork shall be stored directly on the ground.

Small Plant items shall be held in suitable bins, boxes or racks and be clearly labelled.

Items of Plant shall be handled and stored so that they are not subjected to excessive stresses and so that protective coatings are not damaged.

Small plant items shall be held in suitable bins, boxes or racks and be clearly labeled.

Items of plant shall be handled and stored so that they are not subjected to excessive stresses and so that protective coatings are not damaged. The Contractor shall comply with the manufacturer's package and plant markings concerning the use and location of lifting slings, chains and hooks.

2.15.4 Erection, Testing and Commissioning

Please refer a separate sub-section detailing specification for above activities.

SUB-SECTION 7A.3

SITES AND SITE WORKS

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SUB-SECTION 7A.3: SITES AND SITE WORKS

3.1 General

The Contractor will be allowed to use the spaces available with the Employer after permission of the Employer's Representative. The Contractor will be free to use them for establishing his offices, laboratories, staff quarters, storage spaces and workshop as long as they do not interfere with the layout of the works to be carried out under the Project.

The Contractor will also be permitted to use the skeleton constructions available on these spaces for his use after permission from the Employer's Representative.

There may be some encroachments on some of these spaces and structures which may take some time in clearance, for which the Employer will not be held responsible. However, the Contractor shall settle the issues coming across the way of work. The prospective bidders are advised to familiarize themselves with the existing situation and make their own evaluation / assessment before submitting the bid. All the buildings and compound wall / fencing to be handed over by the Employer will be handed over on as "as-is, where-is" basis.

The Contractor will be responsible to arrange and pay for whatever modifications the structures may require for his use and also for providing necessary facilities like access road, water, sanitation and electricity. He will be responsible to maintain a clean and healthy environment at the locations taken by him and will be responsible for conduct of his personnel there.

The Contractor will have to hand over the spaces and structures in a clean and intact condition at the end of the Contract or at an intermediate stage when they may be required by the Employer's Representative on demand after one-month notice.

There shall be charge as per the BDA rules & regulations, for the use of such space or structures. The Employer however does not undertake to provide any further space or accommodation that the Contractor may require to fulfill his contractual responsibilities. The Contractor will be responsible to arrange the same at his own cost. The Employer may assist the Contractor in making his arrangements by giving suitable recommendation letters.

3.2 Access to the Site

The Employer will provide to the Contractor access to and possession of the Site for carrying out the Works. The Contractor shall be deemed to have inspected the Site including access before submitting his Tender.

The Contractor shall ensure that all the Plant offered is of a size and weight or can be divided into sections of a size and weight suitable for access to the place of installation. Also, the equipment used for installation purposes shall be able to have access and position for such purposes.

The Contractor shall ensure that the operation of any facility should not be hindered any way due to mobilization of the equipment, civil or any contract related work.

3.3 Camp and Campus

The Contractor shall construct and maintain to the Employer's representative satisfaction a camp to provide living accommodation for all contractor's staff who have no other local accommodation. The Contractor's camp shall be located close to the Site itself and at a location approved by the Employer's representative. Responsibility for acquiring land and providing all services to the living quarters and compliance with all sanitary laws and other laws and regulations shall be borne by the Contractor. Security and the fencing of these areas shall be the responsibility of the Contractor.

3.4 Facilities and Offices for Employer's Staff and his Representative

The Contractor shall provide and upkeep the following facilities for the Employer and Employer's Representative. The cost for these facilities shall be borne by the Contractor.

Air conditioned offices at one location of floor area not less than 100 square meters and 75 square meters at remaining locations (as per Employers Requirement), with provision of pantry with cooking / catering arrangement for food & snacks, tea & coffee vending machines, crockery and cutlery. Bottled mineral water with dispensers shall be provided by Contractor in all offices. The office at site shall have conference room and **Audio Video Equipment**.

The layout of the offices shall be submitted to the Employer for approval. The office building shall be equipped with office furniture as per the requirement of Project and BDA, and each location shall be provided with a canteen, electricity, standby generator set, telephones, broadband internet connectivity, fans etc. Maintenance and upkeep of the office shall be contractor's responsibility for entire period of the contract.

The locations shall be given by employer after signing of contract.

The construction of all offices shall be completed within 60 days of signing of contract.

For the Employer's representative, two numbers of desktop computers with flat screens loaded with the latest versions of windows MS office, MSP, AutoCAD and Inkjet printer and photocopy machine for A4 & A3 size and a plotter for taking copies of construction drawings. All office shall be provided with adequate stationary for routine office work.

Five air-conditioned cars of INNOVA or equivalent of 2017 make with drivers and five motorcycles shall be provided for use of employer's staff. This shall be provided during Construction Works Period and until completion of the 50% of defect liability period and shall provide for monthly average 500 kms per vehicle. Providing driver, fuel and maintenance of cars shall be responsibility of the contractor.

In addition to above, the Contractor shall provide suitable air conditioned temporary offices along the works while work in progress.

The offices shall remain as the property of the BDA at the end of the Contract and the agency shall have to handover to BDA or remove and restore the site as per the instruction provided by the BDA. The Land for office or plant shall be provided by BDA to contractor free of cost for the specific purpose to which the license to use has been granted. Any violation in the condition for this purpose shall attract Penalty upto one percent of the prevalent land cost per day.

3.5 Areas Outside the Site

In the event of the Contractor making use of any special or temporary way leave or accommodation acquired by him or any tip for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such way leave, accommodation or tip is situated and shall make agreement with the owner, occupier or authority as aforesaid of the condition of the surface of that land before entering thereon.

The Contractor shall permit the Employer's representative and any person authorised by him access for the purposes of the Contract to any such special or temporary way leave or additional accommodation.

In the event of the Contractor making use of any special or temporary wayleave or additional accommodation made available to him by the Employer for the purpose of the Contract, the land in which such wayleave or accommodation is situated shall be deemed to be part of the Site.

Under these circumstances the Contractor shall form a Working Area extending 5m from the edge of the Permanent Works or accommodation on all sides. The Contractor shall restrict his activities to within this Working Area. On completion of the works in this area, the Contractor shall reinstate the area by clearing the stuffs to its original condition to the satisfaction of the Employer's representative.

Private land or other land taken by the Contractor for disposal of debris or other material or for any other purpose must be cleared and made acceptable from health and environmental aspect before.

3.6 Road Works

The Contractor shall obtain all permits required for carrying out works such as excavation on public roads and shall liaise with the appropriate authorities with regard to the timing and execution of the road works.

The Contractor shall be responsible for establishing and maintaining temporary road diversions for the duration of the road works. The road shall be kept open at all times during the road works period, and the work shall be carried out in such a manner as to minimise the disruption to traffic.

3.7 Maintenance of Existing Access Roads

The Contractor shall only use existing access roads within the Site boundary which are necessary for the execution of the Works. The Contractor shall be solely responsible for the maintenance of the existing site access roads. Such maintenance work shall include general up-keep, and any necessary repairs to damaged road surfaces, pavement, drainage, associated slopes, etc. to original condition. While carrying out such maintenance work, the Contractor shall make arrangements to maintain through passage for the Employer's and his staff's vehicles and also those of other contractors over these access roads, which may comprise temporary diversions all to the approval and satisfaction of the Employer's representative.

The Contractor shall take every precaution while operating tracked or unsprang vehicles on surfaced roads and shall use planking or some other protective material to protect the road surface.

3.8 Clearance of the Site

The Contractor shall clear the Site to the extent required by the Employer's representative for the setting-out. Clearance of the Site shall also include the demolition and removal of all articles, objects and obstructions which are expressly required to be cleared to the satisfaction of the Employer's representative.

The Contractor shall remove the material arising from such clearance and dispose of it in a manner and at a location, on or off the Site, to the approval of the Employer's representative.

The Contractor shall fill and make good with appropriate materials those cavities and losses of soil which result from clearing the parts of the Site not subsequently to be occupied by the Works.

The Contractor shall not clear the Site of any structure without the prior written permission of the Employer's representative. As far as possible big trees shall be saved otherwise replanted at approved location.

3.9 Clearance and Reinstatement of the Site on Completion

On completion of the Works, the Contractor shall clear any temporary works areas and temporary access roads and reinstate the areas to their original condition and to the satisfaction of the Employer's representative.

3.10 Site Records

The Contractor shall make records of the position and extent in the excavations of every type of service, stratum and obstruction encountered during the construction of the Works.

3.11 Access for the Employer's Representative

The Contractor shall permit the Employer and the Employer's representative and any person authorised by the Employer including workmen of the Employer, other contractors or utility undertakings access for the purposes of the Contract to all areas of the Site and to any additional accommodation or temporary wayleave for the duration of the Contract period.

3.12 Water Supply and Disposal on Site

The Contractor shall be responsible for arranging water for the purposes of constructing the Works at his own cost and risk. The Contractor shall ensure the quality of the water remains suitable for the purpose for which it is intended.

Wastewater shall be disposed off clear of the Site to the satisfaction of the Employer's representative so as to cause no damage or complaint.

3.13 Latrines and Washing Facilities

Throughout the period of construction of the Works the Contractor shall provide, maintain and cleanse suitable and sufficient latrines and washing facilities for use by his employees. He shall ensure that his employees do not foul the Site but make proper use of the latrines.

Where practicable the latrines shall be connected to the nearest sewer, or if this is not practicable the Contractor shall provide an adequately sized septic tank and soak away.

The Contractor is also to provide separate latrines for the employer's staff and Employer's representative.

After Completion of the works, the latrines and washing facilities shall be removed, all ground disinfected and the surface reinstated to the satisfaction of the Employer's representative.

3.14 Electricity for Contractor's Use on Site

The Contractor shall be responsible for arranging power supply and distribution of an electrical supply for the purpose of constructing the Works and making payment to the power supply authority.

The installation shall comply with all the relevant regulations, Indian Standards and Codes of Practice, and Health and Safety requirements, etc. The Contractor must take every possible precaution to ensure that his installation is safe and injury to personnel or damage to plant and buildings is avoided. The Contractor shall be fully responsible for all safety and maintenance aspects.

The Contractor shall test the temporary site distribution system including energy meter every 3 months for compliance with the relevant standards.

3.15 Compressed Air Use on Site

The Contractor shall provide the necessary compressed air plant and equipment required for construction of the Works.

Electrically driven compressors connected to the site electricity supply shall not be used. Diesel engine driven compressors shall not be sited within buildings or in a location that may cause a health hazard to personnel owing to exhaust fumes or noise.

3.16 Refuse Disposal on Site

Refuse and rubbish of every kind shall be removed from the Site and disposed off by the Contractor at his own expense, frequently and regularly so as to keep the Site in an approved wholesome and tidy condition to the satisfaction of the Employer's representative.

3.17 Health, Hygiene and Contamination of Water Supplies

The Site shall be an area of 'restricted operation'. Exemptions may be granted at the discretion of the Employer's representative for short term operations involving no risk of contamination. The Contractor shall be responsible to ensure the following:

- All personnel shall be medically accepted.
- Water supplies for drinking, cooking and washing is fit for use and minimum drinking water quality standards
- Strict discipline shall be maintained concerning personal hygiene.
- Vehicles, plant, tools and protective clothing shall be kept clean and may require regular disinfection.

The Contractor shall be responsible for regular medical check-up and treatment.

Should any employee is infected with any looseness of bowels, gastric disorder or contagious disease such employee shall be immediately removed from the site.

3.18 Safety and Security on Site

The Contractor shall at all times maintain a safe system of working and shall comply with all enactments, regulations and working rules relating to safety, security, health and welfare of all persons who may be affected by his work.

In particular, he shall ensure that only persons who are properly trained for their duties are employed, and that the correct tools and procedures are used.

Nothing which has been written into or omitted from this Employer's Requirements shall be taken to relieve the Contractor from his obligations under this clause. No clause in this Employer's Requirements shall prevent the Contractor from drawing the attention of the Employer's representative to any feature of the Works which is not consistent with normal safety practices nor prevent him putting forward proposals at any time which would increase the safety of the installations.

Not later than four weeks before work commences on the Site, the Contractor shall submit to the Employer's representative his comprehensive proposals relating to the safety, health and welfare of all his personnel on the Site.

The Contractor shall appoint a suitably qualified representative as Safety Officer who shall be responsible for the implementation of site procedures as per relevant standards which shall include but not be limited to:

- safety;
- working in hazardous areas;
- permit to work;
- fire and smoking regulations;
- first aid;
- warning signs;
- trenching scaffolding and other construction structures;
- safety barriers;
- protective clothing and equipment;
- safety training;
- safety meetings and inspections;
- health and welfare.

The proposals shall be appropriate for all grades of labour and personnel who will work on or visit the Site on behalf of the Employer, Employer's representative or Contractor.

The Employer's representative has the power to stop any activity or work in any area where there is a breach of the published site safety rules such that health or life is put at risk.

The Contractor shall ensure that all employees working on the Site are not working in an unsafe manner so as to endanger themselves, the Contractors personnel, other personnel or the Plant. The Contractor shall bring any violation of Site safety rules by others to the attention of Employer's representative in writing.

3.19 First Aid and Life-saving Apparatus on Site

The Contractor shall provide on the Site such life-saving apparatus as may be appropriate and an adequate and easily accessible first aid outfit or such outfits as may be required in any government ordinances, factories acts, etc., published and subsequently amended from time to time. In addition, an adequate number of persons permanently on the Site shall be instructed in their use, and the persons so designated shall be made known to all employees by the posting of their names and designations in a prominent position on Site.

3.20 Electrical Safety on Site

The Contractor shall be responsible for the electrical safety of all Plant supplied and installed. Whilst any equipment is being installed or tested, the Contractor shall ensure that all necessary precautions are taken to safeguard personnel working on site. If necessary, this shall include fencing off areas which are considered to pose a risk, and erecting warning notices.

The Contractor shall be responsible for ensuring that the electrical installation is carried out by suitably trained competent personnel and that the work is carried out in a safe manner.

The Contractor shall be responsible for the operation on the Site of a permit to work system during the period of electrical equipment installation and testing. This system shall regulate the installation, the energisation and the use of electrical Plant installed and the method of work adopted.

3.21 Noise

The Contractor shall ensure that the operations entailed in the construction of the Works do not cause annoyance to others working on the Site or to persons living adjacent to the Site.

3.22 Warning and Safety Signs

During construction of the Works statutory safety signs, shall be adequately provided throughout the Works, both indoors and outdoors. These safety signs shall cover mandatory, prohibition, warning, emergency, fire-fighting and general notices. All signs shall be positioned around the Works at highly visible points. Provision of signs and the positions of signs shall be subject to the Employer's representative's approval. Special attention shall be given to areas designated hazardous.

3.23 Signboards

The Contractor shall supply and erect signboards at locations to be specified by the Employer's representative. The layout and dimensions of the signboards and their construction shall be to the approval of the Employer's representative and the lettering in both Hindi and English shall be black on a white background or any other colour combination for better indications subject to approval of the Employer's representative.

3.24 Advertising

The Contractor shall not use any part of the Site for any form of advertising without the prior written approval of the Employer's representative.

3.25 Disaster Management and Fire Safety

All fire safety precautions against fire hazards shall be taken by the contractor as per I.S. Code of practice for fire safety of buildings (general) & National Buildings code of India 2005 as applicable. Accordingly, necessary fire equipment's shall be provided in all the buildings and site the fire extinguishers and all provisions shall be suitable for fire fighting for general fire, fire for electrical equipment and fire for chlorine house. Adequate numbers of sand buckets shall be provided.

SUB SECTION 7A. 4

System Performance parameters and Liquidated damages (Service Level Benchmarks)

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4.1 SYSTEM PERFORMANCE PARAMETERS AND LIQUIDATED DAMAGES (SERVICE LEVEL BENCHMARKS)

Service Level Benchmarks (SLB)

SR NO	Parameters	Unit	Level of acceptability / benchmark	permissible deviations	Maximum permissible Penalty in percentage	Penalties	Maximum permissible incentives in percentage	Incentives
1	Surface Roughness	MM/KM	2000 for Bituminous Concrete Surfacing & 2500 for Semi Dense Bituminous Concrete Surfacing	-	2.5	1 % of pavement cost for each instance. Permissible Penalties will be Maximum 2.5%	2.5	1 % of pavement cost for per instance will be deposited . Cumulative for year. Permissible Incentives will be Maximum 2.5%
2	Surface Unevenness	MM	4	-	2.5	1 % of pavement cost for each instance. Permissible Penalties will be Maximum 2.5%	2.5	1 % of pavement cost for per instance will be deposited . Cumulative for year. Permissible Incentives will be Maximum 2.5%

The aforesaid parameters to be tested as per IRC / MORT&H requirements.

Strict quality control measures shall be exercised for the achievements of the recommended values of surface finish both in terms of unevenness and roughness as measured by a Straight edge and Bump integrator respectively.

SUB-SECTION 7A.5

DESIGN, DRAWINGS AND DOCUMENTS

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SUB-SECTION 6A.5: DESIGN, DRAWINGS AND DOCUMENTS

5.1 General

Following 3 categories of Design and Drawings are involved in the bid process and contract.

- i) Design and drawings furnished by the Employer with bid documents
- ii) Tender drawings and documents furnished by the Tenderer with his tender
- iii) Design, drawings and documents submitted by the Contractor for the works

This sub-section describes intent and implications of three categories of design and drawing and stipulates employer's requirements for design and drawings for the works included in this contract.

5.2 Drawings furnished by the Employer

Drawings submitted as part of the Employer's Requirements are enclosed as Tender Drawings. The drawings illustrate an overall conceptual layout of the Works, and are not binding on the Contractor. These drawings shall not be taken as the limiting responsibility of the Contractor for the detailed design of the works.

The Contractor shall carry out such surveys, studies and analyses of any kind as are necessary for the purpose of his general and detailed designs and to verify the information shown on the Tender drawings and other data furnished by the Employer. The Employer shall not be liable for any claim by the Contractor on account of incompleteness or inaccuracy of the data furnished by the Employer irrespective of when the Contractor shall discover such incompleteness or inaccuracy.

All levels indicated except specified as obligatory or mandatory are provisional, and may need to be revised subject to the results of survey and site investigation that may be carried out by the Contractor, in addition to the survey / investigation details furnished with tender documents.

The Contractor shall note the constraint in terms of land available for the works as shown in the drawings. The work including access roads and pipework, shall be located within the area shown on the drawings and in accordance with the overall conceptual design layout shown. No additional land than that shown in the drawing will be provided.

All Drawings, data, technical particulars, temperature rise calculations, detailed literature, catalogues, type test certificates of typical transformer etc shall be submitted along with the bid/ after award of contract as specified under “ Bid/Contract Drawings” General Requirements of Bid Documents

5.3 Tenderer’s Drawings

The Tenderer’s drawings and documents are those furnished by a tenderer with his tender for the purpose of illustrating and clarifying his proposals. These include,

- Alignment Plan & Profile
- Road-side Drain Plan & Profile
- General Arrangement Drawing for Tunnel Approach Works
- Typical Cross Section
- Structural Drawings of culverts, bridges and tunnel approach works
- Street Lighting Layouts
- Arboriculture Layouts
- Such other drawings and documents so as to illustrate and explain tenderer’s proposal

5.4 Design Documents and Drawings by the Contractor

5.4.1 General

The Construction Documents are design and certified Drawings submitted by the Contractor to the Employer during the course of the Contract for approval. The Contractor shall supply to the Employer’s representative **5 (Five) copies** each of the initial design calculations and sizing of all components of the System including road, architectural, structural, process hydraulic, mechanical, electrical and instrumentation equipment, supported by design calculation (Excel spreadsheets), flow diagrams and general arrangement drawings for approval. It is a matter of high priority that the Contractor

ensures the submission and finalization of such designs and drawings in the stipulated time schedules as stipulated elsewhere. It is the intention of the Employer to ensure that the approval of such submissions is made expeditiously and in time.

The Contractor shall be fully responsible for the content of all submissions to the Employer irrespective of the source or origin of information contained in such submissions. All submissions irrespective of the source or origin of information shall be checked by the Contractor and endorsed as such before submission to the Employer. The Employer will not accept submissions for review unless these requirements have been met.

Approval by the Employer of a submission by the Contractor shall mean that the Employer has no objection in principle to the content of the submission, drawings, calculations, certificates, samples and the like and that the Employer finds the content of the submission good enough to allow the work relating to the submission to proceed. Approval by the Employer shall not relieve the Contractor of his responsibility under the Contract. Approval will be given only on the basis of information available at the time to the Employer on the understanding that subsequent event may require withdrawal or modification of such approval.

5.4.2 Design

The design of the works shall be an integral part of the Contract. Such design shall include site investigation, temporary works designs and drawings, functional plans and general designs, diagrams, detailed designs and working drawings for all aspects of the works together with any and all other studies, investigations, computations, analyses and evaluations necessary to comply with the requirements of the Specification.

Functional plans and designs shall be based on the proposals submitted with the Contractor's Tender, subject to such modifications as the Employer may require.

5.4.3 Documents in Electronic Format

All documents submitted for approval shall be provided in both electronic format as well as paper copies of sufficient number as specified elsewhere. Each electronic submission shall be provided on read/writable softcopy clearly marked with the project title, submission reference and a description of the contents.

The Contractor shall provide the following electronic formats as a minimum:

Word-processing documents	-	Microsoft Word / Adobe acrobat
Spreadsheet documents	-	Microsoft Excel / Adobe acrobat
Databases	-	Microsoft Access
Programme of works	-	Primavera or equivalent
Drawings	-	AutoCAD

The Contractor shall submit details of the proposed software versions for the Employer's approval.

5.4.4 Drawing Standards, Format and Numbering

Drawings submitted by the Contractor shall be clearly printed with black lines on white paper, and shall be resistant to fading on exposure to light. Prints shall be on durable paper of good quality. Sheet sizes shall be in accordance with A series to ISO 216, and be drawn electronically at A1 size unless otherwise stated in the Contract or agreed with the Employer.

All drawings submitted by the Contractor shall use SI units.

All drawings shall be clearly and fully cross referenced to the Specification and the Employer's drawings as relevant.

All drawings shall be prepared using an identical title block format. This shall be approved by the Employer and shall identify the project, drawing title, the Employer, the Contractor, Sub-contractor, if applicable.

A formalised drawing numbering system shall be adopted with digits of each number, referencing location, revision, drawing type and size. The numbering

format and allocation of drawing number blocks shall be approved by the Employer's representative. The Contractor shall provide a sequential numbering system for all Construction Documents.

All drawings shall be submitted to a formalised checking procedure prior to submission to the Contractor. Drawings not so checked will not be approved.

Where drawings are revised, the revision letter or number shall be incorporated in the title block and the revision shall be clearly indicated on the drawing with the revision letter or number shown in an adjacent triangle. When drawings are revised, this shall be done electronically and not manually, and softcopies containing the revised files of all drawings, which have been supplied in electronic format shall be submitted at the same time as the paper prints.

5.4.5 Approval of Drawings by the Employer

The Employer representative shall arrange to send observations if necessary within 21 (Twenty-One) days of submission of the design and drawings for modifications to the Contractor. The Contractor shall incorporate all necessary comments in the above design and drawings, if any, and shall re-submit further 5 (five) copies each of the revised design and drawings within 10 (Ten) days for final approval of the Employer. The Contractor shall thereafter submit 7 (Seven) copies each of the approved design and 7 (Seven) copies each of the approved drawings together with one softcopy. The Employer's will return 2 (two) approved copies to the Contractor and retain 5 (five) for his office and field use.

If the submissions require more than one round of revision on account of incomplete compliance from Contractor, the delay will be on account of the Contractor. If new observations are given by the Employer's representative, the Contractor will be entitled to take an additional 10 (ten) days period for compliance but without any impact on contract period / time limit for completion of works. Further design calculations and drawings shall be submitted in sequence as per a schedule to be drawn and agreed upon mutually, immediately after submission of the general arrangement drawings.

Category for drawing approval as follows shall be adopted.

Category I	-	Fully approved; no observation
Category II	-	Good for construction after compliance of observations
Category III	-	Not approved, need major revision

A blank space 90 x 50 mm shall be provided immediately above the title block for the approval stamp. If required in the document elsewhere, the detailed design and the execution drawings shall be submitted only after verification by an institute approved by the Employer or his representative. The Contractor shall be responsible for preparation of working drawings and the construction documents for works, as specified in the Contract.

The Employer may require the Contractor to submit for approval additional drawings if they are necessary to enable him to satisfy himself that the items are well designed, that they comply with the Employer's Requirements and that they are suitable for their intended purpose. These drawings shall form the agreed basis for the execution of the Works. If an approved drawing is revised, revised copies shall be submitted for approval as above and no such revised drawing shall be used for the purposes of the Contract until it has been approved in place of the earlier issue of the drawing.

Approval of drawings by the Employer shall not be held to relieve the Contractor of his responsibilities under the Contract.

The Employer will not permit construction to start on a part or section of the Works unless Construction Documents for that part or section have been approved.

5.5 Preliminary Drawings

Drawings for approval shall be submitted in two Phases both in hard as well as in soft (editable) formats. The first phase shall be the Preliminary Drawings. Drawings submitted during this phase shall be of sufficient detail for the Employer and his representative to understand outline the Contractor's proposals for the design and construction of the Works.

5.6 Construction Drawings

The second phase shall be the detail design phase and shall comprise the submission of the Construction Documents. These shall be submitted after approval of the Preliminary Drawings.

The Construction Documents shall be used for the construction of the Works and shall inter alia comprise:

5.7 As-Built Drawings

These drawings shall be compiled by the Contractor and shall constitute a permanent record of the Works as executed. These shall include all such drawings, schedules, documentation and calculations as necessary for a complete understanding of the Works design, operation and maintenance.

Draft As-Built Drawings shall be submitted 60 days prior to the commissioning. The Employer will signify his approval or disapproval of the As-Built Drawings within 28 days of submission.

The Contractor shall supply to the Employer 5 (Five) copies of the As-Built drawings. The Contractor shall incorporate all necessary comments of the Employer in the above drawings, if any, and shall re-submit further 5 (five) copies each of the revised drawing within 10 (Ten) days for final approval of the Employer. The Contractor shall thereafter submit 7 (Seven) copies each of the approved As-built drawings with softcopies. The Employer will return 2 (two) approved copies to the contractor and retain 5 (Five) for the Employer's office.

A3 and smaller sized As-Built Drawings shall be provided on durable paper for reproduction by photocopier. As-Built Drawings larger than A3 shall be provided as a paper copy and also produced in the form of black lines on a durable translucent film from which further paper prints can be taken by others as required. In addition, drawings shall be provided as an AutoCAD Revision (latest version) software copy (Editable).

Text shall be provided in an industry standard word processing, spreadsheet or database format as appropriate.

SUB-SECTION 7A.6 QUALITY ASSURANCE AND QUALITY CONTROL

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SUB-SECTION 7A.6: QUALITY ASSURANCE AND QUALITY CONTROL

6.1 General

The Quality Assurance/Quality Control requirements shall be followed for ensuring strict compliance of the specifications and for ensuring the highest standards of quality of material and work. All Inspections and Testing shall be carried out in accordance with the specifications and in absence of specifications relevant Indian Standard shall be used.

6.2 QC Tests of Material for Civil Works

The tests on the construction material received on site shall be carried out as follows. The test report in triplicate shall be submitted to the Employer's Representative before use. The Employer's Representative shall return one copy to the contractor duly approved or disapproved. Material will be used only after receipt of above approval.

S.N o.	Material & Tests	Acceptance Criteria			Frequency of Test/Remarks
1	Cement (OPC) [Reference: IS 8112 and IS 12269]				
	i) Initial setting time	Not less than 30 minutes			For each consignment of 50 M.T. or part thereof
	ii) Final setting time	Not more than 600 minutes			
	iii) Fineness by dry sieving	Residue not more than 10% on 90 micron sieve			
	iv) Specific gravity	3.10 to 3.15			
	v) Compressive Strength in kg/cm²	33 Grade	43 Grade	53 Grade	
	a)3 days	160	230	270	
	b) 7 days	220	330	370	
	c) 28 days	330	430	530	
	vi) Soundness by Lechatlier apparatus	Expansion not more than 10 mm			

Note: Sulphate resistant cement as per IS 12330 wherever required as per instruction of Employer's representative shall be used. Generally, tests specified for OPC shall be applicable for Sulphate resistant cement with acceptance criteria given in the IS.

S. No	Material & Tests	Acceptance Criteria		Frequency of Test/Remarks
2	Sand [Reference IS 2116, IS 1542]			
	i) Particle Size			Tests should be carried out in the beginning and if there is a change in source.
	a) For Masonry Mortar	90-100 % passing through 2.36mm I.S. sieve		
	b) For Walls & Plaster	90-100 % passing through 1.18mm I.S. sieve		
	ii) Silt content	Not more than 4%		
	iii) Fineness modulus	a) For concrete 2.6 to 3.6		
		b) For masonry and first coat of plaster, not more than 3		
		c)For pointing & second coat of plaster shall not exceed 1.6		
	iv) Bulkage	Bulkage will have to be determined for applying correction to the quantity of sand as and when necessary.		
3	Steel (Reference: IS 432 Part1)			
	i) Manufacturer's Test Certificates per Lot	Review		-
	ii) Size	Check for actual diameter		Per Lot
	iii) Mass	Check for theoretical weight in kg/m		Per Lot
4	Water for Construction work [Reference IS 3025]			
	i) pH value	Not less than 6		Once for approval of source of supply subsequently every six months
	ii) Sulphate and Chloride content	Sulphate content-500mg/L (Max) Chloride Content-2000mg/L(Max) for PCC, 1000mg/L (Max) for RCC		
5	Coarse Aggregate [Reference IS 383]			
	i) Gradation			One test per 100m³
	Size of metal	100% passing through sieve size	100% Retained on sieve	

S. No	Material & Tests	Acceptance Criteria		Frequency of Test/Remarks
			size	
	80mm	100mm	50mm	
	60mm	80mm	50mm	
	50mm	60mm	40mm	
	40mm	63mm	-	
		40mm (35 to 70%)	40mm (30 to 65%)	
		12.5 mm (0 to 5%)	12.5mm (95to 100%)	
	40mm to 50mm	63mm	25 mm	
	For Bituminous works			
	40mm crushed metal	50mm	25mm	
	25mm crushed metal	40mm	20mm	
	20mm crushed metal	25mm	12.5mm	
	12.5mm crushed metal	20mm	10mm	
	10mm crushed metal	12.5mm	6.3mm	
	6.3 mm crushed metal	10mm	4.75mm	
		For Concrete	For Road Work	At the beginning and if there is change in source
	ii) Impact Value	Shall not exceed 45%	Shall not exceed 30%	
	iii) Crushing value	Shall not exceed 45%	Shall not exceed	

S. No	Material & Tests	Acceptance Criteria		Frequency of Test/Remarks
			17%	
	iv) Los Angels Abrasion Value	Shall not exceed 16%	Shall not exceed 50% (for WBM) and 17% for (B.T. works)	
	v) Flakiness Index	Shall not exceed 35%	Shall not exceed 15%	
	vi) Water Absorption	Shall not exceed 5%	Shall not exceed 5% for WBM and 1% for BT work	
6	Bricks [Reference IS 2212]			
		Class 1	Class 2	A set of 15 bricks for 50000 consignment or part thereof.
	i) Water Absorption	Shall not exceed 20%	shall not exceed 22%	
	ii) Compressive strength (wet condition)	32.8kg/cm² minimum	29.52 kg/cm² minimum	
7	Soil/Earth /Subgrade material [Reference IS 1498, IS 2720]			
	i) Proctor density	Shall not be less than a) 1.52 gm/cc for embankment up to 3 m height		One test per 1000m³
		b) 1.60 gm/cc for subgrade and earthen shoulders/verges/backfill		
		c) 1.65 gm/cc for top 0.5 m height of embankment		
	ii) CBR value	The Embankment shall be designed on ascertaining the CBR value.		

S. No.	Material & Tests	Acceptance Criteria			Frequency of Test/Remarks
8	Soft Murum				
	i) Plasticity Index	Below 8			One test for compaction of one layer in 1 km and every change in source or type of Murum
9	Hard Murum				
	i) Gradation	95% passing through 80mm sieve size and 2% passing through 25 mm sieve size			One test for compaction of one layer in one km and every change in source or type of Murum
	ii) Plasticity Index	Below 4			
10	Size Stone				Each lot
	i) Quality of stone	Visual check			
	ii) Dimension	As per Drawing			
	iii) Water Absorption	Maximum 5%			
	iv) Compressive Strength	Minimum 1530 kg/cm ²			
	v) Specific Gravity	Not less than 3			
11	Cement Flooring Tiles				
	Water absorption	Shall not exceed 10%			6 Tiles shall be tested for a lot of 2000 tiles or part thereof.
12	Glazed Tiles				
	Water Absorption	Shall not exceed 18%			One set of 5 tiles for every 5000 tiles or part thereof.
13	Bitumen [Reference IS 1220]				
		Grade			
		30/40	60/70	80/100	Two samples per

S. No .	Material & Tests	Acceptance Criteria			Frequency of Test/Remarks		
	i) Softening Point	50-65	40-55	35-50	lot		
	ii) Flash and Fire Point(Min)	175	175	175			
	iii) Specific Gravity(Min)	0.99	0.99	0.99			
	iv) Ductility(min)	50cm	75cm	75cm			
	v) Mastic hardness no.	60 to 80 at 25°C without coarse aggregate and 10 to 20 at 25° C after adding coarse aggregate					
14	Cement Mortar Cube [Reference IS 2250]						
	Compressive Strength	Proportion		28 Days Strength	One sample for every 2 m³ of mortar subject to a minimum of 3 samples per day		
		1:3		127 to 211 kg/cm²			
		1:4		84 to 126kg/cm²			
		1:5		56 to 84 kg/cm²			
		1:6		35 to 56 kg/cm²			
15	Cement Concrete Cube [Reference IS 516]						
	Compressive Strength	Grade	7 Days (Min kg/cm²)	28 days (min kg/cm²)	Quantity (m³) and minimum number of samples		
		M10	70	100	1-5 m³	1	
		M15	105	150	6-15m³	2	
		M20	135	200	16-30 m³	3	
		M25	170	250	31-50 m³	4	
		M30	200	300	50&abov e	4 plus	
		M35	235	350	Additional samples for each addition of 50 m³ or part		

S. No	Material & Tests	Acceptance Criteria			Frequency of Test/Remarks
					thereof. (1 sample=6 cubes)
		M40	270	400	
16	Bituminous Mix				
	i) Extraction	To check correct binder content as per the tender. Minimum stability 820kg for SDBC (Semi dense Bituminous Concrete)			2 test for each 100 tonnes of mix subject to a minimum of two tests per day per plant
	ii) Marshall Stability & Flow measurements	Minimum stability 900 kg for DBM/BC (Dense Bituminous Macadam/ Bituminous Concrete) Flow 2-4 mm			For each 100 tonnes of mix produced, a set of 3 Marshall moulds to be prepared and tested

6.3 Plant and Equipment

6.3.1 Extent & Procedure for Submission for Pre-Construction Testing & 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 specification.

6.3.2 Contractor's Quality Assurance System

Major features of the Quality Assurance System 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.

6.3.3 Inspection Call and Quality Assurance Plan (QAP)

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 and notify the Employer's Representative for inspection and testing, at least twenty-eight (28) days prior to packing and shipping and shall submit the following

- Copy of Purchase Order placed on Manufacturer (Prices may be blanked)
- Manufacturer's test results and Quality Control Certificates
- QAP incorporating inspection details and tests to be conducted on basis of relevant IS and requirements stated hereunder subsequently
- Authenticated Characteristics curves for Pump and Motor

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.

6.3.4 Inspection Categories for Plant and Equipments

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 and QAP (Quality Assurance Plan) for testing 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 Expenses of two Representatives of the Employer for travel and stay will be borne by the Contractor including Air fare. 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 Employer's representative. All cost for visit and travel of Employer's Representative will be borne by the Contractor.

Category C: - Samples of the materials and/or equipment shall be submitted to the Employer's Representative for pre-construction review and approval. Following approval by the Employer's Representative, the material may be manufactured as per the approved standards and delivered to the site.

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.

6.3.4.1 Mechanical Work / Plant

S. No.	Items	Category of
1.	a) Vertical Turbine Pumps b) Horizontal Centrifugal Pump	Category A Category B
2.	Sluice Valves with / without Actuators a) Diameter 600mm and above b) Diameter below 600mm	Category A Category B
3.	Butterfly valve with the actuator a) Diameter 600mm and above b) Diameter below 600mm	Category A Category B
4.	Non –Return Valve/Dual Plate Check Valve	Category A
5.	Pipe work a) Diameter 600mm and above b) Diameter below 600mm	Category A Category B

S. No.	Items	Category of
6.	Sluice gates	Category A
7.	E.O.T Crane	Category A
8.	Monorail and other lifting equipments	Category B
9.	Air vessel	Category A
10.	Air compressor	Category B
11.	Chlorination Equipment (Except Pump)	Category A
12.	Motor 90kW and above	Category A
13.	Motor below 90kW	Category B
14.	Blower	Category B
15.	Metallic bellows, Expansion Joints and Dismantling	Category A
16.	Air valves	Category A
17.	Drain and dewatering Pump sets	Category B
18.	Ventilation Equipments	Category A
19.	Portable Fire Extinguisher	Category B
20.	Air Conditioners	Category B
21.	Scrubber System	Category A
22.	Screen	Category A
23.	Flash Mixer, Flocculator Equipment, Rotating Bridge, Centrifuge, Tube Modules (For Tube Settler), Filter Nozzle, Clarifier Plates (For Plate Settler)	Category A
24.	Scrubber system for chlorine Neutralisation	Category A
25.	Stop log Gates	Category A

6.3.4.2 Electrical Works

S. 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.	Power Transformer (including OLTC, RTCC panel)	Category A
6.	MV and LV Capacitors and APFC Panel	Category A
7.	HV, MV and LV switchboards, Relay control panel	Category A

S. No.	Items	Category of Inspection
8.	LV Variable Frequency Drive and Soft Starter	Category A
9.	Starters (Other than Soft Starters)	Category B
10.	Battery and Battery Charger and DCDB	Category A
11.	Cathodic protection- Transformer/ Rectifier (T/ R)	Category A
12.	Outdoor 132kV accessories for substation (i.e. Fuse, ACSR Conductor, Clamps and connectors, hardwares,	Category B
13.	Cathodic Protection equipment other than T/ R units	Category B
14.	Neutral Grounding Resistor	Category B
15.	Sub-Distribution Boards, Lighting Panels and	Category B
16.	Lighting System, illumination	Category B
17.	UPS System	Category B
18.	HV, MV and LV Power and Control Cables	Category B
19.	MV/LV Cable Termination	Category B
20.	Motors MV & LV	Category B
21.	Printers	Category B
22.	Earthing System and lightening protection	Category B
23.	Local Push Buttons, local distribution n boards etc.	Category C
24.	Cable tray and accessories	Category B
25.	LV DG Sets, Diesel Storage tank	Category A

6.3.4.3 Instrumentation Control and Automation

S. No.	Items	Category of Inspection
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
3.	Instrument Control Panel for Water Treatment Plant along with PLC System.	Category A

S. No.	Items	Category of Inspection
4.	Local SCADA Systems (Integrated testing with PLC system including ICP and wireless communication equipment) for RWPS, WTP and for CWPS. Central SCADA MBR & WTP	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.	Full Bore Electromagnetic Flow meters	Category A
11.	Pressure Switches	Category B
12.	Differential pressure Transmitters	Category B
13.	Ultrasonic type level measuring systems	Category B
14.	Float type Level Switches	Category B
15.	Instrumentation and Control cables	Category B
16.	Instrumentation Control Panel	Category A
17.	Radar type level meter	Category B
18.	Pressure transmitter	Category B
19.	Alarm Annunciator	Category A
20.	Open channel flow meter	Category B
21.	Turbidity meters	Category B
22.	Residual chlorine meter	Category B
23.	PH meter	Category B
24.	Laboratory instruments and equipment	Category B
25.	Pressure Gauges	Category B
26.	Portable temperature monitor	Category B
27.	Portable sound level meter	Category B
28.	Portable vibration meter	Category B
29.	Laptop Computers	Category B
30.	EPABX System	Category A

6.3.5 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 and review of Manufacturer's Certificate for Category A and Category B.

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 not 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 Manufacturer 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 certificate 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.

SUB-SECTION 7A.7

ERECTION, TESTING AND COMMISSIONING

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SUB-SECTION 7A.7: ERECTION, TESTING AND COMMISSIONING

7.1 Erection General

The contractor shall obtain all statutory, legal permissions and Licenses as applicable to layout & construction of the complete plant and systems including HT Substations, from appropriate Central Government, State Government, Municipal Corporations and other agencies. The contractor shall obtain all prior approvals from the concerned authority including lay out drawings before execution and after completion of work of plant wherever necessary.

The cost, fees etc. as applicable for obtaining all the statutory, legal permissions, Licenses, approvals shall be borne by the contractor during the execution and defect liability period of project work.

The Contractor's staff shall include adequate and competent (holding license from competent authority) erection engineers with proven, & adequate experience on similar Contracts to supervise the erection of the Works and sufficient skilled, semi-skilled and unskilled labor to ensure completion of Works in time and with quality. The Contractor shall not remove any supervisor, erector or skilled labor from the Site without prior approval of the Employer's Representative.

The Contractor's key supervisor responsible for erection shall be an erection engineer who is conversant with the erection and commissioning of the complete Works. If there are more than one erector, one of them will be in charge and the Contractor shall inform the Employer's Representative in writing which erector is designated as his representative and is in charge

The contractor shall submit the erection methodology stage-wise and stepwise, QAP (Quality Assurance Plan) and name of the erection engineer with qualification and experience for approval of Employer's Representative. The Contractor shall ensure that no installation or erection work shall commence until full and unconditional approval to working drawings, erection method and QAP signed and stamped by the Employer's Representative are available at Site.

The Contractor shall be responsible for setting up and erecting the plant to the line and levels of reference and of the positions, levels, dimensions and alignment, and provision of appliances and labor in connection therewith. The checking of setting out of any line or level by Employer's Representative shall not in any way relieve the Contractor of his responsibility for the correctness thereof.

Erection of Plant shall be phased in such a manner so as not to obstruct the work being done by other contractors or operating staff who may be present at the time. Before commencing any erection work, the Contractor shall check the dimension of structures and pockets for foundation and holding down bolts and other erection aids, anchors, cutouts where the various items of Plants are to be installed and shall bring any deviation from the required position, lines or dimensions to the notice of the Employer's Representative. Plant shall be erected in a neat and workman like manner on the foundations and at the locations shown on the approved drawings. Unless otherwise directed by the Employer's Representative, the Contractor shall adhere strictly to the aforesaid approved drawings.

The Contractor shall align all equipment and holding down bolts and shall inform the Employer's Representative before proceeding with grouting-in the items concerned. The Contractor shall ensure that all equipment is securely held and remains in correct alignment and levels before, during and after grouting-in. The approval by the Employer's Representative of the Contractor's proposals for rigging and hoisting any items of the Plant into their final positions shall not relieve the Contractor from his responsibility for damage to completed structures, parts or members thereof or other installed equipment. He shall at his own cost make good, repair or replace any damaged or injured items, whether structural, electrical, architectural, or of any other description, promptly and effectively to the satisfaction of the Employer's Representative. No Plant, equipment or other loads shall be moved across the floors of structures without first covering the floors with timber of sufficient size so that applied loads will be uniformly transferred to floor beams and girders. If it is required to reduce bending stresses and deflection, the beams and girders shall be provided with temporary supports. During erection of the Plant the Employer's Representative will inspect the installation from time to time in the presence of the Contractor's Site

representative to establish conformity with the requirements of the Specification and good engineering practice. Any deviations, flaws and deficiencies found or evidence of unsatisfactory workmanship shall be corrected as instructed by the Employer's Representative.

7.2 Erection of Plants and Equipment

7.2.1 Leveling and Grouting of Machinery

Contractor shall undertake, sufficiently in advance, chipping of any unevenness of concrete on foundations, anchor bolt pockets, cutouts etc., to achieve uniform level of reference for erection. All concrete surfaces receiving grout shall be chipped as required to ensure better bonding with the grouting. Contractor shall undertake the inspection of all components to be erected sufficiently in advance to check their soundness and conformity to drawings and the inspection records shall be signed by the Employer's Representative as approval for undertaking the installation of the components. Any damage, shortfalls etc. shall be made good to the satisfaction of the Employer's Representative. All grout for equipment shall be carried out using non-shrinkable continuous grout materials with suitable framework of at least 12mm thickness. Surfaces to receive the grout shall be chipped and roughened and laitance shall be removed by wire brush or blast of air. Concrete surface shall be blown off by compressed air before commencing grouting. Before commencing grouting it shall be confirmed that air displaced by pouring grout has way out to atmosphere. Grouting shall be done in one continuous operation from one side such that grout flows in a single wave until grout reaches all confined spaces with no air pockets and air from all confined spaces is expelled. A hydrostatic head of 150 mm shall be maintained during grouting operations. All grouting shall be carried out in the presence of the Employer's Representative. All lines and levels shall be checked after grout is set. Block-outs shall be closed using cement concrete of the same grade as that of the parent structure.

7.2.2 Pumps

- (i) Check the surface of location of pump to be grouted and surface of sole plate for cleanliness and level.
- (ii) Check the foundation bolts for fixing sole plate are rigidly anchored and sufficiently projected above sole plate for rigid tightness.
- (iii) Check the matching of sole plate holes and discharge head plate by assembling before erection of sole plate.
- (iv) Check all the special tools & tackles and lifting arrangement are in working condition.
- (v) Check with high precision spirit level that the sole plate and discharge head plate assembly are at correct horizontal level and the flange at exact vertical level.
- (vi) Check the alignment of pump set for tolerance limit set by manufacturer of pump.
- (vii) Check free rotation of pump.

7.2.3 Air Blower

- (i) Check the grouted foundation anchoring bolts, base frame holes for matching.
- (ii) Check the manufacturers recommended Anti-vibration pad mounting to base frame.
- (iii) Check level of base frame with high precision spirit level and grouting / foundation place.
- (iv) Check manufacturer's recommendation for size of foundation.
- (v) Check alignment air blower set before and after assembly of suction and discharge silencer.

(vi) Check for alignment of air blower set which shall be within tolerance limit set by the manufacturer.

(vii) Check free rotation of air blower set.

7.2.4 Electric operated Crane / Manually operated Crane

(i) Check the horizontal and vertical mounting plates of suitable structural strength perfectly welded to RCC steel bar on Corbel and column.

(ii) Check all the plates installed on RCC column and corbel are aligned in level by water tube.

(iii) Check girder level individually and in parallel for perfect horizontal level before welding to plates on corbel and column.

(iv) Check rail level by tack welding to girder and joints for correct horizontal level.

(v) Check the safety equipment's, lifting equipment's for placing EOT assembly on rails.

(vi) Check that longitudinal travel and lateral travel covers all equipment to be handled.

(vii) Check Crane for rated load capacity after successful erection.

7.3 Records, Procedures and Reports

The Contractor shall maintain records pertaining to the progress and quality of installation / erection work and inspection, testing, compliance with all technical requirements in respect of all his works as described in the previous paragraphs. The reporting shall be in the approved formats. The Contractor shall submit such records to the Employer's Representative after the erection of any particular work before submitting the bill of supply / progress of work. Such report shall comprise shop inspection reports, shop testing reports, material test reports, and all the quality control reports of welding, erection

and alignment records. All the above mentioned records shall be submitted in the final form duly countersigned by the Employer's Representative attesting conformity to specifications and his approval of installation, and duly incorporating all the additions, alternations, and information as required by the Employer's Representative, on the basis of preliminary reports giving the progress of the work. Such records notwithstanding, any records submitted earlier with bill of supply / progress, etc., shall be duly bound and submitted to the Employer's Representative in six copies by the Contractor on completion of erection.

7.4 Completion of Erection

7.4.1 Plant Erection

The completion of erection by the Contractor shall be deemed to occur if all the units of the Plant are structurally and mechanically complete and will include, among other such responsibilities, the following:

- Plant in the Scope of the Contract has been erected, installed and grouted as per specifications
- Stage-wise and stepwise erection checks are completed and approved by the Employer's Representative
- Erected Plants are totally ready for commissioning checks

At the stage of completion of erection, the Contractor shall ensure that all the physical, aesthetic and workmanship aspects are totally complete and the Plant is fit and sound to undergo tests on completion and subsequent pre-commissioning checks.

Upon achieving the completion as described above, the Contractor shall, after having given 21 days advance notice of the expected date for carrying out the inspection, notify the Employer's Representative by a written notice intimating completion of erection and notify the Employer's Representative for inspection along with equipment-wise and item-wise check list submitted and

instruments and gauges such as water tube precision spirit level, feeler gauge, dial gauges, torque wrenches, etc. are kept ready for erection checks. The Employer's Representative shall proceed with the inspection of such units within 7 days.

The Employer's Representative shall certify completion when there are no defaults in the Works or provide the Contractor with a list of deficiencies for rectification, hereinafter referred as the "Punch List". The Contractor shall complete the rectification work within a jointly agreed period before pre-commissioning activities and obtain the Employer's Representative's acceptance or approval before proceeding with pre-commissioning checks. The Employer's Representative may inform the Contractor that the works are accepted with the Punch List (items which do not hamper operability, safety or maintainability) and allow the Contractors to proceed with the pre-commissioning checks when the Contractor undertakes to complete such outstanding works within an agreed time prior to completion of commissioning. Taking over shall be based on rectification of all deficiencies which are to be completed before acceptance as mentioned in the Punch List.

7.4.2 Safety Procedure and Practice

a) Mechanical

- For all rotating equipment coupling guard shall be provided
- Lifting equipment for various items shall be of suitable capacity
- All floors / tiles at work and other places shall not be slippery
- Safety signboards shall be displayed at works
- At all places for alighting in trenches, passages and deep site works ladders, safety belts shall be used
- Barricading and danger boards shall be provided wherever necessary
- Chain, Wire ropes, other tiding apparatus condition shall be checked

b) Electrical

Following safety procedure and practice should be provided by the Contractor in the switchboard room/substation as per latest edition of I.S. 5216.

(i) Rubber matting in front of HV, MV and LV switchboard and other panels in switchboard room

(ii) Shock treatment chart in switchboard / electrical equipment room

(iii) Caution/Danger Board on –

- HV, MV and LV switchboard and other LV panels
- Lighting distribution board
- Transformer yard

(iv) Sand bucket in switchboard / electrical equipment room/ transformer yard

(v) Fire extinguisher in switchboard/ electrical equipment room

(vi) Four sets of hand gloves in switchboard room of each location

(vii) First aid box in electrical equipment room/ Chlorination plant /pumping plant

(viii) Fire Safety

The requirement of hand appliance in switchboard room, electrical equipment room shall be as per the latest edition of Fire Protection IS code of practice and National Building code.

7.4.3 Documentation

Set of documents shall be prepared and maintained by the Contractor and one set of the latest revised documents shall always be kept at site. The following documents shall be prepared by the Contractor:

- (i) All latest approved L-sections and alignment drawings
- (ii) All up-to-date as built drawings as well as approved drawings in Category I for all mechanical, electrical, instrumentation and civil works
- (iii) Data sheets for instrument specification and selection
- (iv) List of all equipment along with data sheet/ literature
- (v) Erection/ Instruction manual for all equipment
- (vi) Commissioning manual for all equipment
- (vii) Instrument Schedule
- (viii) Electrical cable schedule and inter-connection diagram
- (ix) Instrumentation schedule
- (x) Instrumentation cable schedule
- (xi) Loop drawings for instruments in the field and control panel
- (xii) Instrument test and calibration report
- (xiii) Instrument installation drawings
- (xiv) The Contractor shall keep on site two sets of the latest revised Operation, Maintenance and Calibration manuals for all field instruments and sub systems, annunciation system, data loggers, indicating controllers and PLC system etc.

7.5 General Preparations for Pre-Commissioning and Commissioning Tests

The commissioning period as notified by the Contractor shall include all periods of pre-commissioning, trial runs and tests on completion. It is in the Contractor's interest to offer the section/units/systems, progressively under Identified milestones within overall erection and commissioning period, duly completed for rectification of any deficiencies pointed out by the Employer's Representative and to achieve mechanical completion before undertaking the tests on Completion within the specified period. The Employer's Representative also reserves the right to withhold the cost is estimated to be equivalent to the rectification of deficiencies pointed out to the Contractor until such a time as the deficiencies are rectified by the Contractor to the satisfaction of the Employer's Representative.

The documents listed in Sub-clauses 7.5.1, 7.5.2, 7.5.3 and 7.5.4 shall be completed in accordance with the Contract schedule before commencement of pre-commissioning and commissioning tests. The Employer's Representative and the Contractor shall preserve and control these documents in a safe and appropriate place on Site in order that both parties' personnel can make use of them at any time.

7.5.1 Technical Documents

- Operation and Maintenance manual
- Design documents including the Contractor's design data, drawings and Specifications
- Tools and test equipment list
- Spare parts list
- Lubricant list

7.5.2 Procedures

- Mechanical testing procedure
- Electrical testing procedure
- Instrumentation testing procedure
- Detailed pre-commissioning and commissioning procedures and tests
- Detailed Performance Test procedure

7.5.3 General and Coordination Documents

- Detailed organization charts for pre-commissioning and commissioning tests showing lines of authorities and responsibility, and functions of all key personnel
- Job description of the members of the team
- Scheduled dates of assignment of each member to pre-commissioning and commissioning works
- Detailed schedule showing the time sequence which the Contractor anticipates to follow for the various steps in completion of trial run, pre-commissioning and commissioning of each unit and equipment
- Regulations for safety, hygiene and discipline
- Practical organization of the relationship (meetings, reports, etc.) between the Contractor and the Employer's Representative at the phases of pre-commissioning and commissioning
- Emergency communication route

7.5.4 Manpower

Required manpower shall be provided as agreed between the Contractor and the Employer's Representative in a Manpower Mobilization Plan, which shall include the number and qualifications of the operator and maintenance personnel to be furnished by the Employer's Representative for the Plant.

7.6 Pre-Commissioning Checks and Commissioning Tests

7.6.1 General Requirements

After the completion of erection, pre-commissioning activities listed below shall be carried out to make the Plant ready for commissioning. All instruments, materials and provisions necessary for conducting site tests shall be provided by the Contractor at his own cost. Upon completion of erection of each piece of equipment, facility or discrete part of the plant, mechanical checks and tests shall be carried out according to the Contractor's checklist. The mechanical checks and tests shall be to establish that:

- The Plant is erected in accordance with the Contractor's construction drawings, pipe work drawings, instrument diagrams, etc., issued for the Plant;
- Materials are installed and mechanically function in accordance with the Contract; and
- Applicable codes as listed in the Contract are followed for materials and workmanship

Items such as painting, thermal insulation and final cleanup which do not materially affect the operation or safety of the Plant will be excluded. All these items shall be listed and completed after pre-commissioning but before acceptance.

The Contractor shall prepare and maintain at Site test forms and records, which shall include:

- Check list details in the tests and checks;

- Date and times of test or check;
- Identification of equipment and facilities;
- Test pressure, test data and results, including remarks, if any; and
- Signature of the Contractor's personnel attesting to data recorded; if any.
The Contractor's construction forces thereof shall carry out checks, tests and records

Wherever the Employer's Representative's is witnessing or attesting of the check or test is required, the Employer's Representative's personnel shall attend such check and test. For this purpose, the Contractor shall keep the Employer's Representative informed of a day-to-day test plan schedule. The test plan schedule may be revised from time to time to reflect the actual progress of the work and test. Any items found incomplete or requiring rectification repair or adjustment shall be marked as such on the test records and reported by the Contractor to the Employer's Representative and the Contractor's personnel in-charge of the relevant unit. Checking procedures shall be repeated until all the items on the checklist are cleared. A complete set of test records shall be handed over to the Employer's Representative on completion. The tests on the different mechanical and electrical equipment shall include but not be limited to:

7.6.2 Mechanical Equipment

A) Pumps, Piping and Valves and other mechanical plant

- i) Leakage tests shall be carried out on all erected pipe work, pumps and valves and immediately after erection where possible before being built in
- ii) Operating tests shall be conducted on valves and actuators

- iii) The pumps shall be tested for mechanical performance. The vibration and noise levels shall be checked to be within the specified limits
- iv) Pump performance tests shall be conducted for all raw water and clear water pump sets. Each pump shall be tested one pump at a time
- v) Check and verify efficiency of each pump and vibration of pump
- vi) Check the running of different combinations of pump sets and verify the various parameters within permissible limits
- vii) To check the sequential start and stop of pumps with level control and automation scheme
- viii) Check suitability of dismantling joint by working on nut-bolts and sliding flange
- ix) Check whether motor current is within safe limit
- x) Check feasibility of access for lubrication and maintenance to all bearings
- xi) Check operation of EOT crane current drawn limit and position switch for pendants

B) Stop Log Gates

The frames for stop logs gates shall be properly grouted and level and inner gap suitable to stop log gate shall be checked, stop log gates rubbers shall be checked for rigid fixing with gates. Chain pulley block shall be checked for proper load capacity and load chain travel for required depth. The structural members for lifting arrangement levels and its grouting foundation shall be checked. The lifting arm for stop logs shall be checked by lifting the gates with lifting arm outside before insertion of gates. Operation, function of complete stop log arrangement shall be checked for water leakage at site

C) Screen and its Lifting Arrangement

Check frame for screen insertion for proper grouting and levels with inside tolerance suitable for screens. Check the dimensions of screen suitable for frame which shall cover complete area for screening function. Check lifting arrangement for removing screen for cleaning and other maintenance purpose. Structural members of lifting arrangement grouting and level of chain /wire rope shall be aligned so that screens can be easily inserted in or removed from location. Chain pulley block shall be checked for proper load capacity and load chain travel for required depth. Operation of all complete screen shall be checked

D) Sluice Gates & Manual Actuators and Lifting Arrangements

Check the erection & level of frames of all sluice gates as per requirements. The shaft of sluice gate shall be checked for intermediate supports for smooth operations. Gearbox / lifting arrangement shall be exactly in vertical position. Operation of all the gates shall be checked one by one. All the gates shall be checked for function open and closure.

E) Load Testing of Lifting Equipment

The Contractor shall carry out all the tests to the satisfaction of the Employer's Representative. The Contractor shall be responsible for coordinating the Programme of site testing of all items methodology for testing shall be submitted to Employers representative for prior approval.

7.6.3 Pump Motors

Condition of winding insulation be tested and insulation values shall be restored to required level by suitable heating arrangements locally.

7.6.4 Instrumentation Testing Requirements

(a) Tests on Cables

- i. Check details are in accordance with the specification
- ii. Check for physical damage
- iii. Megger test between each core and armour / sheath
- iv. Continuity check
- v. Connections

(b) Continuity of Signal/Control/Power Supply Cables

After laying of the field signal/control/power supply cables and prior to connection up to the control panels/instruments, the following procedures shall be adopted:

- i. The signal/control/power supply cables shall be disconnected from each termination point in turn when the wires shall be 'rung-through' for identification and tagged.
- ii. The signal/control/power supply cables shall be reconnected to the termination points and again 'rung-through'.

(c) Loop Test

After testing and calibration of individual instruments forming the various loops, simulated functional test of the whole loop shall be performed before pre-commissioning. The procedure for conducting these tests shall be decided by the Employer's Representative and results shall be recorded. During loop test, it is the Contractor's responsibility to ensure that the calibration of instruments is intact and in order and if any instrument is found defective in calibration, he shall recalibrate the same without any extra cost. After the loop test is over, he shall connect back all the terminations and connections removed for loop test.

(d) Tests on Electrical Installation

- i. Check all closing, tripping, supervision and interlocking of control devices.
- ii. Check operation of all alarm circuits.

(e) Test on Complete Control System

- i. On completion, the functioning of the complete control system shall be tested to demonstrate its correct operation in accordance with the Specification.
- ii. For control system testing, the Contractor may provide temporary means to simulate operating conditions, but the system will not be finally accepted until correct operation has been demonstrated to the satisfaction of the Employer's Representative when all the Plant is operating.
- iii. The system shall be shown to operate correctly whatever the selection of duty and standby equipment's may be.
- iv. Conditions to be tested shall include:
 - Normal automatic operation
 - Normal manual operation
 - Emergency manual operation

(f) System Validation

- i) The services of factory trained and field experienced instrumentation engineer(s) shall be provided to validate each system and verify that it is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean square sum of the system component published specified accuracy from input to output.

- ii) Each system shall be validated by simulating inputs at the first element in loop (i.e. Sensor) of 10 %, 50 % and 90 % of span, or on/off and verifying loop output devices (i.e. Indicator, alarm etc. except controllers).
- iii) During system validation, provisional settings shall be made on levels, pressure, alarms etc.
- iv) Correct operation of controllers shall be verified by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. All logic sequences shall be verified to operate in accordance with the specifications. All defects and malfunctions disclosed by tests shall be corrected immediately. New parts and materials shall be used as required and approved and tests shall be repeated.
- v) A report certifying completion of validation of each instrument system indicating calculated system tolerances, verification that the system meets these tolerances and any provisional settings made to devices shall be provided. The report shall be made in the format required by the Employer's Representative and shall be certified by the Employer's Representative when he approves it.

(g) Final Operational Testing and Acceptance

- i) Upon completion of instrument calibration and system validation, all systems shall be tested under process conditions.
- ii) The testing shall include, but not limited to all specified operational modes, taking process variables to their limits (simulated or process) to verify all alarms, failures, interlocks and operational interlocks between systems and/or mechanical equipment.
- iii) Any defects or malfunctions shall be immediately corrected using approved methods and materials and the tests shall then be repeated.

- iv) Upon completion of final operational testing, a report shall be submitted, indicating that the total control system provided meets all the functional requirements specified herein. This report shall be made in the format required by the Employer's Representative.

The Employer's Representative shall certify this report when he approves it and it shall constitute final acceptance of the control system.

7.7 Electrical

The commissioning engineer shall verify any commissioning tests / completion checks to satisfy him with suitable and calibrated testing kits as required, that the plant is fit and sound. The commissioning tests / completion checks to be carried out shall include, but not be limited to, those described in subsequent paragraphs, as applicable to the individual equipment / system.

7.7.1 Sub-Station Installation

Installation work should be divided in two broad categories.

a) Indoor installation work preconditions for commencing

- Civil works should be complete
- Material, equipment should be available
- Essential interface work should be complete

Indoor work can be conducted during rainy season

b) Outdoor work preconditions for commencing

- Civil work in that area including foundations, cable trenches, approach roads etc. should be complete

- Material and equipment should be available
- Planned sequence should be followed
- Rainy season should be avoided for final assembly work of equipment like circuit breakers, transformers

c) Preliminary Preparation

The preliminary preparations include study of drawings, acceptance reports, checking certificates and test reports of the equipment. Completion of civil engineering works, arranging the tools, lifting gears etc. organizing the labour, prepare the schedule of installation, preparing sequences cards for erection major items etc.

d) Drawings for erection

The drawings include:

- Circuit diagrams of the plant
- Civil engineering plans, foundation plans etc.
- Dimensions drawings of equipment
- Equipment assembly, subassembly, component drawings
- Interface drawings (inter relationship between various auxiliaries)

e) Field Quality Plans (FQP)

Each equipment should have FQP for erection, pre-commissioning and final testing. The instructions for field quality checks, formats for test records etc. shall be prepared for monitoring.

f) Safety Procedures

Procedures and paper works for the following should be enforced from the beginning.

(i) Permit to work

(ii) Access to work

(iii) Entry passes

(iv) Material gate pass etc.

(v) Follow the safety rules faithfully

(vi) Take permission from authorized person for doing specific work

(vii) Place condition notice and danger notices

(viii) Make sure to switch off the supply from both ends

g) Installation

The erection sequence may differ somewhat from site to site depending on various circumstances. After the erection of the steel structures comes the erection of the insulators and the phase conductors, bus bars etc. Thereafter follows excavation for the underground earth mat.

(i) Erection of Galvanized Steel Structures

Structure shall be built by bolting of section from ground to top. Skilled erection personnel shall be provided to build up the upper portion step by step. The construction should be complete and final lightning shall be done after adjustment into straight position.

The structures shall be provided with identification marks to enable proper and speedy assembly at site. The vertical axis shall be maintained. Alignment in vertical position shall be ensured by use of the odolite, plumb line, spirit level on horizontal members.

Cross beams shall be erected on the ground and hoisted up by means of a derrick or a mobile crane.

(ii) Insulators

All insulators shall be checked immediately upon arrival at site.

Post insulators shall be installed on respective support structures by using suitable crane. Correct galvanized hardware and torque spanners of specified torque shall be used.

String insulators shall be then raised up to gantry holding point and installed by using correct galvanized hardware.

The main problem with insulators is protection against damage during transportation, handling and erection. Insulators shall be protected by wooden cages during the entire erection period.

(iii) Rigid Aluminium Tublor or ACSR Busbars

After installing post insulators, the bus bars shall be erected. The length of tubes shall be cut to size, edges are filed for perpendicularity and removal of byros and sharp corners. Edges are prepared for welding.

The tubular busbars shall be fastened on to the rigid insulators by using correct hardware. Mating surfaces of clamp and tube shall be cleaned by energy paper prior to tightening the nut bolts anti-oxidation jelly shall be applied immediately.

When connecting conductors etc. care must be taken not to introduce stresses such as bending forces, pull etc.

The erection of ACSR conductors of flexible bus is stringing and connection for all conductors. Erection of connectors and

clamps is a very critical activity and must be done as per instructions. Necessary quality checks shall be made. Connectors shall be handled carefully to avoid scratches, dirt, damage to threads etc. Preparation for connections and tightening of bolts shall be done carefully.

(iv) CTs, VTs

These shall be installed on respective structures. The porcelain shall be closely observed for cracks. Small chips up to 8 mm diameter shall be rectified by means of epoxy resin. Larger chips shall not be allowed.

When erecting current and voltage transformers, the oil level shall be checked and it should be checked that the insulator etc. has not oil leakage. The connections of secondary earth, primary shall be checked twice.

Lifting equipment, slings etc. must be applied at the correct places. Lifting by slinging on the primary connection must not be done under any circumstances.

The following tests shall be done before the erection to verify the healthiness of CT / VT.

(i) Ratio test (ii) Insulation measurement (iii) Continuity (iv) DC resistance

(v) Surge Arrestors

Surge arrestor shall be lifted and assembled on the structure. The correct functioning and protective ability of the surge arrestors shall be ensured by:

- The erection of the arrestor as close as possible to the object to be protected, usually a power transformer

- Connection of the arrestor's lower main earthing terminal shall be made with the shortest possible conductor to the earth mat
- The transformer tank shall be connected to the same ground point as the arrestor lower main earthing terminal
- Separate earthing of arrestor and transformer tank must not be made under any circumstances, as the arrestor cannot protect the transformer in such case

(vi) Disconnectors (Isolators)

The manufacturer's instructions shall be carefully followed for erection of isolators, operating mechanism etc.

The insulator columns shall be assembled on the structure. The contact arms, operating mechanism, the linkages between three poles shall be assembled. Correctness of alignment, simultaneous closing of all contacts shall be checked by manually and electrically operation.

(vii) Outdoor Circuit Breakers

The breaker shall be assembled by trained personnel of the erector or manufacturer. The breaker is dried out by hot air circulation followed by evacuation. Breaker is kept in vacuum for at least 20 hours to ensure removal of water drop lets and moisture completely. Thereafter SF6 gas is filled. The leakage test shall be carried out by means of soap solution, SF6 leakage detector and by monitoring pressure gauge. Leakage free performance should be ensured before commissioning.

The auxiliary systems of mechanism, gas monitoring system, operating pressures of compressed air or hydraulic mechanism etc. shall be verified. Settings of pressure switches and their functioning shall be verified. The reaction of the circuit breaker is a comprehensive job shall be carried out in accordance with the erection manual.

Outdoor circuit breakers shall be mounted on pre-fabricated galvanized steel structures. Structures shall be supplied by the manufacturer of breakers.

(viii) Installation of Transformers

The tank filled with dry nitrogen gas shall be unloaded near the final plinth or in nearby concreted floor of adequate bearing capacity by sliding on the wooden sleepers. Sufficient number of hydraulic jack shall be used for unloading.

After unloading the tank on the plinth, the following activities are carried out:

- Assembly of tap changer
- Assembly of bushings
- Installation of control cabinet
- Power cables
- Fitment of accessories

Filtered oil is filled into the transformer tank. The oil is circulated through the filtering plant. The filtration continued till the following is achieved

- Enough breakdown value of the oil sample from the tank
- Enough dryness of oil from the tank
- Designed chemical composition (purity)
- Insulation resistance and polarization index of transformer
- “Tans” measurement

(ix) Earthing System

Earth resistance shall be measured during dry season and wet season. These values shall be within permitted limits.

The earth mat work includes burying of earth rods and earthing copper plates, earthing mat, risers. All recommended parts are connected to earth mat to eliminate the danger of step and touch potentials. The earth mat must be made with great care to ensure personnel safety from dangerous touch potential and step potential. The part of the earthing system above ground must be carefully laid and connected. Follow strictly the erection documentation for:

- Structure earthing
- Tower earthing and earthing of overhead earthings hold
- Apparatus and cabinet earthing
- Earthing switches terminal
- Disconnecter with switch terminal
- Equipment earthing
- Transformer neutral earthing
- Transformer tank earthing
- Surge arrestor terminal earthing
- Cable racks earthing
- Capacitor neutral earthing
- Earthing of fencing, doors, screens, lamp post etc.

(x) Commissioning of substation

Commissioning activity follows erection and involves final checks, subsystem tests, system tests and load tests.

The commissioning organization includes:

- Commissioning in charge
- Control room engineers
- Test engineers for AC yard
- Test engineers for auxiliaries etc.
- Supervisors and electricians, mechanics etc. for quick repairs
- Documentation and field quality engineers

(xi) Documentation

- Test records of every equipment shall be verified and signed
- If test results show abnormal or doubtful values the “hold points” shall be identified and corrective actions are taken before continuing the further work in that apparatus
- After completing all the equipment tests, the subsystem tests shall be carried out. These involve a group of equipment's i.e. a switchgear bay with circuit breakers, isolators, earthing switches, CTs, protection system etc.
- Final system tests shall be performed as per agreed schedule and sequence
- Commissioning shall be carried out from control room in liaison with all the sub system engineers

The sequence of operations of earthing switches, isolators, circuit breakers is listed, before commencing the charging operations.

After each operation from control room, the position of indicating mark on mimic board is observed.

Meanwhile, the observers in yard inspect the equipment from nearby location and inform the status about operation to control room engineer over walkie-talkie / phone.

The sequence of operations is completed and the system is energized.

All the equipment's in yard are observed for corona, hot-spots leakage, flashovers, sparking etc.

Hot-spots on clamp and connectors are observed by means of remote sensing binoculars.

During commissioning, control board is closely observed for meter readings, indication by relays etc.

If alarm or tripping occurs, investigation and corrective actions are taken before proceeding further.

(xii) Commissioning Tests

These are divided in the following categories:

- i) Equipment functional checks and tests
- ii) Sub system checks and tests
- iii) Complete system tests at low voltage; without voltage

iv) Commissioning tests before and after system HV energization

v) Performance tests

(xiii) Equipment Tests

The equipment tests on each individual equipment are performed in accordance with the site testing plan, site tests are with all the associated equipment, auxiliaries, sub system etc.

The equipment tests include the following (as applicable)

- Insulation resistance measurements
- Resistance measurements
- Phase sequence tests
- Polarity tests
- Ratio tests
- Operating timing tests
- Continuity tests
- Insulation resistance of auxiliary circuits
- Mechanical operation tests
- Sequential operation tests
- Applied voltage tests
- Primary injection tests

- Secondary injection tests
- Functional operation tests
- Performance characteristics tests

Site tests shall be carried out on individual equipment's as per manufacturer's recommendations. The site test results shall be compared with the shop tests results to confirm that the equipment has been assembled correctly and is in proper functioning state.

(xiv) Sub-Systems Tests

The sub-system comprises several equipment's, associated electrical and mechanical connections, controls, interlocks etc.

The sub-system tests are performed as per schedule. These include:

- Tests on main circuits
- Tests on auxiliary circuits
- Tests on protective and control circuits
- Tests from local points
- Tests from control room
- Current injection tests
- Applied voltage tests
- Insulation resistance tests
- Functional tests

(xv) Tests on Protection Systems

- Tests before energizing the secondary equipment
- Tests before energizing primary equipment's
- Synchronizing tests
- Tests on each protection zone
- Tests on overlapping of protective zones
- Test by initiating protection from the control room
- Staging fault tests by artificial fault in protective zone

Secondary Injection Tests:

These tests consist of injecting current through the secondary circuits and checking operation of relays.

Primary Injection Tests:

These tests shall be conducted by injecting currents through primary circuits of CT's.

Tripping and closing tests on circuit breakers

These shall be conducted from:

- Local kiosk near the CB
- By initiating the protective relay from the protection panel
- By initiating the push button from the control panel

Indications and Alarms

- Each indication and alarm on the annunciation panel should be checked

(xvi) Phasing Tests

Before paralleling a transformer, the following shall be checked

- The phase sequence
- The polarity
- The ratio, etc.

(xvii) On Load Tests

The voltage is applied initially for a fraction of second to one second under close observation.

After satisfying healthy installation, the voltage is applied for a little longer duration under close observation. Relay panels, instrumentation panels. Auxiliaries, outdoor years are observed closely for flashovers, corona, noise etc.

After ensuring no flashovers and tripping, the voltage is applied for a longer period.

During commissioning close observation is necessary for several hours, days etc. as per field quality norms.

After loading, the busbars and connectors should be observed for hot spots if any.

(xviii) Handing over to the operating staff

After successful commissioning and trial period, the installation is handed over to the trained operating staff. Sufficient maintenance spares, consumables, operating instructions and maintenance instructions shall be made available to the trained operating staff.

7.7.2 Commissioning Tests / Completion Checks

7.7.2.1 Preliminary Checks

In general, the following checks shall be carried out on all the equipment/systems, as applicable.

- a) Name plate details according to approved drawings / specifications
- b) Any physical damage or defect and cleanliness
- c) Tightness of all bolts, clamps and connections
- d) Oil leakages and oil level
- e) Condition of accessories and their completeness
- f) Clearances
- g) Earthing connections
- h) Correctness of installation with respect to approved drawings / specifications
- i) Lubrication of moving parts
- j) Alignment
- k) Correctness and condition of connections
- l) Operation test for all protection relay for protection of motor

7.7.2.2 General Tests

a) Commissioning Tests of Motor

- Insulation resistance test of motor windings and cables.
- Continuity check for power and control cables

- Winding resistance measurement in case of motors rated 55 kW and above
- Control, interlock and protection schemes
- Operation and setting of timer, in case of Star Delta starters (LT Motors)
- Phase sequence and rotation
- No load trial run for observation of vibrations, noise and temperature of bearings etc.
- On load operation, starting and running load current (also observe vibrations, noise and temperature of bearing and winding)
- Starting current shall be checked whether its specified limit or not
- Relay setting as per relay co-ordination chart
- Simulation check of motor control circuit by local/ remote closing and tripping

b) Commissioning Tests of Transformer:

- i) Test oil for dielectric strength, and resistivity, Insulation resistance test of windings.
- ii) IR for bushings, before assembly.
- iii) Test the transformer for the following:
 - Winding resistance at all the taps
 - Short circuit impedance (at low voltage)
 - Core loss at normal tap at low voltage
 - IR and PI

- iv) Vector group test.
- v) Phase sequence test.
- vi) Test the current transformers for following:
 - Continuity test
 - Polarity test
 - Insulation resistance test
 - Measurement of secondary winding resistance
- vii) Line connection as per phasing diagram.
- viii) Winding resistance.
- ix) Insulation resistance of control wiring.
- x) Buchholz relay operation (for alarm and trip).
- xi) OLTC control indicating and alarm circuit.
- xii) Operation test of all protective devices (electrical and mechanical) and interlocks.
- xiii) Calibration of temperature indicators (oil and winding) and temperature relays.

c) Commissioning Tests of Switchboard (HT / LT):

- i) Checks on relays.
- ii) Insulation resistance test
- iii) High voltage test

- iv) Millivolt drop test for busbar joints
- v) Checks on motors/ simulation check.
- vi) Setting of relays, other alarms, tripping devices and interlocks as per scheme.
- vii) Phase angle checks, measurement of magnitude and phase angle of current transformer secondary currents and potential transformer secondary voltage.
- viii) Functional checking of all power and control circuits e.g. closing, tripping, control, interlock, supervision and alarm circuits including proper functioning of the component equipment.
- ix) Earthing Terminals.

d) Commissioning Checks of Relay:

- i) Check operating characteristics over the entire range by secondary injection.
- ii) Check minimum pick up voltage.
- iii) Check operation of electrical / mechanical targets.
- iv) Relay settings.

e) Commissioning Checks of Energy Meter:

- i) Check calibration (Test certificates).
- ii) Megger all insulated portions.
- iii) Check CT and VT connection with particular reference to their polarities for relevant
- iv) Meters

f) Commissioning Test of Circuit Breaker:

- i) Check control wiring for correctness of connections, continuity and IR values.
- ii) Manual operation of breaker.
- iii) Power closing / operating manually and electrically.
- iv) Breaker tripping and closing time (Test certificates).
- v) Trip free and anti-pumping operation.
- vi) IR Values- resistance
- vii) Contact resistance.
- viii) Simultaneous closing and mechanical interlocks provided.
- ix) Check electrical and mechanical interlocks provided.
- x) Checks on spring charging motor, correct operation of limit switch and time of charging,
- xi) Checks on CTs.
- xii) High voltage test (LT breakers only)
- xiii) All functional tests.

g) Commissioning Tests of Voltage Transformer:

- i) Insulation resistance test.
- ii) Polarity test.
- iii) Ratio test on all cores.
- iv) Line connections as per connection diagram.

h) Commissioning Tests on Current Transformer:

- i) Megger between windings, winding terminals and body.
- ii) Polarity test.
- iii) Ratio identification checking of all ratios on all cores by primary injection of current.
- iv) Magnetization characteristics, secondary winding resistance.
- v) Capacitance and tan delta test (Test certificates).
- vi) Dielectric test of oil (wherever applicable).

i) Commissioning Checks of Cable:

- i) Megger test between each core and armour / sheet.
- ii) Continuity check.
- iii) Connections.
- vii) High voltage test for cables above 1.1kV.

j) Commissioning Checks of Capacitor:

- i) Measurement of capacitance
- ii) Capacitor loss tangent measurement (for above 1000V)

k) Commissioning Checks of Neutral Grounding Resistor:

- i) High voltage test
- ii) Ohmic value test, Insulation resistance measurement test

l) Lightning System

Commissioning tests stipulated in applicable standards and code of practice covering all lightning system equipment

m) Earthing System

Continuity of all conductors and joints shall be checked. The Employer's Representative may ask for earth continuity tests, earth resistance measurements and other tests, which in his opinion are necessary to prove that the system is in accordance with design, specification, code of practice and Indian Electricity rules (1956). Earth grid resistance value should be not greater than one ohm.

n) Commissioning Checks for Battery:

- i) Specific gravity test.
- ii) Cell voltage test.
- iii) Capacity test.
- iv) Initial charging/ discharging cycle.

o) Commissioning Checks of Battery Charger:

- i) Functional check of auxiliary devices, such as alarms, indicating lamps etc. and operational checks.
- ii) Insulation test of all circuits.
- iii) Measurement of voltage regulation and efficiency.
- iv) No load current and voltage (AC) and voltage and current (both AC and DC) at different points.
- v) Voltage at tap cell (While boost Charging)

Test for Battery and Battery Charger

All tests shall be conducted as per the relevant standards. Tests shall include following:

Type & Acceptance tests.

- i) Type Tests: Performed at manufacturer's works
- ii) Acceptance Tests: Performed at site after installation and commissioning of the battery.

All tests shall be witnessed by the Employer's representative Commissioning Test.

- a. The following routine tests shall be conducted at site at no extra cost.
 - i. Visual checks for dimensions and general arrangement.
 - ii. Wiring checks
 - iii. Functional checks
 - iv. Voltage regulation for rated input supply for loads from 0-100%.
 - v. Load test to show the charger can serve the rated duty without the current limiter device operating.
 - vi. Calibration of potentiometer vis-a-vis the DC output for float and boost chargers.
 - vii. Ripple and harmonics measurement by oscilloscope at different loads.
 - viii. Demonstration of guaranteed efficiency and power factor.
 - ix. Insulation test (with 500 V megger)
 - x. Hipot test, excluding electronic controller, at 2 kV AC for one min.

- b. The following type tests shall be conducted at the factory. Extra cost, if any, shall be specifically stated by the manufacturer.

Heat run test with both float and boost chargers on full load especially for float and boost charger schemes/systems and if housed in same/adjacent panel/ cubicle with or without dividing partitions.

- c. Vendor shall ensure use of calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards.

Acceptance Test of Batteries

Acceptance tests shall be conducted at site on completion of installation and commissioning and immediately prior to putting the battery in service. These tests shall comprise of:

- i. Visual inspection
- ii. Dimensional check
- iii. Ampere hour Capacity test
- iv. Retention of charge
- v. Insulation resistance

Routine Test

- i. Physical examination.
- ii. Dimension, mass and layout
- iii. Marking
- iv. Polarity.

Test reports

A copy of routine and type test results shall be submitted for approval before the dispatch of batteries. Specified number of bound copies of complete test results shall be furnished with the batteries.

p) DG Set

Acceptance tests shall be conducted at site on completion of installation and Commissioning and immediately prior to putting the DG Set in service. These tests shall comprise of:

- Functionality check:
- Manufacturers standard tests:
- H.V (High Voltage Test)
- Megger test Insulation Megger test
- Phase sequence
- Change over test with LT Auxiliary Transformer along with AMF Panel.
- All functional interlocking test at No-load test shall be done before charging the transformers.
- Indicating, Metering, closing, tripping circuits as per approved drawings.

Load Test

- Run set for 2 hours at full load (all critical Loads as approved)
- step load acceptance and rejection tests using the maximum step loads

q) Building Services

Contractor has to check and test the illumination and ventilation system shall be erected and commission as per approved drawings for point wiring, lighting fixtures exhaust fans, ceiling fans, power sockets, etc.

After installation each point wiring and equipment's shall be tested as required before handover.

7.8 Instrumentation and Control

- i. The list of tests to be carried for SAT along with test instruments to be used shall be furnished for review by the Employer's Representative.
- ii. The testing of all the equipment and accessories shall be carried out as per latest applicable Indian/International standards recommendations.
- iii. Prior to testing, all relevant documentation and sufficient briefing about the tests shall be given to Employer's Representative who would witness the testing.
- iv. After installation and commissioning, the Contractor shall demonstrate, by tests in the field, compliance of the values, functionalities, quality and reliability of the complete system and its components, both hardware and software, as specified and as per guarantees.
- v. Contractor shall be fully responsible for interfacing to the equipment of Others as indicated in the scope of works. It shall be Contractor's responsibility to ensure satisfactory functioning of the system in conjunction with related equipment like exchanges, data equipment and other communication equipment of the Employer's Representative. Problems relating to such interconnections shall be mutually resolved.
- vi. After tests as above, the complete system shall be on continuous uninterrupted service with all functionalities and interconnections

without any failures or manual interventions for correction, modification, rectification or replacements in the Contractor's system.

- vii. Additional specific tests, if required, would be decided mutually. SAT on local SCADA, UPS systems shall include the all tests covered under FAT documents except tests such heat run test and those tests which cannot be conducted at site (such tests shall be approved by the Employer's Representative) in addition to integrated local SCADA, UPS systems testing at site with all field equipment's/instruments

7.8.1 Site Calibration

Standard calibration procedures shall be used for calibrating all field instruments. All reference equipment, used for calibration, shall be certified from an authorized certifying agency, to be arranged by the Contractor at his own cost. At the time of calibration, standard calibration norms shall be adopted and the same will be documented for record purposes. Calibration shall be performed in the presence of the Employer's Representative. The instrumentation shall be calibrated while being commissioned in order to verify that the high quality calibration carried out during FAT is not being disturbed (No undue adjustments shall be made for minor deviations). The Contractor will monitor and check the instrument calibration throughout the Operation and Maintenance period.

7.8.2 Instrumentation Installation and Pre-Commissioning Checks

- a) Check the exact location of the instrument with reference to the pipe and instrumentation diagram and/or the General Arrangement drawing.
- b) Check that tag plate with tag no. and description is provided for each instrument.
- c) Check the model No. and instrument type with reference to the technical specification requirements.

- d) Check all mounting and fixing arrangements and required accessories such as isolation valve, nuts and bolts, siphon etc.
- e) Check that the instrument installation is as per the installation drawing.
- f) Check the cable type, connections for power supply as well as signal cables.
- g) Check that cable shields for the instruments are properly terminated.
- h) For the flow meters, check that the flow rate and totalized flow reading on the various displays match.
- i) Check that the earthing is as per manufacturer's recommendation.
- j) Check that there are no leakages.
- k) For the level switches check that the level electrodes are connected to the correct level control units.
- l) For the temperature scanners, check that the communication port of temperature scanner is properly configured and interfaced with the PLC system. Also check that the alarm and trip signals for various channels of temperature scanner are properly configured.
- m) Check the loop continuity for every circuit. While this is being done, the power supply to the instrument shall be cut-off.
- n) Calibration checks of the instruments shall be carried out to ensure integrity with the manufacturer's factory test reports. (No undue adjustments shall be made for minor deviations)
- o) After switching on the instrument/system, it shall be monitored hourly and the data obtained shall be recorded and compared with the reference norms to ascertain whether any recalibration is required. If recalibration is required it shall be carried out using standard reference equipment/instruments at no extra cost.

7.8.3 Instrumentation Commissioning

- a) Each control loop and interlock shall be tested independently, in manual mode first and then in auto mode from the PLC and local SCADA system. The operation shall be checked for conformity with the approved logic in both modes. All pump control ON/OFF shall be checked in manual mode first.
- b) Annunciation system shall be checked as performance testing by simulating the condition and bypassing in actual mode and then individual loop will be checked for annunciation system.
- c) All motorized valves shall be checked in manual mode first, from controls on the control panel, and feed-back from the field for valve on/off shall be checked on the panel.

7.8.4 Programmable Logic Control (PLC)

- a) The PLC system and software shall be loaded by the representative of the PLC manufacturer.
- b) Testing, commissioning and stabilization of the software shall be carried out by the authorized representative of the PLC manufacturer. The following checks shall be carried out:
 - All indicators and indicating controllers will be put in manual mode after independent checking
 - Check that the PLC is properly configured and installed as per the approved drawings
 - Check that the PLC wiring is as per approved drawing
 - Check that the cables terminating in the PLC are properly dressed

- Check that the PLC is earthed as per manufacturer's recommendations
 - Check that the PLC on-line battery is functioning properly
 - Check that the PLC is correctly time synchronized with the local SCADA system
 - Check that the signals and events are getting correctly time stamped
 - Check the PLC response when input signal is out of range
 - Check that the correct ladder program is loaded in the PLC
 - Check the PLC ladder program by simulating various normal and abnormal conditions
 - Check that the data sheets and drawings are updated to reflect the as-built status
 - All analogue inputs shall be connected to the PLC system first. All digital inputs shall be checked at terminals before connecting to the I/O card of PLC system. PLC system shall be installed and checked first, before connecting any control signals/cables. Software shall be loaded in the PLC first, before connecting I/O cards with signal cables. After complete checking of the system in manual mode, system shall be put in Auto mode
- c) The PLC system manufacturer/supplier shall provide assistance/commissioning support at the time of commissioning, to be arranged and coordinated by the Contractor. Details regarding commissioning shall be provided prior to commissioning and any required modifications or changes shall be advised in advance.

7.8.5 Control Panel

- a) Check name plate details of every piece of associated equipment for conformity with the specifications.
- b) Check the tightness of all bolts, clamps, connecting terminals.
- c) Check for physical damage.
- d) Check cleanliness
- e) Check switch development
- f) Each wire shall be traced by continuity tests and it should be confirmed that wiring is as per the relevant drawings. All interconnections between panels/equipment shall be checked
- g) Megger test on all wires.
- h) Check on meters
- i) Check that the primary devices are set as per the system requirements.
- j) Checks on the control circuit for the functional requirements
- k) Check that the control panel front fascia layout is as per approved drawings.
- l) Check that the panel and all the panel equipment (viz. panel indicators, alarm annunciators, etc.) are connected to the proper earth.
- m) Check that spare cutouts on the control panel are blanked.
- n) Check that the panel indicator tag plates reflect the tag no. and the correct service description.
- o) Check whether the panel meters are fixed properly in their cutouts.

- p) Check that the instruments are identified inside the panel.
- q) Check that the panel meter instrument ranges are as per approved data sheets.
- r) Check that panel meters are provided with password protection facility.
- s) Check that the alarm inscription details are as per approved drawings.
- t) Check that the MCBs are identified by their function.
- u) Check that safety guards are provided for power supply terminals.
- v) Check the cables terminating in the control panel are properly dressed.
- w) Check that proper node addresses are given to the panel meters/ scanners connected on the communication bus.
- x) Check that the communication bus is terminated properly.
- y) Check working of alarm annunciator by simulating alarm conditions.
- z) Check that the panel meter readings match with other displays.
- aa) Check that the no. of decimal places and unit of measurement are same for all the displays.
- bb) Check that the data sheets and drawings are updated to reflect the as-built status.

7.8.6 Tests for Local SCADA

SAT on local SCADA systems shall include all the tests covered under FAT documents except tests which cannot be conducted at site (such tests shall be approved by the Employer's Representative) in addition to integrated local SCADA, communication system and UPS systems testing at site with all field equipment/instruments.

7.8.7 Tests for UPS

SAT on UPS systems shall include the all tests covered under FAT documents except tests which cannot be conducted at site (such tests shall be approved by the Employer's Representative) in addition to integrated local SCADA, UPS systems testing at site with all field equipments/instruments.

7.9 Commissioning

After the completion of pre-commissioning activities, the final checks and preparations necessary for startup of the plant shall be carried out. The Contractor shall submit to the Employer's Representative a written Notice of Mechanical Completion, which shall include:

1. Identity part of the Plant considered mechanically complete.
2. Copies of all relevant completed test reports.
3. Date on which the completion of the tests was achieved.
4. Check list& commissioning data formats.
5. Request for issuance of a Mechanical Completion Certificate in respect of that part.
6. Within fourteen (14) days from the date of receipt of the Contractor's written Notice, the Employer's Representative shall:
 - In the case of acceptance, issue a Mechanical Completion Certificate
 - In the case of objection, submit a rejection statement setting forth-remaining items to be completed or defects or deficiencies to be corrected before Mechanical Completion status can be accepted. When the Employer's Representative rejects the Contractor's Notice the Contractor shall take any necessary action to complete or correct the items marked and give the Employer's Representative a second Notice of Mechanical Completion

7. After the issuance by the Employer's Representative of a Mechanical Completion Certificate, commissioning activities listed below shall be carried out to enable the start-up and operation of the Plant. Procedures are described as below:

A) Commissioning procedure shall be carried out in a methodical sequence as follows

- Warming up
- Start-up
- Initial running
- Operability adjustment
- Stable operation
- Final adjustment

8. At all stages of commissioning sequence, the Plant shall be operated at optimum Plant conditions. To ensure this, the Contractor may make minor adjustment to the conditions indicated in the Operation and Maintenance Manual as necessary.
9. The Contractor shall check the operating conditions of the Plant by constantly monitoring operating data.
10. The Contractor shall specify for each discrete part of the Plant the operational data to be recorded and the manner in which the data is to be taken.
11. The Employer's Representative on the forms to be mutually agreed shall record all the operating data. The Employer's Representative shall make a copy of the operating log and analytical data from initial operation through to the completion of Performance Test available to the Contractor for evaluation.

12. The Contractor shall carry out commissioning tests in the presence of the Employer's Representative. The evaluation of test results and decision passed by the Employer's
13. Representative regarding the test results will be final and binding on the Contractor. Any additional tests or repetition of tests to establish satisfactory operation of any equipment shall be carried out by the Contractor, if so desired by the Employer's Representative, at no extra cost.
14. All checks and tests shall be as per the Manufacturer's drawing manuals, relevant codes of installation and as per commissioning checklists.
15. Among other commissioning tests, the following shall be carried out at site after completion of installation. Contractor shall ensure to use calibrated test equipment having valid calibration test certificates from standard laboratories traceable to National Standards / International Standards. All tests to be carried out in the presence of Employer's Representative.

7.9.1 Commissioning Tests

Following commissioning tests are to be carried out on all the equipment/systems, as applicable.

- Insulation resistance measurement of equipment, accessories, cabling/wiring etc.
- Dielectric tests on equipment, accessories, cabling/ wires etc.
- Phase sequence and polarity
- Voltage and current ratios
- Vector group

- Resistance measurement of winding, contacts etc.
- Continuity tests
- Calibration of indicators, meters, relays, etc.
- Control and interlock checks
- Settings of equipment and accessories
- Checking of accuracy/error
- Checking of operating characteristics, pick-up voltages and currents, etc.
- Operational and functional tests on equipment, accessories, control schemes, alarm/trip/indication circuits, etc.
- Measurement of guaranteed/approved design values including lighting levels, earth resistance measurement, etc.
- Complete commissioning checks of the system

7.10 Pipeline Works

7.10.1 Hydraulic Testing of Pipeline

7.10.1.1 Testing Procedure

Pipelines and fittings shall be subjected to hydraulic pressure tests in the presence of the Employer's Representative which shall comply with IS 5822 unless otherwise specified.

Testing shall be carried out in two stages:

- Test of sections as pipeline laying proceeds
- Tests on completion of the entire pipeline as-a-whole, including the intermediate sections that were not included under the sectional testing stage

The Contractor shall provide all plant, equipment, fittings and water necessary for the hydraulic tests. The Contractor shall submit to the Employer's Representative, well in advance of the time of tests, details of his proposals, including the supply of adequate quantity of water and its supply arrangement. No connections from the existing pipelines will be allowed, nor will any connections to the pipeline and pipe work be allowed which would involve cutting, off takes, or otherwise altering the Permanent Works. Test gauges shall be of approved manufacture having dials of at least **200 mm diameter**, graduated such that the test pressure is at least 75% of the full scale reading. If necessary, different gauges shall be supplied for different pipeline sections. Two gauges shall be provided for the sole use of the Employer's Representative and shall remain in the Employer's Representative's possession for the duration of the Contract. All gauges shall be dead weight tested and calibrated from testing institutions approved by the Employers representative at the commencement of work and at regular intervals as required by the Employer's Representative.

The Contractor's arrangements for testing shall include a suitable means for quick installation and removal of the Employer's Representative' gauges and any replacement gauges required during testing.

7.10.1.2 Sectional Testing

Sectional hydraulic tests shall be carried out after the pipeline section to be tested has been laid, jointed and backfilled to a depth sufficient to prevent floatation, **the sections to be tested shall not be longer 5000 m** unless otherwise approved by Employer's Representative.

In addition to the above requirements, the Contractor shall perform an initial hydraulic test on the first **500 m** length of pipeline to be laid under the Contract. This test shall be undertaken within one month of the Contractor commencing the laying of pipes. Should the pipeline fail the test, or should the Contractor fail to undertake the test, all laying and welding work shall come to a halt until that section of pipeline passes the hydraulic test. Any delay which may occur as a result of this will be to the Contractor's account, and will not be a cause for any variation. Each length of the pipeline to be tested shall be capped or blanked off at each end and securely strutted or restrained by

means of adequately designed and provided thrust block to withstand the forces which will be exerted when the test pressure is applied. Testing against closed valves will not be permitted. Washout valves shall be fitted with blank flanges and these, together with in-line valves, shall be left open. Air valves already fitted shall be permitted to function during the test. Proposals for testing where thrusts on structures are involved, even where thrust flanges on the piping are installed, shall be submitted, with the calculations of the forces to be carried, to the Employer's Representative for approval.

The method of filling the pipeline with water shall be approved by the Employer's Representative. The length under test shall be filled making certain that all air is displaced through an air valve installed at the top of the blank flange situated at the high end of the line. The length shall then remain under constant moderate pressure 10 to 20 m head of water, for a period of several hours until the pressure can be maintained without additional pumping. The pressure shall then be slowly increased at a maximum rate of 1 bar per minute to the full test pressure and pumping discontinued for 4 hours or until the pressure has dropped by 10 m, whichever occurs earlier. Thereafter pumping shall be resumed and continued until the test pressure has been restored. The quantity of water pumped to restore the pressure shall be the measure of leakage from discontinuation of pumping until its resumption. In general, the welded MS pipe joints are not expected to show any loss of water.

The pipe length shall pass the test if the leakage is not more than 0.1 liters per mm diameter per kilometer per 24 hours for each 30 m head of pressure applied.

Notwithstanding the satisfactory completion of the hydraulic test, if there is any discernible leakage of water from any pipe or joint the Contractor shall, at his own cost, replace the pipe, repair the pipe or remake the joint and repeat the hydraulic test. No pipeline shall be accepted until the leakage on any length is not more than the rate of leakage specified above and all sources of leakage have been rectified.

7.10.1.3 Test Pressures

The field tests for both sectional testing and testing on completion shall be carried out as per the provisions in the IS 5822 latest revisions. Proposed test pressures shall be determined based on the actual Site conditions, and shall be reviewed and approved by the Employer's Representative.

The field test pressure shall be as under:

- For gravity main :1.5 times maximum static head on the pipeline corresponding to the HGL @ BPT at C=120 + 5m residual head
- For Pumping main: Working pressure + water hammer pressure without water hammer control devices
- Where the field test pressure is less than two-thirds the factory test pressure, the period of test should be at least 24 hours. Test pressures are to be measured at the center of the blank flange situated at the lowest end of the pipeline under test

7.10.2 Tests on Completion of Pipeline Works

7.10.2.1 General

The tests on completion shall be carried out after all the pipeline sections have been satisfactorily tested and the joints between each section completed to provide a continuous test length between the Contract interfaces. The entire length of the pipeline tunnel will be subjected to hydraulic testing, in accordance with the preceding procedures, after joining the intermediate portions which did not come under testing of different sections during the sectional testing period.

The laid pipeline will be joined with respective manifold through valves. Just before the commissioning the complete transmission main will be checked for:

- i. All valves in the system will be inspected for proper lubrication, manual /electrical operation as applicable
- ii. All air valves shall be inspected for proper fitting and operation of isolating valves.
- iii. All flange joints/ expansion joints/ couplings will be checked for tightness of all bolts, clamps, etc.
- iv. The entire transmission system shall be checked for proper soil cover/ backfilling/ thrust and anchor blocking, etc.
- v. The structures will be checked for any constructional defects.
- vi. The valve chambers and their surroundings will be checked for its cleanliness.
- vii. The all CP stations will be checked for their functioning along with pipe to soil potentials (PSP) at every test lead point for proper soil potential. All CP stations, test stations to be monitored regularly during the commissioning and trial run period and data related, individual anode current, **energy consumption, battery performance**, etc., to be incorporated in the log-book.

7.10.2.2 Pressure Test

The entire pipeline shall be subjected to a hydraulic test as follows, to the required test pressure as per IS: 5822 and as specified in clause 7.10.1.3 the field test pressure shall be maintained for minimum 6(Six) hours. If a drop in pressure occurs, the quantity of water added in order to reestablish the test pressure should be carefully measured. This should not exceed 0.1 liter/ mm of pipe diameter per kilometer of pipeline per 24 hours for each 30 m head of pressure applied. All the joints, valves, fittings which are not tested during sectional testing shall be physically checked for leakages and leakages repaired if found. The Contractor shall provide and maintain all requisite facilities, instruments, for the field testing of the material. All pipes, specials, valves and civil works shall be replaced by the Contractor free of cost if damaged during testing.

7.10.3 Cathodic Protection System Test

The effectiveness of the cathodic protection system shall be checked by monitoring the current requirements at all the Cathodic Protection (CP) Stations. Corrective steps shall be taken if the direction of current is not as per requirements.

7.11 Tests for Water-Retaining Structures

Water retaining structures for water supply purposes shall satisfy the following tests for water tightness, before external finishes are applied (if any). The water for testing shall fill the first 1.25 meters and may be filled as quickly as supply permits. Between this and top water level, the rate of filling shall not exceed a steady rate of 300 mm per 24 hours unless otherwise directed. After filling to top water level no further water shall be introduced for 7 days. After expiry of seven days and after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hours over a period of seven days and the structure shall satisfy the test if at the end of this week no leakage is apparent and or the water level does not drop more than 40 mm over the period of 7 days. The Employer's Representative shall decide on the actual permissible nature of this drop in surface level, taking into account whether the tanks are open or closed and the corresponding effect it has on evaporation losses. Foregoing visible leakages and sweating will not be accepted. If the structure does not satisfy the condition of test and the daily drop in water level is decreasing the period of test may be extended for a further seven days and the if specified limit is then reached the structure may be considered as satisfactory.

Following satisfactory completion of the tests the Contractor shall empty the structures and dispose of satisfactorily the contents. He shall clean and disinfect the structures and any equipment therein of all deposits left by the testing.

7.12 Treatment Plant

7.12.1 General

Prior to the commencement of Tests on Completion the Contractor shall submit for approval the following:

- Site Acceptance Test Documents;
- As-Built Drawings;
- Operation and Maintenance Manuals.

Tests on Completion shall not be commenced until the aforementioned documents are approved. The charges of oil, grease, electrolyte, generator fuel, etc., necessary for Tests on Completion shall be provided by the Contractor. Chemicals required for Tests on Completion will be provided by the Contractor. Electricity shall be provided by the Employer. The Contractor shall provide adequate raw water to meet his requirements prior to commencement of the Tests on Completion involving its use.

7.12.2 Dry Test Requirements

General

As a minimum requirement the following dry tests shall be carried out as a general requirement:

- A general inspection to check for correct assembly and quality of workmanship;
- A check on the presence of lubricant, cooling medium, electrolyte, etc.:
- A check on adequacy and security of plant fixing arrangements;
- A general check to ensure that all covers, access ladders, water proofing, guard railings, etc. are in place;

- A check on damp-proofing, rust-proofing and vermin-proofing and particularly the sealing of apertures between building structures, chambers etc. and the outside;

7.12.3 Hydraulic Wet Test Requirements

Hydraulic wet tests shall be carried out on completion of dry tests. Raw water or treated water (if available) shall be used for hydraulic wet tests. The purpose of the tests is to prove as far as practical the hydraulic performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is hydraulically loaded to its rated throughput for a period of at least four hours. In order to ensure a sufficient supply of raw water to carry out these tests the Contractor shall provide facilities for the disposal off-Site in an approved manner not less one third of the Works rated output.

In order to remove doubt, the following tests, inter alia, shall be carried out:

- Pressure testing of all piped systems laid direct in ground in accordance with the relevant standards;
- Fill all structures and check for leaks;
- Filling of all storage vessels to check for leaks and distortion;
- Running of all pumped systems in order to check for:
 - Correct functionality;
 - Absence of leaks;
 - Correct running temperatures
 - Smoothness of running and the absence of undue vibration or stress;

- Check drive running currents;
- Carry out calibration of instruments where appropriate;
- Hydraulic testing of primary/ impulse tubing.
- Carry out valving, diversions, etc., to full hydraulic load (or where there is a requirement to withstand an over load to overload) for each process element;
- Demonstrate correct functionality of electrical, control and instrumentation systems.
- The Contractor shall simulate the conditions that will prevail when operating as a process in order to demonstrate the correct functionality of process control loops, etc.

During these tests a check on the performance of Plant shall be made, as far as site facilities will allow, to compare its site performance with the factory test data and to identify any constraints on performance due to site conditions.

7.12.4 Filter Wet Tests

The Contractor shall carry out the following tests on each of the completed filters:

7.12.4.1 Pressure Test

All the nozzle outlets shall be plugged and the filter under drainage system shall then be filled with water leaving an air gap of between 25 mm and 50 mm between the water surface and the underside of the filter floor. The top of the filter floor shall be covered with water to a depth of 50 mm above the top of the nozzle plugs. The underside of the filter floor shall then be pressurized to 0.5 bar, by either utilizing the Plant air scour blowers or by providing and connecting up a temporary air blower. The test shall be maintained for one hour and all leaks identified. The pressure shall then be relieved, the water removed from the filter and the detected leaks rectified. The filter shall then

be retested and the procedure repeated until all leaks are rectified to the satisfaction of the Employer's Representative. On rectification of all leaks the filter's strength shall be tested by applying the above mentioned test pressure for a period of 48 hours. Any leaks or minor structural damage shall be rectified and the filter retested to the satisfaction of the Employer's Representative. If, in the opinion of the Employer's Representative, structural damage has occurred to the filter floor, which cannot be satisfactorily repaired without affecting the structural integrity or performance of the filter, the entire floor shall be replaced.

During the above tests the Contractor shall set the pressure relief valve on the air blower system to relieve pressure above the test pressure. He shall also install a standpipe connected to the under drain to ensure that over-pressurization cannot take place. The bottom end of the standpipe shall be below the air/water interface under the filter floor and the top end shall be at the level equivalent to the test pressure.

7.12.4.2 Flow Distribution Tests

a) Air Distribution Test

The empty filter shall be filled with water to a level of 25 mm above the top of the nozzles. Air shall be introduced into the under drain system at such a rate that the system can be seen to pass air through the nozzles over the whole filter area. Any discrepancies in distribution over the filter shall be rectified and the test repeated until the Employer's Representative is satisfied that the air distribution is uniform over the entire filter with all nozzles blowing.

b) Combined Air Scour and Backwash Distribution Test

The filter shall be tested for combined air and water scour at the design rates in the same manner as described above for the air distribution test. Air shall be brought on first and allowed to fully develop before the water is introduced. Any discrepancy in distribution over the filter shall be rectified and the test repeated until the Employer's Representative is

satisfied that the distribution is uniform over the entire filter with all nozzles blowing.

If for any reason it is necessary to remove a nozzle dome after it has been fully tightened, it shall not be re-used but replaced by a new one. As soon as possible after satisfactory completion of the above tests the filter shall be charged with filter media.

7.12.4.3 Safety Audit

After satisfactory completion of hydraulic wet tests and prior to introduction of process fluid to the plant a safety audit shall be carried out to ensure compliance with the necessary requirement for safety and for operation of Plant. The safety audit shall be documented. The safety audit document shall be approved by the Employer's Representative prior to commencement of Plant sterilization.

7.12.4.4 Plant Sterilization

On approval of the safety audit document the Contractor shall carry out sterilization of the wetted parts of the Works. In order to remove doubt this shall also include the wetted surfaces of water treatment chemical storage and dosing systems.

The sterilization process shall be carried out by completely filling the item or items concerned with water containing not less than 30 mg/l of free chlorine and leaving it to stand for not less than 2 hours. On draining down the Contractor shall demonstrate that the chlorine residual has not fallen below 20 mg/l of free chlorine. If this is not true, the sterilization process shall be repeated until this condition is met.

The Contractor shall be responsible for the disposal of the sterilization solution. The Contractor shall take the necessary measures to ensure that the free chlorine residual of the solution for disposal is not greater than 1 mg/l before discharge to the environment.

Areas such as the roofs of tanks not easily wetted by filling the vessel with sterilization solution shall be sterilized using a procedure approved by the Employer's Representative.

The Contractor shall give 2 weeks advance notice to the Employer's Representative and the Employer of the proposed date for carrying out sterilization.

The Contractor shall advise the Employer's Representative and the Employer in writing when all wetted parts of Plant and civil structures have been sterilized. If the Contractor carries out any new work that invades a previously sterilized area the Contractor shall be required to carry out re-sterilization of that area to the approval of the Employer's Representative.

7.12.5 Process Wet Tests

On approval of the sterilization process the Contractor shall carry out process wet tests.

Raw water shall be used as the primary feed stock for process wet tests. These tests shall be carried out to demonstrate the process performance of the Works. In order to demonstrate this, the Contractor shall ensure that each part of the Works is loaded to its rated throughput (including a period of overload if required in order to demonstrate compliance with the Employer's Requirements) for a continuous stable operating period of not less 48 hours.

The Contractor shall provide facilities for the disposal off Site in an approved manner a quantity of treated water equal to not less than one third of the Works rated output.

The following tests, inter alia, shall be carried out:

- Check for leaks on vessels, structures, pumps and pipe work;
- Running of all pumped systems in order to check for:

- Correct functionality;
 - Absence of leaks;
 - Correct running temperatures
 - Smoothness of running and the absence of undue vibration or stress;
- Check drive running currents where the solution pumped is different from that pumped during hydraulic wet tests;
 - Carry out calibration of water quality instruments;
 - Carry out valving, diversions, etc., to full hydraulic load (or where there is a requirement to withstand an over load) for each process element;
 - Demonstrate correct functionality of electrical, control and instrumentation systems
 - On completion of the tests on the various parts of the works the Contractor shall run the plant as a whole in order to demonstrate the full functionality and performance of the Works at various throughput rates for a continuous period of not less than 5 days or as per directives from Employers representative.

During the various process tests the Contractor shall take samples and carry out water quality analysis at not greater than one hourly intervals in order to demonstrate to the Employer's Representative that the Works is functioning in accordance with the Employer's Requirements. Each sample shall comprise two 1liter (minimum) quantities and shall be labeled to identify the contents, where taken and time and date.

One sample shall be used by the Contractor for his analysis; the other shall be handed over to the Employer's Representative. The Employer's Representative reserves the right to take additional samples and to carry out his own tests or to check the samples taken by the Contractor. The

Employer's Representative shall be given reasonable access to the premises where analysis is taking place in order to check on working practices and the procedures being adopted.

7.13 Trial Run of the entire System

After individual commissioning tests of components of the works the Contractor shall make trial runs. A continuous operation for a period of 7 days to the satisfaction of the Employer's Representative will be deemed to demonstrate satisfactory completion of trial run for the individual component. The cost of chemicals and other consumables for operation and maintenance of the System during the period of this trial run will be borne by the Contractor. The costs towards the Contractor's supervisors and other operating personnel along with cost of tools and spare parts, which are required for operation and maintenance of the plant and equipment during the trial run period shall also be borne by the Contractor and shall be included in Contract Price. In the event that the System or any of the facilities do not satisfactorily achieve the required performance standards during this period, the trial run period shall be extended until such time as the Contractor has satisfactorily rectified any deficiencies as may be necessary to satisfy the performance requirements, at the risk and cost of the Contractor

7.14 Commissioning of the entire System

On completion of the Trial Run, commissioning of the System shall be done by the Contractor. The total time allotted for commissioning of the full system is 90 days. The commissioning of the system shall be considered as fully achieved after the full system has run continuously for a period of 15 days without any breakdown to the satisfaction of Employer's Representative. If continuous run is not achieved fully to the satisfaction of Employer's Representative, the Contractor has to do the needful to achieve the same at his cost. All the costs thereof, including the cost of staff, maintenance, and any other consumables including chemicals used for operation and maintenance of the system during the period of commissioning except electricity consumed during the commissioning period shall be borne by the Contractor. The cost of electricity will be borne by the Employer.

Last 30 days during the commissioning period of the entire system shall be considered as test on completion as detailed below.

7.15 Tests after Completion

7.15.1 Employer's Obligations

The Contractor shall provide the necessary labor, materials, electricity, fuel and water, and shall carry out the Tests after Completion in accordance with the manuals provided by the Contractor and such guidance as the Contractor may be required to give during the course of such Tests.

The Tests after Completion shall be carried out for last 30 days of commissioning period.

The results of the Tests after Completion shall be compiled and evaluated by the Employer and the Contractor. Any effect on the results of the Tests after Completion which can reasonably be shown to be due to the prior use of the Works by the Employer shall be taken into account in assessing such results.

7.15.2 Retesting on Failure

If the Works, or a Section, fail to pass the Tests after Completion, the Employer or the Contractor may require such failed Tests, and the Tests after Completion on any related work, to be repeated under the same terms and conditions. If such failure and retesting result from a default of the Contractor and cause the Employer to incur additional costs, such costs shall be recoverable from the Contractor by the Employer, and may be deducted by the Employer from any monies due, or to become due, to the Contractor.

7.15.3 Test during Monsoon

After successful completion of the Tests on Completion the Contractor shall carry out, as soon as reasonably possible but over a period of time not exceeding one year, 30 days' operational tests during monsoon. These tests shall be used to prove the operation of the Works at varying flows and with varying raw water quality. During the tests water produced by the Works will be entering the public supply network. The tests after completion shall be undertaken in accordance with as mentioned above each part of the Works shall be considered separately as far as the tests are concerned.

The timing of the tests shall be determined by the Employer who shall give notice to the Contractor in accordance with Contract. The total time for carrying out the tests shall not be less than 30 days corresponding to period of high raw water turbidity.

On commencement of 30 days test the Contractor shall allocate a continuous period to complete the test. If the part of the Works fails to pass the test in the 30 days period, the test shall be deemed as a failure and the Contractor shall carry out any necessary remedial work to the satisfaction of the Employer's Representative before the Contractor restarts the test again. During the tests the Contractor shall take samples to demonstrate that the part of the Works is performing in accordance with the Employer's Requirements. Samples shall be taken at locations and intervals as directed by the Employer's Representative. The tests for performance of the system to meet the tender requirements shall be completed in this period and the penalties if any due on the Contractor as per the Contract shall be finalized. The results of the Tests after Completion shall be compared and evaluated by the Employer and Contractor. The Contractor will not be held responsible for interruptions to the water treatment process as a result of power failures (unless as a result of a Plant failure), interruptions in the raw water supply, etc., which are out of his control. However, the Contractor shall be required to demonstrate that the Works can cope with these inevitable interruptions in an orderly fashion and recover to a normal operational state with the minimum of manual intervention. All staff and consumables needed for operation of the Works such as fuels, lubricants etc. and transportation of sludge off site, except raw water and power shall be provided by the Contractor under his operation and maintenance responsibilities. The Contractor shall be required reasonably to co-operate and co-ordinate his activities with those of the Employer and other agencies. The Contractor shall provide all facilities and equipment not supplied under the Contract and which are deemed necessary to carry out and monitor the tests after completion.

7.15.4 Treated Water Quality Criteria

The Works shall be considered to have passed the 30 Day Test for treated water quality if all samples taken during the 30-day period comply with the criteria set out below in Table.

The Works shall have fulfilled the treated water quantity criteria if the Works have demonstrated that this can provide the quantity of treated water detailed in the Contractors Functional Guarantee over a sustained and continuous period during the tests after Completion. The treated water quantity criteria are an absolute requirement; i.e. the guaranteed treated water quantity must be achieved.

SUB-SECTION 7A.8

HEALTH, SAFETY, WELFARE AND ENVIRONMENT

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SUB-SECTION 7A.8: HEALTH, SAFETY, WELFARE AND ENVIRONMENT

8.1 Applicable Regulations, Acts etc.

The Contractor shall comply with the relevant requirements of all local and the national health, safety, welfare and environment acts and regulations issued by the Ministry of Labour (MoL).

Compliance with the requirements of acts and regulations by the Contractor shall not relieve the Contractor from responsibility for the safety of his workers and employees and those of his subcontractors.

8.2 Health, Safety and Welfare

8.2.1 Failure to Comply

In the event that the Contractor fails to comply with the requirements of the regulations or with the Specification in respect of safe working conditions or practices on the Site, the Employer's representative will have the authority to instruct the Contractor to stop work in any particular location until the unsafe conditions or practices have been rectified to the satisfaction of the Employer's representative. The Employer's representative will issue safety violation notices to the Contractor, informing him that he is working unsafely and describing the nature of the unsafe working practice, the time and date and the location. In this event, the Contractor shall be responsible for all costs and delays resulting from complying with such instruction by the Employer's representative and for the actual costs incurred on rectification of the unsafe conditions or practices.

8.2.2 Contractor's Health, Safety, Welfare and Security Implementation Plan

The Contractor shall prepare and submit to the Employer's representative for review a Site implementation plan specific to health, safety, welfare and security practices of the work to be carried out under the Contract. The Contractor shall carry out all work on the Site in accordance with the agreed Site implementation plan. The Contractor's plan shall reflect the requirement of the local and national requirements. It will include a methodology for carrying out risk assessments by the Contractor where these are deemed necessary. The plan will be updated from time to time to reflect any significant changes to laws and

regulations or site activities.

8.2.3 Contractor's Health, Safety, Welfare and Security (HSWS) Officer

The Contractor shall appoint a qualified and experienced HSWS officer for the duration of the Contract. The full time duty of the officer will be to implement the site implementation plan, to prevent accidents and enforce the requirements of legislation in force. The name and qualifications of the officer so designated shall be submitted to the Employer's representative by the Contractor for approval within two weeks of the commencement of the Contract. The officer shall attend full time on site during normal working hours and whenever work is in progress during out of hours working, public and national holidays approved by the Employer's representative and available by phone and mobile during non-working hours.

The Contractor shall engage senior site engineers and foremen that are properly trained in the application of correct Health and Safety practices. These individuals shall liaise closely with the HSWS to maintain safety on site at all times. The Contractor shall submit the details of the Health and Safety qualifications of all such site personnel.

The HSWS officer will be responsible for ensuring all relevant information and posters are displayed at locations throughout the site in accordance with the site implementation plan.

The HSWS officer will be responsible for keeping a site accident book to record all site incidents or any major site rescue events. The book will be available for inspection by the Employer's representative or any MOL authorized person. Record keeping must also be maintained to comply with any other legal or regulatory requirements.

The HSWS officer will be responsible for ensuring that every site worker and regular visitor is given site HSWS procedure training when they first enter the site and refresher training at an appropriate frequency agreed by the Employer's representative. All occasional visitors will be trained on arrival and be provided with the appropriate personal, protective equipment. Records of the training will be kept and available for inspection by the Employer's representative.

8.2.4 Contractor's Health, Safety, Welfare and Security Committee

The Contractor shall set up a safety committee comprising the full-time HSWS officer, project manager, site engineers and foremen for the Contract. The committee shall meet weekly and minutes shall be recorded and a copy shall be submitted to the Employer's representative. The Employer's representative shall be invited to be present at the meetings.

The purpose of the meetings will be to discuss and resolve health, safety, welfare and security aspects of various parts of the work, including possible areas of conflict or difficulty. Where different contractors are working in the same area or adjacent areas, or where the work of one may impinge upon the work of another, the meetings will consider what action needs to be taken to ensure that each contractor is aware of the safety requirements of others.

8.2.5 Site Health, Safety, Welfare and Security Coordinator

The Employer may oversee the health, safety, welfare and security arrangements of the various contractors working on the Site, to liaise with the Employer's representative and to draw his attention to any breaches of Contract requirements or the approved safety plans of the Contractor.

8.2.6 First Aid Facilities

The Contractor shall provide a complete approved first aid kit in his site office. The kit shall be in the charge of either the Contractor's HSWS Officer or some other responsible person who will also be on the site during all working hours to ensure that the first aid kit is available without delay. The Contractor shall also provide a first aid kit in the office for the Employer's representative. Kits shall also be provided at all remote sites. The HSWS Officer and adequate numbers of other senior members of the Contractor's staff shall be trained in occupational site first aid duties including resuscitation to take account of numbers of site workers located on the permanent site and mobile site operations.

The Contractor will make arrangements with the emergency and rescue services to provide adequate support where on site first aid assistance is inadequate to meet the welfare requirements of all site workers.

The Contractor shall comply fully with all rules and regulations from time to time issued and orders given by the Health Service of the Government or the local medical or sanitary authorities.

8.2.7 Overhead Hazards

Overhead protection shall be provided at any location where there is a hazard of falling objects. This shall particularly be observed around any scaffolding and in excavations.

'Goalposts' shall be erected beneath all overhead lines to prevent the arms or jibs of plant from approaching such lines. No plant shall be trafficked beneath overhead lines until the Employer's representative has inspected and approved the erected goalposts.

8.2.8 Excavations or Underground Hazards

Every excavation or underground space into or through which a person may fall shall be covered by a temporary cover fixed securely in position or guarded by an effective barrier to prevent falls except where free access is required by work actually in progress. In such a case where work is in progress, the barrier shall be maintained in position to the extent possible, and suitable warning signs shall be erected.

8.2.9 Drowning Hazards

Where the work involves filling tanks with water leaving an open surface, the Contractor shall provide at all times and at suitable locations equipment for promptly rescuing persons from the water and resuscitating rescued persons. The Contractor shall take all necessary steps to prevent any such accidents occurring by providing adequate guarding.

8.2.10 Slipping Hazards

The Contractor shall not suffer or permit an employee to use a passageway, or a scaffold, platform or other elevated working surface which is in a slippery condition. Oil, grease, water and other substances causing slippery footing shall be removed, sanded or covered to provide safe footing.

8.2.11 Tripping Hazards

All passageways, platforms and other places of work shall be kept free from accumulations of dirt and debris and from other obstructions that may cause tripping. Sharp projections shall be removed or covered.

8.2.12 Access to workplace

Temporary stairways, ramps or runways shall be provided as the means of access to working levels above or below ground except where the nature or progress of the work prevents their installation, in which case ladders or other safe means shall be provided. The Contractor shall not assume that access arrangements provided by the Employer will necessarily remain in place after the time that the Contractor commences work in a particular area.

8.2.13 Dust and Gases

Dust and gases shall be controlled by ventilation or otherwise so as to prevent concentrations tending to injure health or obstruct vision or from exceeding safe levels.

8.2.14 Hazardous and Corrosive Substances

All alkalis, acids, gases and other hazardous and corrosive substances shall be so stored and used so as not to endanger employees in accordance with national and state regulations. Suitable protective equipment for the use of such substances shall be provided. Clean water supply shall be readily available for washing off any spillage of any corrosive substance on the employees.

8.2.15 Eye and Ear Protection

Suitable eye protection equipment shall be provided for and shall be used by employees while engaged in welding or cutting operations or in chipping, cutting or grinding any material from which particles may fly, or while engaged in any other operation which may endanger the eyes. The Contractor shall ensure that fully equipped eye washing facilities are available on permanent and mobile site locations. Ear protectors shall be made available for employees when operating noisy machinery.

8.2.16 Respiratory and Resuscitation Equipment

Where required the Contractor shall provide sufficient numbers of respiratory equipment and the employee shall be trained to use respiratory equipment suitable for the type of operation for which it is to be used. The Contractor shall maintain such respiratory equipment in good condition and shall furnish the means for its continued efficient working condition. The Contractor shall provide regular inspection, cleansing and sterilization of such equipment. Such equipment, when not in use, shall be stored in an accessible, closed container.

The respiratory equipment shall be either of the escape set type, where it is provided for possible emergency use, or working sets where work has to be carried out in conditions where toxic gases are present or where there may be a deficiency of oxygen identified by the HSWS officer or his appointed staff when a risk assessment is undertaken prior to a site operation commencing. Risk assessments will be available for inspection by the Employer's representative immediately on request.

All persons who may be required to use such equipment shall be adequately trained and shall have certificates to that effect. Individual certificates will be available for inspection from all authorized workers by the Employer's representative.

8.2.17 Work in Confined Spaces

Where work is required to take place in a confined space, defined as an enclosed space or excavation with limited access and where there is no natural ventilation, the Contractor shall provide equipment for monitoring the quality of the atmosphere within the space. The equipment will be calibrated to occupational standards to measure the range of gases and atmospheres identified as part of the risk assessment undertake prior to entry. The equipment shall be used to check the atmosphere before personnel enter, and shall remain in place while work is in progress to ensure that the confined space is free of harmful or noxious gases. The Contractor shall not permit anyone to enter or work in a confined space, including personnel from other contractors, the Employer's representative staff or the Employer's staff if harmful or noxious gases are detected. Any personnel inside shall be evacuated immediately.

Prior to the commencement of the work, the Contractor will document a safe system of work which will be available for inspection by the Employer's representative.

All personnel working in such conditions shall be provided with escape sets. The Contractor shall provide a "top-man" who shall be stationed immediately outside the entrance to the confined space, and who shall maintain communication with personnel working inside the confined space. In the event of a transverse entry, this may require additional personnel to be used to facilitate a reliable line of communication if evacuation has to take place. The top man shall have the means to raise the alarm in case of any emergency inside the confined space.

The Contractor shall provide adequate ventilation for workers carrying out work inside a confined space, pipeline or chamber or other enclosed areas by using blowers or other suitable means.

8.2.18 Personal Protective Equipment (PPE)

Every site worker and visitor shall be provided with a full set of personal protective equipment for use at all times including a luminous vest, helmet of a type tested and approved by the MOL, steel toe-capped boots, gloves and other specific work related clothing offering ear and eye protection. All site workers and visitors shall be required to wear PPE while working on the Site, except in the Employer's representative's and Contractor's office. The Contractor shall display a notice on the access to the site stating that entry is for authorized personnel only, and that PPE is to be worn at all times.

Every employee required to work in water, wet concrete or other wet footing shall be provided with suitable safety, waterproof boots.

Every employee required to use or handle alkaline, acid or other corrosive substances shall be provided with appropriate PPE.

8.2.19 Electrical Hazards

Before work commences, the Contractor shall ascertain by inquiry or direct

observation, or by instruments, where any part of an electric power circuit exposed or concealed is so located that the performance of the work may bring any person, tool, or machine into physical or electrical contact therewith. The Contractor shall post and maintain proper warning signs to his employees of the location of such lines, the hazards involved and the protective measures to be taken and shall, if practicable, de-energise the electric power circuit.

The Contractor shall not suffer or permit an employee to work in such proximity to any part of an electric power circuit that he may contact the same in the course of his work unless the employee is protected against electric shock by de-energising the circuit and earthing it or by guarding it, by effective insulation or other means acceptable to the Employer's representative. The location of underground power lines that encroach on the Works shall be confirmed using cable detectors, the path of the cable shall be clearly marked. If such cables are adjacent to excavations, the cable location shall be confirmed by finding the cable using carefully controlled hand-dig methods under the supervision of a senior member of the Contractor's staff. No live cables shall be retained within working trenches or other excavations. Any such cables shall be diverted prior to excavation commencing. The Contractor shall at all times liaise with the local electricity supplier with regard to the locating and diverting of any supplies.

8.2.20 Power Driven Saws, Abrasive Wheels and Grinders

All portable power-driven hand operated saws, abrasive wheels and grinders shall be equipped with guards above the base plate which completely protects the operator from contact with the saw blade when in motion and with self-adjusting guards below the base plate which completely covers the saw to the depth of the teeth when the saw is removed from the cut.

8.2.21 Public vehicular traffic

Whenever any work is being performed over, on, or in proximity to a highway or any other place where public vehicular traffic may cause danger to men at work, the working area shall be so barricaded with fluorescent signs as to direct traffic away from it or the traffic shall be specially controlled by persons designated for that purpose.

8.2.22 Site traffic

All vehicles used at the worksite must be roadworthy and registered with the appropriate authority. No person shall drive a vehicle at the worksite unless they are a holder of the appropriate driving license or certificate.

A site internal access management system including all appropriate road signs will be submitted by the Contractor to the Employer's representative for approval at the commencement of the Contract.

8.2.23 Stability of structures

No section of the plant or other structure or part of a structure shall be left unguarded in such condition that it may fall, collapse or be weakened due to wind pressure or vibration.

8.2.24 Storage of materials and equipment

All materials shall be stored or stacked in a safe and orderly manner so as not to obstruct any passageway or place of work. Material piles shall be stored or stacked in such a manner as to ensure stability. Hazardous materials shall be stored in secure areas and the HSWS shall maintain an up-to-date list of the persons with a key to those areas.

8.2.25 Disposal of debris

Debris shall be handled and disposed of by a method which will not endanger persons. Debris shall not be allowed to accumulate so as to constitute a hazard.

8.2.26 Excavations

No employee shall be permitted to enter any excavated area, including areas excavated by other contractors on the Site, unless sheet piling, shoring or other safeguard that may be necessary for his protection is provided. In most cases, excavations will be considered to be confined spaces and the appropriate procedures followed.

Where any employee in an excavation is exposed to the hazard of falling or sliding material from any bank or side more than 1.5 m high above his footing, adequate piling and bracing shall be provided against the bank or side to eliminate such hazard. The excavation and its vicinity shall be checked by a designated person after every rain, storm or other hazard-increasing occurrence and the protection against slides and cave-ins increased if necessary.

Shoring adequate to support the overhanging material shall be provided where banks are undercut.

Excavated material and other superimposed loads shall be placed at least 1 m back from the edge of open excavations and trenches and shall be so shored or retained that no part thereof can fall into the excavation, or cause the banks to slip or cause the upheaval of the excavation bed. Banks shall be stripped of loose rock or other materials which may slide, roll or fall upon persons below.

Open sides of excavations where a person may fall more than 1.5 m shall be guarded by adequate barricades, and suitable warning signs shall be put up at conspicuous positions.

No employee shall be allowed to work where he may be struck or endangered by an excavating machine with which his activity is not directly related.

8.2.27 Ladders, step ladders and access platforms

Every ladder, step-ladder and access platform shall be of good construction, sound material and adequate strength for the purpose of which it is used. Ladders, step-ladders and access platforms shall not stand on loose bricks or other loose packing, but shall have a levelled and firm footing. Ladders of over 2m in height shall be securely tied to the structure it is propped against. Free-standing, portable ladders over 4m in height shall not be used.

8.2.28 Working at height

All site workers who work at height shall be provided with appropriate PPE to prevent an accident by slipping or falling.

8.2.29 Positioning of machinery

No person shall be permitted to position or operate machinery in a manner likely to endanger himself or others.

8.2.30 Fixed and mobile cranes

Fixed and mobile cranes shall be so constructed, positioned and operated as to be stable. No crane shall be loaded beyond the safe working load except by an approved person or an inspector for the purpose of testing such machine.

Every crane including all blocks, shackles, sheaves, wire ropes and the various devices on the mast and jib shall be thoroughly inspected by an approved person at intervals not exceeding 12 months. Cranes shall be inspected before being first erected or operated on each job or after any major repair. Inspection and repair of crane jib shall be made only when the jib is lowered and adequately supported.

Outriggers and counter-weights shall be provided and used as specified by the manufacturer of the crane or by an approved person. Counter-weights shall be properly placed and secured. Levelling jacks or other suitable means shall be provided and used with outriggers of truck-mounted mobile cranes.

Firm and uniform footing shall be provided for cranes. When such a footing is not otherwise supplied it shall be provided by substantial timber, or other structural members sufficient to distribute the load so as not to exceed the safe bearing capacity of the underlying material.

Every power-operated crane shall be provided with efficient brake or brakes or other locking devices which will prevent the fall of the load when suspended and by which the load can be effectively controlled whilst being lowered. Hand or foot-operated bakes shall be provided with a substantial locking device to lock the brake in engagement.

No load-bearing part of any crane shall be replaced by another part, and no such machine shall be modified by the addition thereto or removal therefrom of any loads bearing part, unless the replacement or modification shall be certified by either the manufacturer or the approved person who tested the crane.

A capacity chart shall be provided for every crane. Such chart shall be posted and maintained in a place clearly visible to the operator and shall set forth the safe loads for various lengths of jib at various jib angles and radial distances. Where outriggers are provided such loads shall be set forth with and without the use of outriggers.

Unless furnished by the manufacturer or builder of the crane, a capacity chart shall be prepared and certified by an approved person. Cranes shall have audible overload warning alarms.

A crane shall not lift any load that exceeds the corresponding safe working load specified by its capacity chart.

Every crane having a jib shall be provided with an accurate indicator which shows, clearly to the operator, the radius of the jib and the safe working load corresponding to that radius at all times and gives warning signal when the radius is unsafe.

Before hoisting any load at a new job site, the jib shall be operated to its maximum height.

Crane cabs shall be locked when the operator is not present and no unauthorized person shall enter the cab or remain immediately adjacent to any crane in operation. If locking of a crane cab is impracticable, the operating mechanism shall be locked as to prevent the crane from being operated by an unauthorized person.

No crane shall be operated in such a location that any part of the crane or of its load in any position of jib or swing may come within 3 meters of live power line.

All the lifting equipment used at site shall be registered with the appropriate GOI Ministry and shall have a valid certificate at the time of usage.

All crane operatives should be authorized to operate the particular type of fixed or mobile crane. Valid certificates will be available for inspection by the Employer's representative. All banksmen will be formally trained to undertake their duties and refresher training will be given at an appropriate frequency agreed by the Employer's representative.

8.2.31 Attachment of loads

Where a sling is employed to hoist long-length material, a lifting beam shall be used to space the sling legs for proper balance. When load is suspended at two or more points with slings, the eyes of the lifting legs of the slings shall be shackled together and this shackle or the eyes of the lifting legs may be shackled directly on the hoisting block or balance beam. The eyes may be placed on the lifting hook without shackles if the hook is of the safety type.

Each container or receptacle used for raising or lowering filter media or other loose material of any kind shall be so enclosed, constructed or designed as to prevent the accidental fall of such material.

Crane loads shall be raised vertically so as to avoid swinging during hoisting.

No crane shall travel with a suspended load except upon a safe runway. During travel without loads, crane's falls shall be secured or placed so as to prevent accident or damage by swinging.

8.2.32 Fire Hazards

Approvals for Fire Fighting System, Emergency Evacuation System and other allied facilities for tunnels needs to be taken by appointed agency specially from fire department.

8.3 Environmental Protection

The Contractor shall minimize, as far as is practically possible, the effects of all his and his Subcontractors' activities upon the environment and shall implement and monitor measures to prevent:

- (a) Contamination of surfaces, ground, groundwater, surface water and rivers,
- (b) Emissions to air, including smells, gases, smoke, and dust.
- (c) Unsanitary or unsafe storage or discharge to drain, sewer and surface waters,
- (d) Unsanitary or unsafe storage or discharge of solid wastes,
- (e) Noise,

- (f) Visual intrusion, and
- (g) Excessive energy and water consumption.

These requirements shall be met through the constant and careful attention of the Contractor's management of all Site and off-site activities, and by instruction to all staff and labour in these matters.

The Contractor shall appoint an Environmental Control Manager for the Works, who shall be responsible for preparing an Environmental Management Plan and ensuring its implementation by the Contractor after obtaining approval of the Employer's representative.

Implementation shall include for monitoring and reporting on the results of the above measures. Monitoring reports shall be in writing and submitted on a monthly basis as part of the monthly report referred to above. The report shall include a listing and summary of daily monitoring results on all aspects listed above.

All potentially affected areas of the Site, other areas used for or affected by the works and all adjacent or affected waterways shall be monitored and where instructed by the Employer's representative tested.

The Environmental Management Plan (EMP) shall identify the potential environmental impacts from the various construction and operations and maintenance activities to be undertaken in the Contract and set out in detail the approach he will adopt in mitigating these environmental impacts to ensure that the residual impacts are minor and confined to a short period.

The EMP shall consider but not be limited to the following:

- The methods of materials delivery, storage, usage and disposal; equipment usage; and site activities to ensure they have minimal impact on the environment,
- Only environmentally safe products and practices shall be adopted in performing his works, and
- The Contractor shall comply with all of the statutes regarding environmental effects.

The EMP shall provide separate descriptions of its proposals for minimizing any adverse environmental impacts/effects during the construction phase and the subsequent defect liability phase.

The EMP shall be provided in draft form within 28 days from the Notice to Commence, and shall be updated from time to time by the Contractor as agreed or required by the Employer's representative to ensure the objectives of environmental protection are fully met.

SUB-SECTION 7A.9

ENVIRONMENTAL MANAGEMENT PLAN

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SUB-SECTION 7A.9: ENVIRONMENTAL MANAGEMENT PLAN

9.1 Introduction

An Environmental Management Plan (EMP) takes into account all the environmental issues and the corresponding mitigation measures to minimize the impacts.

The EMP presented below includes:

- Specific actions to be taken regarding site-specific issues;
- Responsible agencies for its implementation & supervision;
- Time frame for implementing Mitigation actions;
- Reference to contract documents and specifications;
- Project level environmental monitoring;
- Environmental status reporting frequency; and
- Institutional arrangement, Strengthening of their capability, and role

It also includes a monitoring plan to enable evaluation of the success or failure of environmental management measures and reorientation of the plan if required. Several of the protective and enhancement measures can be implemented by adopting suitable planning and design criteria during construction of the project. Further, it is necessary that the resources required for the mitigation / protection, enhancement measures and monitoring are provided for in the cost estimates of the project, to ensure proper implementation.

9.2 Environmental Management and Implementation

The EMP has been delineated for all the three stages viz., Pre-construction, Construction and Defect Liability stages of the project. During construction phase, contractors as well as site-in-charge will be responsible for implementing all the mitigation measures. Table-1, Table-2 and Table-3 show the EMP for Pre construction, construction & defect liability phase respectively.

Table 1: EMP for Pre-Construction Stage

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
1	Resettlement and rehabilitation	The entitlement framework to the PAPs shall be in accordance to the RAP of the project. It shall be ensured that all R&R activities be reasonably completed as per RAP, before the construction activity starts in the relevant sub- section.	Before Start of construction	-
2	Ecological impacts due to tree cutting	Trees falling within the alignment which are to be removed before commencement of construction shall be identified and approved by PIA. Prior permission from Forest dept by contractor.. Tree authorities shall be obtained. Compensatory plantation shall be carried out. However the relevant letters/ documents and statutory fess (if any) payable in this regard, shall be provided by BDA.	Before Start of construction of relevant sub- section	-
3	Local traffic arrangement	Temporary traffic arrangement during construction within RoW shall be planned. This plan shall be periodically reviewed with respect to site conditions. During site clearance activity, the demolition debris shall be preferably removed during non-peak	During site clearance and construction	M/ORT&H: 112

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
		hours and with deployment of more vehicles for the purpose.		
4	Providing labour camps and facilities	The Contractor shall abide by the Contract conditions and directions of PMC/PIA with respect to siting of labour camps, providing sanitation facilities and labour welfare issues etc.	During construction	M/ORT&H: 105.2
5	Siting of construction site/casting yard	The Contractor shall abide by the Contract conditions and directions of PMC/PIA with respect to siting of construction camps. The construction camps should have located at least 500 m away from sensitive receptors/residential area.	During construction	M/ORT&H: 105.2
6	Traffic Control and Safety	The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the PMC for the information and protection of traffic.	During pre-construction	M/ORT&H: 112.4 and 112
7	Safety of pedestrians	Special consideration shall be given in the local traffic management to the safety of pedestrians.	Before Construction and during construction	M/ORT&H: 112.2

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
8	Impact on land use outside RoW	Construction activities shall be preferably restricted within project road RoW.	During site clearance and construction	M/ORT&H: 201.2
9	Utility relocation including shifting of gas pipeline	All utilities, such as water supply lines, electrical installations, telephone lines etc. to be shifted after prior approval of agencies. Utility relocation shall be carried out in shortest possible time to reduce inconvenience to public.	Before Start of construction of relevant sub- section	M/ORT&H: 110

Table 2: EMP for Construction Stage

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
1.	Traffic Control and Safety	The contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the PMC for the information and protection of traffic.	During construction	M/ORT&H: 112.4 and 112
2.	Air Pollution	All vehicles delivering material to the site shall be covered by tarpaulin to avoid material spillage.	Entire construction phase	M/ORT&H: 111.9, 111.11 and 11.12
3.	Using existing hot mix/ Concrete/ asphalt plants	If the contractor uses the existing Concrete, Asphalt and Hot Mix Plants, he shall ensure that existing plants, which are sourced, are licensed and	During entire construction phase	M/ORT&H: 111.5

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
		authorised for operation by concerned authorities and shall intimate the PMC/PIA prior to procuring materials from them. PMC shall procure relevant documents from the plant owners to ensure that they are adhering to relevant emission norms as laid out by MoEF/ CPCB. If the contractor wishes to establish a new plant, he should obtain consent-to-establish and consent-to-operate under Air and Water Act from MPCB.		
4.	Plying vehicles on unpaved roads	The unpaved roads, if used by the contractor, shall be sprinkled with water at least once in a day to control the fugitive dust emissions. Dust emission will be a critical issue near villages.	Construction phase	M/ORT&H: 111.1
5.	Location of batching plant	Batching plant, if contractor wish to establish, shall be located away from the residential/sensitive area and shall be licensed and authorised for operation by concerned authorities.	During construction phase	-
6.	Watering to control dust at site	Construction site to be watered periodically to minimize fugitive dust generation during construction near urbanised area	During entire construction phase	M/ORT&H: 111.8

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
7.	Roads used for transport	Contractor shall ensure that the transport vehicles used to ferry materials and dispose debris does not create hazardous conditions for general traffic using the roadway especially the National Highway.	During entire construction phase	M/ORT&H: 111.9
8.	Barricading site	The construction site especially near habitation should be barricaded at all time in a day with adequate marking, flags, reflectors etc., for the safety of general traffic movement and pedestrians.	During construction phase	M/ORT&H: 112
9.	Earthwork	All earthwork and construction material should be stored in such a manner to minimise generation of dust and spillage on roads. The stacks of earthwork shall be preferably located away from habitation	During entire construction phase	M/ORT&H: 201.4
10.	Inspection of site	Daily inspection at construction site should be carried out to ensure removal of construction debris. Debris removal frequency shall be quicker to the extent possible. Piling up of debris generated near steep slope section would create hazardous condition for traffic movement and pedestrians.	During construction phase	Contract Documents

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
11.	Earthwork debris disposal	The excavated material to the extent possible would be reused for proposed construction and the remaining material would be disposed at authorised dumping grounds. In no case, loose earth should be allowed to pile up along the alignment.	During construction phase	M/ORT&H: 201.4 and 301.3.11
12.	Idling of vehicles	Idling of delivery trucks or other equipment should not be permitted during periods of unloading or when they are not in active use.	During construction phase	M/ORT&H: 201.2
13.	Construction equipment emissions	Exhaust and noise emissions of construction equipment shall adhere to emission norms as laid out by MoEF/ CPCB.	During construction	Legal requirement
14.	Noise from construction equipment	All construction equipment shall be fitted with exhaust silencers. Damaged silencers to be promptly replaced by contractor.	During construction	M/ORT&H: 111.0
15.	Noise impact due to operation of DG sets	DG sets, if used, shall adhere to noise standards of MoEF. Operation of DG sets shall be preferably avoided near habitation and sensitive receptors.	During construction	M/ORT&H: 111

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
16.	Noise level near residential areas and sensitive receptors	Construction activity induced noise levels shall be mitigated. The contractor can employ mitigation measures such as restricted and/or intermittent activity or as directed by PMC.	During construction of relevant sub- sections	M/ORT&H: 111
17.	Exposure to loud noise	Workers exposed to loud noise shall wear earplugs/earmuffs.	During construction	M/ORT&H: 111.6 and 105.2
18.	Storage of construction material	Construction material containing fine particles shall be stored in an enclosure such that sediment-laden water does not drain into nearby storm water drains and underground sewage pipes.	During construction	M/ORT&H: 306
19.	Blockage and change in drainage pattern	Along steep slope section located along alignment, earth, stone, pipes or any other construction material shall be properly stored, if storage cannot be avoided, so as not to block the flow of water. If the channel/ drains gets blocked due to negligence, contractor should ensure that they are cleaned especially during monsoon season. Once the work is completed in all respects, the contractor shall, as a mark of good gesture, clean	During construction	M/ORT&H: 306

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
		up the drains along the project road to the extent possible.		
20.	Soil erosion	On road embankment near steep hill section, slope shall be stabilized. The work shall consist of construction of retaining wall.	During construction	M/ORT&H: 306
21.	Areas susceptible to erosion	Along the steep hill section along the alignment, earthwork should be preferably carried out before rainy season or temporary/permanent erosion protection work as may be feasible shall be provided.	During construction	M/ORT&H: 306.2/ Project construction requirement
22.	Debris disposal	Debris generated due to dismantling of existing road/ pavement/structures shall be suitably reused in proposed construction. Un-utilisable debris shall be suitably disposed at sites authorised by competent authority with the approval of PMC.	During construction	M/ORT&H: 112.10 and 301.3.11
23.	Soil contamination by construction wastes, fuel etc.	Oil and fuel spills from construction equipment shall be minimised by good O&M practice. Soils contaminated by such spills shall be disposed as per MoEF requirements.	During construction	Project requirement

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
24.	Sourcing quarry materials	Sand, aggregates and other quarry material shall be sourced from licensed quarries.	During construction	M/ORT&H: 111.30
25.	Compensatory plantation	Compensatory plantation shall be done in line with Tree authority / Forest Dept. regulations and guidelines. Also it is recommended to grow trees in lieu of loss of trees.	During construction	Preservation of Trees
26.	Providing labour camps and facilities	The contractor shall abide by the contract conditions and directions of PMC with respect to labour camps, providing sanitation facilities and labour welfare issues.	During construction	M/ORT&H: 105.2
27.	Occupational Health and Safety	The contractor is required to comply with all the precautions as required for the safety of workmen as per the International Labour Organisation (ILO) Convention No. 62, as far as those are applicable to the contract.	During Construction	M/ORT&H: 105.2
28.	Provision of Safety accessories/ appliances to each worker	The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, ear plugs, masks etc. to the worker and staff. All laws related to safe scaffolding, ladders, working platform, gangway, stairwells, excavations, safety entry and exit etc. shall be complied with.	During Construction	M/ORT&H: 105.2

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
29.	Safety precautions	Adequate precautions shall be taken to prevent danger from electrical equipment. All machines/equipment used shall confirm to the relevant Indian Standards (IS) codes and shall be regularly inspected by the PMC.	During Construction	-
30.	Availability of first aid kit at construction site	A readily available first aid unit including an adequate supply of sterilized dressing material and appliances shall be provided.	During Construction	M/ORT&H: 105.2
31.	Workers health and hygiene	All anti-malarial measures as prescribed by the PMC shall be complied with, including filling up of burrow pits.	During Construction	M/ORT&H: 105.2
32.	Non-compliance of EMP	If during progress of work, breach in compliance / observance of mitigation measures observed, competent authority/committee will have right to levy any penalty as per the nature of default summarily without assigning any reasons thereof.	During Construction	-

Table 3:EMP for Operation Phase

S. No.	Environmental Issue	Mitigation Measures	Time Frame	Cross Reference to Documents
1	Air quality impact	Ambient air concentrations of various pollutants shall be monitored as per the pollution monitoring plan.	Starting immediately after completion of construction	Project requirement
2	Noise pollution	Monitoring of noise levels at locations as per monitoring plan.	Starting immediately after completion of construction	Project requirement
3	Survival rate of plantation	Adequate care of the compensatory plantation should be taken up so as to comply the survival rates recommended in the relevant policies of the Tree authority	Up to 3 years after project becomes operational	Project requirement
4	Road embankment & cut section stability	Road embankment & cut section stability should be checked for erosion and rutting. The high embankment section along the alignment shall be periodically checked for soil erosion and stability. Any sign of instability should warrant adequate response immediately and well before succeeding monsoon season	Throughout defect liability stage	Project requirement

9.3 Environmental Monitoring Plan

Recommended Project level Environment monitoring plan is presented in **Table 4**

Table 4: Environmental Monitoring Plan

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration
Air Quality	Before Construction	SPM, PM10, SO2, NOx	NAAQS of CPCB	NPKL	Once every season –Winter,	24 hr/day for 2 consecutive working days per week
Air Quality	Construction	SPM, PM10, SO2, NOx	NAAQS of CPCB	NPKL	Once every season – Summer, Winter, post monsoon	24 hr/day for 2 consecutive working days per week
Air Quality	Operation	SPM, PM10, SO2, NOx	NAAQS of CPCB	NPKL	Once every season – Summer, Winter, post monsoon	8 hr/day for 2 consecutive working days per week
Noise Level	Construction	Leq Day, Leq night, L10, L50, L90 dB(A)	CPCB noise standards	Sensitive and residential locations located near construction equipment	At start of construction activity, followed by every season (Summer, winter and post monsoon) during construction period	Continuous 24 hr reading with a frequency of 10 minutes for 2 non-consecutive days per week for 2 weeks
Noise Level	Operation	Leq Day, Leq night, L10, L50, L90 dB(A)	CPCB noise standards		Once every season (excluding monsoon) for 1 year after	Continuous 24 hr reading with a frequency of 10 minutes for 2 non-

Development of Major Arterial Road, Phase -1 in Nada Prabhu Kempegowda Layout

Component	Project Stage	Parameters	Standard	Location	Frequency	Duration
					operation starts	consecutive days per week for 2 weeks
Soil Quality	Construction	Heavy metals and Oil and grease	Contaminant threshold level given by USEPA	Debris disposal site	At start and end of construction activity	One time sample
Ecology	Pre-construction	Monitoring of tree felling/ transplantation	As laid out in project detail design. Trees to be adequately marked for felling	At locations of Tree felling	During tree felling	--
Ecology	Operation	Survival rate of plantation and other compensatory plantation	Survival rate to be at least 70%.Below which replantation should be done.	At locations of compensatory plantation	Annual	For 3 years after operation starts

*All Mandatory requirements as per the prevalent environmental laws and regulations and those mentioned in the environmental clearance obtained for the project has to be compulsorily complied by the agency/ bidder at its own cost

SUB-SECTION 7A.10

ACCEPTABLE MAKES

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SUB-SECTION 7A.10: ACCEPTABLE MAKES

Acceptable makes for Plant, pipe and material are specified in the table below. The tenderer shall offer makes included in the list. Equivalent makes unless specified in the list will not be accepted except where prior approval by the Employer is granted before bidding.

10.1 CIVIL

S. No.	Equipment	Acceptable Makes
1.	Cement	ACC, Vikram, Ambuja, JK, Shri, Uttam
2.	Structural Steel	SAIL, TISCO, ISSCO
3.	RCC Pipes	ISI Marked
4.	SW Pipes	ISI Marked
5.	RCC Manhole Cover & Frame	ISI Marked
6.	Epoxy Paint	Hindustan Ciba Giegy, Fosroc, Seiko Roffec, Burger
7.	Bituminous Paint	Burger, Asian Paints, Shalimar, Tar Products
8.	Synthetic Paints	Burger, Asian Paints, Nerolac, Delux, Salimar
9.	Water proofing Compounds	Sika, Fosroc
10.	Concrete Admixtures	Sika, Fosroc
11.	Bitumen	IOCL, HPCL, BPCL

10.1.1 Approved Manufacturers List for Mechanical

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
1	Air Compressor	M/s Ingersoll Rand
		M/s Kaeser
		M/s Kirloskar Pneumatic
		M/s Atlas Copco
2	High Speed Turbo Air Blowers	M/s Turbo Max
		M/s Korea Fluid Machinery
		M/s DaeHa Engineering
3	Cranes (Hoists ,Jib cranes)	M/s W.H. Brady
		M/s Transpade Engineers
		M/s Eddy Cranes
		M/s Safex Electromech
4	Jet / Exhaust Fans	M/s System Air
		M/s Kruger
		M/s Dynair
		M/s Hind(Maico)
5	Horizontal Centrifugal Pumps	M/s Grundfos
		M/s KBL
		M/s Wilo/Mather & Platt
		M/s KSB
		M/s Pentair
6	Submersible Pumps	M/s Grundfos
		M/s Xylem
		M/s Wilo/Mather & Platt
		M/s ABS Sulzer
		M/s KSB
7	Booster Pumps	M/s Grundfos
		M/s Xylem
		M/s Wilo
		M/s ABS Sulzer
		M/s KSB
8	Screens	M/s Triveni
		M/s Bilfinger
		M/s Huber

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
		M/s Estragua
		M/s Smith & Loveless Inc.
		M/s. Johnston
		M/s. Jash
9	Butterfly Valve	M/s Pentair
		M/s Fouress
		M/s VAG Valves
		M/s AVK Valves
		M/s KBL
		M/s. DVPL -Durga
		M/s. Jupiter
10	Sluice Gate Valve	M/s VAG
		M/s KBL
		M/s AVK
11	PP Valve	M/s Shenco
		M/s. DVPL -Durga
		M/s. Jupiter
		M/s U N Polyvalves
12	Penstock Gates	M/s Jash
		M/s Yashwant
		M/s. DVPL-Durga
13	M.S- Cement Lined Pipes	M/s Jindal
		M/s PSL
		M/s Welspun
14	SS Pipes	M/s SAIL
		M/s Jindal
		M/s. Remi Pipes
		M/s Rupam Steel
15	DI/GI pipes	M/s Electrosteel
		M/s Lanco steel
		M/s Jindal
		M/s Kejriwal Castings
		M/s Surya Pipes
16	DI Pipe Fittings	M/s Kiswok
		M/s Kejriwal Castings

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
17	Motorised Weir Gates	M/s Jash
		M/s. DVPL-Durga
		M/s Southern scogen
		M/s. Eutotek
18	Centrifugal Air Blowers	M/s Howden
		M/s Siemens
		M/s Neuros
		M/s Godrej Aerzen
19	Electric Actuators	M/s Auma
		M/s Limitork
		M/s Rotork
20	Pneumatic Actuators	M/s Rotex
		M/s D Torque
		M/s Elomatic
21	UPVC & HDPE Pipes	M/s Jain Irrigation
		M/s Finloex
		M/s Duraline
		M/s Manikya Plastichem
		M/s Pennwalt Agro
		M/s. Prince Pipes & Fittings Pvt. Ltd.
		M/s Supreme
22	Motors	M/s Crompton Greaves Ltd
		M/s Marathon Electric (Alstom)
		M/s Kirloskar Electric company
		M/s Bharat Bijlee Ltd
		M/s ABB
23	Ball Valves	M/s BDK Engineers
		M/s Flowchem
		M/s Virgo
		M/s KBL
		M/s Microfinish
24	Knife Gate valves	M/s Jash Engineering (Scheute)
		M/s Bray
		M/s Fouress

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
		M/s VAG
		M/s AVK
		M/s. DVPL -Durga
		M/s. Jupiter
25	Diaphragm valves	Crane Process
		Microfinish
		BDK Engineers
		Leader
26	Eccentric Plug valves	M/s Dezurik
		M/s VAAS
		M/s. Arflu
27	Air conditioner	M/s Bluestar
		M/s Voltas
		M/s. O General
		M/s Hitachi
28	Screw Impeller Submersible Pumps	M/s Hydrostal
		M/s Kubota Pumps
29	DG	M/s. Powerica Limited
		M/s. Sterling Generators
		M/s. Mahindra Powerol

10.1.2 Approved Manufacturers List for Electrical

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
1	Power transformers	M/s ABB
		M/s BHEL
		M/s Siemens
		M/s Areva T&D
		M/s Crompton Greaves Limited
2	Auxiliary transformers	M/s ABB
		M/s BHEL
		M/s Siemens
		M/s Areva T&D
		M/s Crompton Greaves Limited
		M/S Volt Amp
		M/S Bharat Bijlee
		M/s Kirloskar Electric
3	11 kV Metal enclosed switchgears /MCC	M/s Siemens
		M/s ABB
		M/s Crompton Greaves Limited
		M/s BHEL
		M/s Areva
4	HV Vacuum Circuit Breaker	M/s Siemens
		M/s ABB
		M/s Crompton Greaves Limited
		M/s Areva
		M/s BHEL
5	Protective Relays	M/s ABB
		M/s Schneider Electric
		M/s L&T
		M/s GE
		M/s Siemens
		M/s Areva T&D
6	H.T & L.T Current Transformers	M/s ABB
		M/s Areva T&D
		M/s CGL
		M/s BHEL
7	Neutral earthing resistors	M/s Bharatia Cutler Hammer (I). Ltd

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
		M/s Crompton Greaves Limited
		M/s Indcoil Mfg Company Limited
8	11 kV capacitor and panel	M/s BHEL
		M/s ABB,
		M/s CG Power Systems
		M/s Universal Cables
9	LV Switchgears /MCC	M/s Schneider Electric
		M/s ABB
		M/s. Siemens
		M/s GE
		M/s L&T
10	LED Lighting Fixtures and Accessories	M/s Philips
		M/s ABB
		M/s Crompton Greaves Limited
		M/s Wipro
		M/s Bajaj Electricals
11	L.T Power Capacitors	M/s BHEL
		M/s ABB,
		M/s CG Power Systems
		M/s Universal Cables
12	Alternators for DG Sets	M/s Kirloskar Electric
		M/s CGL
		M/s BHEL
		M/s Jyoti
		M/s Stomford
13	Cables	M/s Universal Cables
		M/s Polycab
		M/s Havell"s
		M/s Lapp India
14	Battery	M/s Exide Industries
		M/s AMCO
		M/s HBL-NIFE
15	Battery Chargers	M/s Universal Instruments
		M/s Amara Raja
		M/s Chabhi Electricals

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
		M/s HBL-NIFE
		M/s Caldyne
16	Cable Termination Kits	M/s Mahindra Engg and Chemical Products
		M/s REPL
		M/s Raychem
17	FCMA Starters	M/s. Innovative technomics
		M/s. Sunshine controls
		M/s. Sakthi power innovative
		(or) Equivalent as per tender requirement.
18	Energy meters with MODBUS	L&T
		Enercon
		Conserve

10.1.3 Approved Manufacturers List for Instrumentation

Sr.No	Item Description	Approved Vendor/ Manufacturer/ Make
1	Level Indicator Transmitter	M/s EMERSON
		M/s ABB,
		M/s Nivelco
		M/s Royce Instruments
		M/s Xylem/MJK
		M/s Global Water
		M/s Endress+Hauser
		M/s Pulsar
		M/s Kobold
		M/s Yokogawa
		M/s Siemens
2	Flow meters/Flow Indicator/ Transmitter	M/s EMERSON
		M/s ABB
		M/s Royce Instruments
		M/s Xylem/MJK
		M/s Dynameters
		M/s Pulsar
		M/s Yokogawa
		M/s Endress+Hauser
		M/s Krohne Marshall
		M/s Siemens
3	Level/Float Switches	M/s EMERSON
		M/s ABB
		M/s Xylem/MJK
		M/s Nivelco
		M/s Royce Instruments
		M/s Endress+Hauser, M/s Kobold
		M/s Pune Techtrol
4	Pressure Gauges/Pressure Switches	M/S Warry
		M/S ABB,
		M/s Wika
		M/s Kobold
		M/s Gen Inst Co
		M/s Switzer

Sr.No	Item Description	Approved Vendor/ Manufacturer/ Make
		M/s Dandfoss
5	Pressure Indicator Transmitter	M/s EMERSON
		M/s ABB,
		M/s Kobold
		M/s Switzer
		M/s Rosemount
		M/s Endress+Hauser
		M/s Siemens
6	Temperature Indicator Transmitters	M/s Kobold
		M/s Endress+Hauser
		M/s ABB
		M/s Hach Company
7	Air Quality Analysers/ Instruments	M/s Bosch
		M/s Air Pointer
		M/s Aero Qual
	List of Makes For UPS & Batteries:	
	(a) List of Makes for UPS	
	S. NO	MANUFACTURER / MAKE
	1	M/s APC
	2	M/s DB & ELECTRONICS
	3	M/s HI-REL
	4	M/s NUMERIC POWER SYSTEMS
	(b) List of Makes for Batteries	
	S. NO	MANUFACTURER / MAKE
	1	M/s AMAR RAJA
	2	M/s HBL NIFE
	3	M/s AMCO
	4	M/s EXIDE
	5	M/s Tata Green
	iii) List of Makes for Cables	
	S. NO	MANUFACTURER / MAKE
	1	M/s Universal Cables

Sr.No	Item Description	Approved Vendor/ Manufacturer/ Make
	2	M/s Polycab
	3	M/s Havell's
	4	M/s CCI
	5	M/s Finolex
	6	M/s NICCO
	7	M/s Delton Cables Limited
	8	M/s Thermo cables
	(iv) List of Makes for Enclosures/ Panels	
	S. NO	MANUFACTURER / MAKE
	1	M/s Rittal
	2	M/s ECIL
	(v) List of Makes for Alarm Annunciators	
	S. NO	MANUFACTURER / MAKE
	1	M/s ALAN
	2	M/s Unitech Instruments
	3	M/s Minilec
	(vi) List of Makes for Process Indicators	
	S. NO	MANUFACTURER / MAKE
	1	M/s Masibus
	2	M/s Unitech Instruments

10.1.4 Approved Manufacturers List for Automation

Sr.No.	Item Description	Approved Vendor/ Manufacturer/ Make
1	Workstations , Servers	Dell
		Hewlett-Packar
		Compaq
		Lenovo
2	Programmable Logic Controllers	Schneider Electric (Quantum Series)
		Siemens PLC(S7-400H series)
		Allan Bradley (Control Logix series)
		ABB(AC 800 M Series)
		Mitsubishi (Q 25 Series)
		GE(7Xi Series)
		YOKOGAWA (CENTUM)
		Omron PLC(CS1 D Series),
3	SCADA Programming Software	Intellution IFix
		Wonderware
		WIN CC V 6.2
		RS View,
		Visio Citect
		Iconics
		CX-Supervisor V3
		Fast Tools
4	GSM/GPRS Equipment	Motorola
		GE
		Seimens
		GSV Microtek
		DataRadio
		Sheetal Wire-less Systems

SUB-SECTION 7A.11

BUILDING INFORMATION MODEL SPECIFICATION (BIM)

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SUB-SECTION 7A.11: BUILDING INFORMATION MODELING (BIM)

Building Information Modeling (BIM) is the process of creating and managing information throughout the whole life of the asset by using model-based technologies linked to a database of reliable information. Virtual models are created in three dimensions before work proceeds on site; the attributes of all the elements of the asset (metro rail in this case) that will be constructed can be found in the model; and spatial 'clashes' can be identified and resolved in the model instead of on site.

Ideally within a BIM perspective, the 3D model and related information (within databases) exist and are developed throughout the whole life of the asset – from initial conception to final disposal of the asset – and houses the on-going work and communication efforts of the complete supply chain. The 3D models helps to visualize and, understand the relationships between the structure and its systems in regards to aesthetics, performance and programme issues.

In a BIM environment, data and information is structured and managed to ensure only the right information is used and created at the right time for optimizing the whole life usage of the infrastructure. This means the requirements during the operation and maintenance phases are key drivers for what data is required (and when).

BIM can streamline processes through the integration of design, engineering, construction, operation, maintenance and decommissioning of an asset into rich models of data that include: 3D models, spatial mapping, asset information, documentation, financials, etc. However, data and information should only be produced for one of two purposes:

- To meet a requirement or obligation
- To assist in decision making

BIM methodologies have a focus on what is required to operate and maintain facilities and infrastructure. This helps to optimise the process of ensuring the appropriate data will be delivered and:

- Not too little so that maintainers have to re-visit assets and collect more data
- Not too much that can be unmanageable.

11.1 BUSINESS BENEFITS OF BIM

Business outcomes that can be influenced by BIM typically include:

- *Providing stakeholders with interactive learning applications and animated 3D simulations to deliver quality training without the need to create physical mock-ups*
- *Providing operations staff with information, such as visualization models, which can support key decisions reducing the reliance on manual validation onsite*
- *Providing a model which can be accessed by a number of systems to enable swift and accurate comparisons of information, reducing the risk of delay misuse in the event of a problem being identified along the stretch of the road, thereby reducing operational costs*
- *Providing a data model which can be monitored against trends in failures and repairs reducing maintenance cost through developing strategies dealing with proactive preventative measures, resulting in lower maintenance costs*
- *Minimising re-surveying areas before design/construction changes through the re-use of information, reducing repair, replace and new project creation costs*
- *Supporting maintenance activities through the use of rehearsing complex procedures, optimising temporary works designs and planning procurement of materials, equipment and manpower, reducing renewal and maintenance costs.*

11.2 PROJECT EFFICIENCY BENEFITS

- *Improved collective understanding of design intent*

Because of BIM's ability to support 3D visualization and its rich database of reliable information, the collective understanding of design intent provides a high level of value because models can be used to better understand and monitor ideas that carry through the whole life of the assets.

- *Early mitigation of potential conflicts and changes during construction*

Conflicts and changes in the field are costly, affecting both budget and schedule. By using the BIM model to identify potential issues before they occur on site, users can prevent costly mistakes and reduce Requests for Information (RFIs), site change requests, non-conformities and site coordination problems.

- *Risk Reduction*
 - Increased confidence in design, construction and operational costs
 - Crowd behaviour and fire modelling capability enable designs to be optimised for public safety. Asset managers can use the 3D model to enhance operational safety. Contractors can minimise construction risks by reviewing complex details or procedures before going on site.
- *Enables efficient project team coordination and collaboration*

All project partners, different design disciplines, the customer, contractor, specialists and suppliers use a single, shared 3D model, cultivating collaborative working relationships. This ensures everyone is focused on achieving best value, from project inception to eventual decommissioning

- *Makes project delivery efficient and economical by leveraging the latest computing technology e.g. data mobility, apps, etc.*
- *Reduced information loss throughout the whole life of the asset including between project phases*
- *Delivering quality training to staff by using the BIM model to deliver interactive learning applications and animated 3D simulations*

11.3

SAFETY BENEFITS

- *Understanding what is proposed during construction*

Because of BIM's ability to support 3D visualization and its rich database of reliable information, the collective understanding of design intent provides a high level of value because models can be used to better understand and monitor ideas that carry through the whole life of the asset and enables non-technical staff to readily understand processes and relationships.

- *Demonstrating "Readiness to Dig"*

Using simple 4D models as visual validation that the contractor and site teams understand what is to be built and when, and the key steps to starting groundworks.

- *Eliminating mistakes with the potential to cause harm*

Documentation and briefing materials is improved as objects are only modelled once in BIM, meaning that drawings automatically derived from that model are more consistent and accurate, and avoid clashes that may otherwise occur.

11.4 QUALITY BENEFITS

Contractors using BIM report a general improvement in the quality of design data and information received for construction. Design errors, typically through clashes and spatial interfacing conflicts can typically account for some 2% of cost increases in civil engineering works. Quality benefits include:

- *High quality, single source of truth in data and information for decision-making ensures only one version of each document is kept*
- *Provides up-to-date reliable and trusted information for both the client and supply chain*
- *Using 4D (time-based) data provides the tools to maximise the efficient coordination of site labour*
- *Requests for Information (RFIs), change requests and non-conformities will be significantly reduced during field construction due to the enhanced coordination and conflict reduction with the use of 3D models*
- *Accurate as-built drawings are available immediately at the close of construction. The 3D model, as it is updated throughout the project duration, provides a virtual as-built representation of the physical asset.*

11.5 COST BENEFITS

BIM has been proven to help reduce the waste and errors that occur in infrastructure projects, where the assembly process is usually a “one-off”.

Studies in the US have shown that net savings when using BIM are around 5% on the construction of new-build projects, and the ROI for BIM systems has been estimated at more than 60%. Data published by the UK government shows a consistent reduction of 8-10% of construction costs.

11.6 PLANNING AND DESIGN

- BIM involves people, process and technology. The technology aspect of the BIM will involve use of engineering applications that are used for planning as well as design of the asset. The road to be *constructed* involves different engineering disciplines such as road design, bridges, geotechnical, geospatial etc. Each of these disciplines will use discipline specific design applications (with ability to attach intelligent attributes) to come up with individual 3D intelligent models (and 3D intelligent master model for review and analysis. All such design applications needs to be interoperable and able to exchange information seamlessly. The design applications will work in a 3D as well as 2D environment (for plans production, detailing, measurements, markups etc.). The 3D design models from the different applications needs to be geo-coordinated so that so that the master model which is a result of collaboration can exactly fit at the desired location if referenced back on the map and is an important aspect of the applications to be used.

All such design applications needs to be interoperable and able to exchange information seamlessly. Each discipline works with a standardized model structure, object structure and layer structure (part of Standards, Methods and Processes set for the project) to ensure that model information can be exchanged. At the same time these applications need to tightly integrate with the engineering collaboration system in order to use their workflow and processes set.

11.7 DESIGN REVIEW

The review solution used should be able to:

- Help the reviewers make better decisions, faster, throughout the lifecycle of a project, while reducing project risk. The solution should

be able to give an insight into the project and operations with clearer visibility into the information in 3D models

- Speed project delivery with immediate access to the latest information through one experience on every device, in the office, on-site, or in the field (through mobile applications). Improve project coordination and accelerate collaboration through faster reliable capture of feedback from field staff
- Ensure the coordination of engineering disciplines with the ability to perform clash detection for timely issue resolution during design
- Perform construction simulation and collaborate between office, site, and field to gain insight into project planning and execution for faster resolution of issues found in the field during construction
- To improve the safety and speed of inspections and maintenance with the ability to see asset information within the context of 3D models during operations

Thus the integrated master 3D model will be utilized for reviews at various phases of the project right from design to operations. Especially during the design phase markups need to be created and directed to the originator for revisions (if any). These markups need to be in neutral formats such as pdf's. Also these review solutions should be able to create intelligent 3D pdf's that can be used for review in absence of the originator software. At the same time one can query in to get the intelligent attributes attached to the 3D model. Also walkthrough, flythrough can be created to review the model in detail. This solution needs to tightly integrate with the engineering collaboration system in order to use their workflow and processes set. The solution needs to cater to the 4D (time) aspect of the BIM thus offering a complete review solution.

Table 11. 1:Technology Deployment for BIM

Sr. No.	Particulars	Quantity	Unit
1	Carrying out the survey of the Road & Tunnel alignment using mid height capability mapping drone of Indian licensed manufacturer having various interoperable medium altitude long endurance (MALE) drone with atleast 24 megapixel camera and variety of payload and sensors	14.25	Per kilometer of alignment
2	The detailed topographic survey of the Road & Tunnel alignment shall be done using digital aero triangulation and GPS and will be produced in both electronic format (in X, Y, Z Coordinate system), 3D Models and hard copies. The digital output needs to be a high-resolution 3D model of the existing conditions with a navigable fully photo-textured, geographically located 3D model with precise geometric. A licensed version of the software for future processing needs to be delivered along with the 3d model. Plans, longitudinal sections and cross sections shall be prepared to the scale.	14.25	Per kilometer of alignment
3	The agency needs to use still oblique photography to create 3D vector model having the specifications as mentioned in Annexure I	14.25	Per kilometer of alignment
4	The agency needs to create a scaled 3D rendered model in 3D software having appropriate resolution of roads, tunnels and required structures, utilities based on the technical specifications, drawings & design approved by BDA.	14.25	Per kilometer of alignment per structure/ utility
5	The said 3D model of the proposed Roads, Tunnel & respective structures with relevant features needs to be incorporated on actual model so created of the alignment surroundings.	14.25	Per kilometer of alignment

Sr. No.	Particulars	Quantity	Unit
6	The animation film in Augmented Reality software using the rendered models and actual video's with well researched and drafted script in Kannada and English languages.	8	Per minute of rendering/shooting
7	Carrying out periodic photography using appropriate cameras and software to show the actual work progress (As built)which shall be carried out on site and needs to be superimposed on the vector model so created.	18	Per kilometer of alignment or part there off per instance
8	Prepare final documentary film of actual work been done and the challenges faced using stock photos and video's)	10	per minute of editing and shooting of video's
9	Providing Laser Scanner with skilled operators, Relevant processing software and back office integrators to capture the base line data and actual site execution data of Tunnel & Road works for the scan to BIM project to generate the EMB and correlate the data in BIM	10	Per Month
10	Integration of the above vector 3D data in the required 5D BIM enabled software to include the work schedule, and construction management in order to generate Electronic Measurement Book (EMB), as per the specification approved by BDA's representative.	2	Man Month
11	Skilled Manpower in BIM Modelling having work experience up to 450 LOD and in 5D BIM environment for entire construction period	10	Per Month
12	Supply of Software with Subscription/ Perpetual License as per specifications attached as mentioned below:	1	As per Spec.
	Software for 3D Resolution Map have capability to associate resolution to any 3D location on Virtual model Like Context Capture Center with Perpetual License with 2 years Support.		

Sr. No.	Particulars	Quantity	Unit
	Graduated Subscriptions for 2 years for below software's or its equivalent software available in Market		
	LumenRT Perpetual License	2	
	Staad.Pro Advanced Perpetual License	2	
	Open Roads Designer Perpetual License	2	
	Open Roads Concept Station Perpetual License	2	
	Open Acosim Designer Perpetual License	2	
	gINT Professional Perpetual License	2	
	Bentley Map Enterprise Perpetual License	2	

SUB SECTION 7A: 12

HANDING OVER REQUIREMENTS

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SUB SECTION 7A:12

HANDING OVER

12.1 General

This section applies to procedure(s) on handing over the works and sites back to the Employer at the end of defect liability period by the Contractor. This shall include all civil structures, mechanical systems including pumping main system, the instrumentation/control & automation system, communication system, electrical system including substations, SCADA systems, all ancillary buildings and campus area.

The procedure for Handing Over shall include the final examination/tests of the system by the Engineer. Contract Completion Certificate shall be issued by the Employer after the successful final examination/tests and submission of the relevant documents.

12.2 Duties and Responsibilities

- 1) All cost for the examination, tests and preparation of any documents of the activities shall be the Contractor's responsibility.
- 2) The Contractor shall provide all necessary labour, materials, and fuel required for tests.
- 3) Conduct Joint Inspection Prior to Contract Completion:
To verify the condition of Works / Facilities at the end of defect liability period for identifying damaged works, replacements and other works to be carried out to satisfy the requirements, a joint inspection will be carried out by the Engineer, Employer and contractor.
- 4) Conduct Tests prior to Contract Completion:
Contractor shall conduct all the required Tests prior to Contract Completion. The contractor is responsible to conduct annual inspections of cranes & other lifting equipment, pressure vessels and other equipment as required by law/Govt. of Karnataka.

The inspection items are given below in Table 12.1 but not limited to this.

Table 12.1: Items to be examined at the End of Defect Liability Period

Items	Description
1. Appearance test /Visual examination (Damage/crack, differential settlement, soil settlement, peel off painting, missing/lost, leakage of water/solution/gas, corrosion, condition of structures, others)	- All Civil structures, building including interior/exterior, fence/gate, stairs, others - All Mechanical & Electrical equipment/accessories, others - All Pipe line valves and gates, others - All Instrumentation and Control equipment, others
2. Performance examination (Selection of operation mode, selection of facilities, flow/water level, overflow, vibration/noise level, speed of pump/motor, smoothness, gap/spaces, accuracy, setting value, condition of structures, others)	- Check Sequence, or Manual operation including water level, pressure sensors/protections, others - Check specification of all Mechanical equipment including pressure and water level gauges, pressure relief valves, others - Check specification of all Electrical equipment, others - Check specification of all Pipeline including valves, gates, others - Check specifications of all Instrumentation and Control equipment, others - Check specification of all accrual condition after troubleshooting, others - Performance tests of pumps, blowers and other equipment
3. Verification of rectified works (System, leakage, crack, damage, soil settlement, corrosion, others)	- Check a list of all defect items, history, tendency, repeating, others - Verification of action on the take measures, others - Verification of all rectified works with the reports and photo, others - Check emergency works and its factor, action plan, others - Check actual condition after rectified works, others
4. Operation skill (Staff member, others)	- Review of summary reports on Defect Liability Period activities

Items	Description
	- Check time and motion of staff member, others - Interview operator regarding troubleshooting, others - Paper test (basic knowledge, calculation of chemical dosing, safety, others) - Fieldtest (using/put on the safety gear, drill of chlorine leakage accident, others)
5. Record	Check inventory list (parts, chemical, reagent, others) - Check the quantity of inventory, others - Check maintenance tools and equipment, vehicle, others
6. Spare parts and others	- Check inventory list (parts, chemical, reagent, others) - Check the quantity of inventory, others - Check maintenance tools and equipment, vehicle, others

5) Submission of the report on completion of Contract:

The Contractor shall submit the completion report after pass the final examination/tests.

The report shall consist of relevant documents, for request for issue the Completion certificate of Contract Completion period, which is given below in Table 17.2 but not limited to this.

Table 17.2: Documents to be handed over at the End of Defect Liability Period

Contents	Description
1. Outline	Outline - Summary of project, scope of work, location of project, main component with specification, others
2. Completion Photographs (At acceptance complete inspection, completion inspection and final inspection)	Photographs with short description - Civil (structural, buildings, others) - Mechanical, Electrical and I&C (equipment, facility, others) - Piping works
3. Inspection summary (At acceptance complete inspection, completion)	Appearance test /Visual/ Performance examination - Table of Summary of test activity based on daily and monthly

Contents	Description
inspection and final inspection)	- List of type of test, date, inspector, evaluation, comments - Civil (name of structure, drawing no., drawings, design dimension, previous dimension, actual dimension, others) - Mechanical (name of facility and equipment, tagno., quantity, others) - Electrical (name of facility and equipment, tag no., quantity, others) - Instrumentation and Control (name of facility and equipment, tag no., quantity, others)
4. Main inspection data (At construction)	Summary of data with graphic /chart - Civil (plate load bearing test, compressive strength test, water retaining test, compaction field test, road construction works, hydrostatic test, others) - Mechanical (disinfection test, others) - Electrical (earthing resistance test, others) - Instrumentation and Control
5. Inspection record (At acceptance complete inspection, completion inspection and final inspection)	Appearance test /Visual/ Performance examination/ Verification of rectified works - Civil (Refer to Table 17.1, point no.1,2,3) - Mechanical (Refer to Table 17.1, point no.1,2,3) - Electrical (Refer to Table 17.1, point no.1,2,3) - Instrumentation and Control (Refer to Table 17.1, point no.1,2,3)
6. Spare parts list	-Mechanical (name of parts, tag no., quantity, location of stock, others) - Electrical (name of parts, tag no., quantity, location of stock, others) -Pipes& fittings (name of parts, tag no., quantity, location of stock, others) -Valve &Gates (name of parts, tag no., quantity, location of stock, others) - Instrumentation&Control (name of parts, tag no., quantity,location of stock, others)

Contents	Description
	-Safety equipment and devices including for staff and for testing -Others (name of parts, tag no., quantity, location of stock, others)
7. Key list with boxes	- Name of key, location, tag no., quantity, Civil (all related material: reinforcement bar, cement, aggregate, sand, gravel, asphalt, crashed stone, chemical admixture, water reducing agent, pozzolana, water-tightness sheet, construction equipment, manhole, water-resistant coating, paint, windows, door, others) - Mechanical (all related equipment; screens, pumps, blowers, dewateringCentrifuge, heat exchanger, Gas engines, Gas scrubbers, Chlorinators, scarper, conveyor, hopper, central drive& rotating mechanisms, pipes, valves, gates, pressure gauges, safety valves, safety equipment, flow meters, coating, painting, others) - Electrical (all related equipment: electrical wire, electrical conduit, motor, control panel, relay, transformer, heater, generator and silencer, timer, breaker, light/lamp, switch, street light, earthing, measurement equipment, air condition, communication equipment, electric pole, coating painting, ventilation fan, air duct, others) - Instrumentation & Control (all related equipment, others) - Safety equipment - Others
8.Manufacture produced catalogue(Civil, Mechanical, Electrical and Instrumentation &Control)	- Civil (all related material: reinforcement bar, cement, aggregate, sand, gravel, asphalt, crashed stone, chemical admixture, water reducing agent, pozzolana, water-tightness sheet, construction equipment, manhole, water-resistant coating, paint, windows, door, others) - Mechanical (all related equipment; screens, pumps, blowers, dewateringCentrifuge, heat exchanger, Gas engines, Gas scrubbers, Chlorinators, scarper, conveyor, hopper, central drive& rotating mechanisms, pipes, valves, gates, pressure gauges, safety valves, safety

Contents	Description
	equipment, flow meters, coating, painting, others) - Electrical (all related equipment: electrical wire, electrical conduit, motor, control panel, relay, transformer, heater, generator and silencer, timer, breaker, light/lamp, switch, street light, earthing, measurement equipment, air condition, communication equipment, electric pole, coating painting, ventilation fan, air duct, others) - Instrumentation & Control (all related equipment, others) - Safety equipment Others
9. Instruction manual (Civil, Mechanical, Electrical and Instrumentation & Control)	- See above
10. Factory inspection record or Quality assurance (Civil, Mechanical, Electrical and Instrumentation & Control)	- Civil (all related material: reinforcement bar, cement, aggregate, sand, gravel, asphalt, crashed stone, chemical admixture, water reducing agent, pozzolana, water-tightness sheet, construction equipment, manhole, water-resistant coating, paint, windows, door, others) - Mechanical (all related equipment; screens, pumps, blowers, dewatering Centrifuge, heat exchanger, Gas engines, Gas scrubbers, Chlorinators, scarper, conveyor, hopper, central drive & rotating mechanisms, pipes, valves, gates, pressure gauges, safety valves, safety equipment, flow meters, coating, painting, others) - Electrical (all related equipment: electrical wire, electrical conduit, motor, control panel, relay, transformer, heater, generator and silencer, timer, breaker, light/lamp, switch, street light, earthing, measurement equipment, air condition, communication equipment, electric pole, coating painting, ventilation fan, air duct, others) - Instrumentation & Control (all related equipment, others) - Safety equipment - Others
	History of construction

Contents	Description
11. Photograph (During Construction, at defect liability, at joint completion inspection) (Civil, Mechanical, Electrical, Instrumentation & Control)	Replacement of defect liability - Civil: construction site before starting construction, earthwork, arrangement of bar, cleaning before placing, formwork, concrete mixing work, placing, vibrating, curing, remove of formwork, backfill, compaction, all field inspection and lab test, others - Mechanical: inspection at factory, receiving inspection, completion inspection, all field inspection and lab. test, others - Electrical: inspection at factory, receiving inspection, completion inspection, all field inspection and lab. test, others - Instrumentation and Control: inspection at factory, receiving inspection, completion inspection, all field inspection and lab. test, others
12. Production samples (Civil, Mechanical, and Instrumentation & Control)	All samples for technical approval - Attach Analytical instruments name, approved sign of the Engineer.
13. Report	- Monthly and Annual report - Others

These data shall be provided both in soft and hardcopies, in proper professional format.

12.3 Specifications

The specification of materials used for repairs shall be the same as have been used in the original work. Specifications for any materials which were not used during construction shall be approved by the Engineer prior to Handing Over.

12.4 Check List

12.4.1 General

- a) Within the framework of the Contractor's responsibilities given above, the Contractor shall carry out the following activities. However, these shall not limit the requirement for other activities which otherwise are required as per terms

and conditions of the Contract or to fulfill the Contractor's responsibilities or are essential as per good industrial practices. The Contractor shall hand over all the components of works in good working condition for the following, but not limited to:

- b) All required consumables required for functioning of plant with inventory of material.
- c) All Electrical Equipments such as Transformers, HT Metal Enclosed Switchboards (11kV)& Switchgears, 415 V metal enclosed switchgears (PCC/MCC), 415 V Power capacitor and control panel, Diesel Standby Generator with AMF Control Panel and Synchronizing panel, Battery, battery charger and DC Distribution Board, Variable Frequency Drives, Non Segregated Bus Duct, Power & control cables, Cable carrier system, Lighting system, Earthing and lightning protection systems of the Plant (All works constructed in this Contract).
- d) All Instrumentation and control equipment, etc., at the pumping stations (All works constructed in this Contract).
- e) Administrative buildings, pumping stations etc. (All works constructed in this Contract) in neat and clean condition.
- f) AMC contracts with system / equipment suppliers, as necessary for PLC and SCADA system supplier or the authorized system integrator as executed the work for this project.
- g) Lighting fixtures and the lighting system of all areas and replacement of all non-functional lighting fixtures.
- h) Records for the followings but not limited to
 - Water quality report
 - Repair history of all mechanical, electrical and instrumentation control
 - Logbooks through PLC system;
 - Daily log of operations of all the important equipment with time tag;
 - Hourly readings of water levels, pressure sensors, flow rates and integrated quantity of water;
 - Operational cost;
 - Monthly Running hours of the all Mechanical equipment and total electrical power consumption;
 - Generator running hour and production of electricity
 - Sludge and screenings handling amount
 - Daily list of alarms with time tag; (Power consumption by each Pump and each Pump House)

- Logbook format and the data to be included in the logbook;
- Last periodic maintenance done for all equipment/buildings of the system;
- i) Required spares, general and special tools& tackles, test equipment and adequate inventory of required accessories or equipment itself for repair/replacement of defective electrical, mechanical, instrumentation and control system, pipe, and the communication system. However at the end of the Contract, the Contractor shall hand over the full spares, tools and tackles as supplied with the Contract by replacing the used items with fresh supplies of the same specifications.
- j) Repair of the roads, buildings and campus area utilities.
- k) Record of stores for the electrical, mechanical and instrumentation and control equipment as well as that for consumables. The records will include but shall not be limited to:
 - Materials received and issued for works;
 - Proper arrangement of material in stores to ensure its safety and easy availability;
 - Maintaining store areas in a neat and tidy condition;
 - Keeping records and accounting for the incoming materials,
 - Keeping records and accounting for the consumed materials.
- m) Structures/buildings of campus areas of and others built in the Contract must ensure adequate cleanliness, ventilation, illumination and structural safety. In addition to this, the general hygienic standards must be in acceptable condition and adequate plantation; horticultural activities must be well maintained to give pleasant environment of the campus / building.
- n) 6 sets of Hard Copies and 2 sets of Soft copies of all "As Commissioned Final Drawings".

12.4.2 Electrical System

The Contractor shall hand over the following at the end of Defect Liability Period:

- (i) Revised as built drawings based on all modifications. All Electrical Drawings like Single Line Diagrams, Control Circuits Equipment Layout, Cable Layout, and Cable Schedules, Lighting Layouts, Earthing Layouts etc., should be maintained and handed over.
- (ii) Details of Protective Relay Settings and time relay settings including any changes done during the contract period, Details of Oil Changes /Filtration of Transformers, Records of any changes made in the System during the contract period etc should be maintained.

- (iii) Equipment wise maintenance record during contract Period, as per daily checking out/inspection and regular (every 6 months or 12 months).
- (iv) Motor wise Power consumption Details and over all power consumption detail of plant.
- (v) Details of IR Test of all Equipments like HT/LT Switchgear Panels, Diesel Generators, Transformers and Cables etc should be maintained.
- (vi) Log book showing details Electrical faults that have occurred in the plant and record of corrective actions taken during contract period.
- (vii) Equipment wise technical data given by equipment supplier, Documents showing Bill of Materials (hard copy or soft copy).
- (viii) List of mandatory spares that are to be maintained at stores and their actual availability in plant, if it is below same has to be replenished.
- (ix) Details of Measurement of Earth resistance, Earth Pit wise and Overall Values during the Defect Liability Period.
- (x) Details of Illumination Levels during the Defect Liability Period along with details of changes, if any effected.

12.4.3 Electrical Checks to be done during handover after Defect Liability Period

- (i) Contractor to provide a test schedule & format to be approved by engineer before commencing any test.
- (ii) Checking of all electrical equipment, items etc as per bill of materials. Visual checking and tracing out the circuit based on revised as built drawings.
- (iii) Physical Operational checks of all Equipment & Protections have to be done.
- (iv) Power frequency voltage tests & IR measurement for various electrical equipment items & cables to be done.
- (v) Testing of transformer oil samples.
- (vi) Measurement of earth resistance for individual earthing system & overall for the installation.
- (vii) Checking of Lightning Protection System.
- (viii) Measurement of illumination level at various premises.
- (ix) If any item is found to be faulty during the above checks/tests the same shall be rectified/replaced as necessary.

12.4.4 Instrumentation, Control and Automation System

The Contractor shall hand over the following documents/manuals/programs at the end of this contract:

- i. Detailed drawings and manuals of all the Instruments, Panels, Valve Actuators, Field Instruments etc supplied under IC&A package of the contract.
- ii. Detailed drawing and manual of the PLC installed .Manual shall include the PLC series installed along with complete details on I/O modules, Ethernet switch, Relay modules, and converters (if any).
- iii. A complete manual shall be provided which shall include operating instructions and troubleshooting techniques of the PLC and accessories installed illustrated with examples. This shall be provided along with the standard manufacturer's literature.
- iv. A complete manual shall be provided which shall include operating instructions and troubleshooting techniques of the SCADA and accessories installed, illustrated with examples .This shall be provided along with the standard manufacturer's literature.
- v. A complete manual shall be provided which shall include operating instructions and troubleshooting techniques of the interface control panel to head office, illustrated with examples .This shall be provided along with the standard manufacturer's literature.
- vi. Interoperability testing tool/software shall be provided along with relevant manuals and operating instruction with examples.
- vii. Latest PLC program back-up, SCADA software back-up with license, SCADA database backup, reports and alarm back-up, Historical archived data containing reports and alarms and configuration set-up shall be provided.
- viii. All software's used under ICA shall be handed over along with their original licenses.
- ix. Complete list of database /addresses shall be provided clearly indicating the spare tags for PLC, SCADA software.
- x. List of mandatory spares that are to be maintained at stores for complete ICA package and their actual availability in plant, has to be provided.
- xi. Any password's set to access the internal PLC program; interface control panel shall be provided and demonstrated.
- xii. All passwords (PLC, Interface control panel & SCADA and other software/hardware) shall be provided in a sealed envelope and addressed to the Chief Engineer (K).
- xiii. PLC, SCADA package shall be updated with the latest software version/ patch before handing over. The same has to be demonstrated to the engineer.

- xiv. Latest licensed version of windows operating system along with MS–Office or equivalent software which is prevailing at that point of time shall be installed on SCADA machines and other machines installed and integrated with the SCADA package. The same shall be demonstrated to the engineer.
- xv. Contractor shall conduct an adequate training session for the client's staff which shall include PLC configuration, troubleshooting techniques, SCADA configuration and troubleshooting techniques, diagnostic techniques and troubleshooting techniques for wireless technology employed for communication.
- xvi. The training session shall be of duration of minimum Five (5) working days at a stretch.
- xvii. Manufacturer's literature/Manuals for flow meters, level transmitters, switches, pressure transmitters etc and analytical instruments installed.
- xviii. Instrument wise, PLC and SCADA wise maintenance records of complete Defect Liability period shall be provided.
- xix. A complete and updated list of all manufacturers/system integrators/contractors of ICA with contact numbers shall be provided. The same shall also be made available on site for ready reference.
- xx. The final as commissioned versions of all drawings of ICA, which will include cable termination details, I/O mapping, database details etc shall be provided in PDF format and editable format and loaded in the operator machine available on site. The same shall be demonstrated to the engineer.

12.4.5 Wireless Communication System

- (i) Make good a wireless communication system to ensure reliable and easy communication to and from under this contract. Make good a wireless communication system to ensure reliable and easy communication to and from control center at head office.
- (ii) Replacement of batteries, faulty sets and all other non-functional equipment to ensure trouble free communication if required.

12.4.6 Completion Documents

Completion (Handing over) documents shall include on a minimum 3 sets of softcopies and 3 sets of hard copies. The hard copies shall be spiral bounded clearly

indicating the version/revision submitted. All the contents shall be indexed. The contents of completion documents shall be clearly legible and shall include original manufacturer's literature on a minimum, and in-corporate any changes as per site conditions.

12.4.7 As-Built Drawings

Revised As-built drawings based on all modifications during Defect Liability Period shall be submitted at the end of period. It shall include all drawings of utility and ancillary buildings, drawing of pump house, layout of pumps and all other mechanical equipment and piping, all electrical drawings like Single Line Diagrams, Schematic Diagrams, Control Circuits Equipment Layout, Cable Layout & Cable Schedules, Earthing Layouts and all ICA Drawings like P&ID, System configuration diagram (PLC & SCADA architecture), Instrument installation drawings, Instrument cable schedule, and cable layouts. Six sets of the revised as-built drawings shall be submitted in hardcopies and softcopies (editable form).

12.4.8 Prices

The Contractor, at the time of bidding, will be responsible to ensure the completeness and adequacy of his Bid Price to fulfill the entire responsibilities as described above. His bid price, as quoted on a yearly basis in the Schedule of Prices, shall include all costs for handing over.

12.4.9 Completion certificate for Contract

1. The Contractor on completion of period will request the Employer for a joint inspection of the Plant, after ensuring that all the Plant equipment's are in good handing over condition and all the requirements/documents as specified in this contract are also ready for handing over.
2. Based on above request a Joint Inspection with Engineer shall be arranged by the Contractor to assess the condition of civil structure, mechanical, electrical and instrumentation equipment and First Joint Inspection Report, for various required remedial actions, repair actions, replacement actions, tests etc. shall be prepared.
3. The Contractor shall attend to all points of Joint Inspection Report, by carrying out all such remedial/repair/replacement actions, tests at his own cost, and after attending, will confirm the same to the Employer.

4. On receipt of the confirmation as above 3, Second Joint Inspection shall be arranged by the Contractor, for certification of completeness of remedial work, as well as condition of all civil works to its original appearance.
5. The Contractor shall submit the entire required documents to Employer for review and comments. The Contractor shall resubmit the documents incorporating the comments.
6. The Employer shall issue the Completion Certificate of the Contract to the Contractor within 30 days of acceptance of Second Joint Inspection Report, subject to the above documents and obligations are met by the Contractor before 90 days prior to handing over of the plant.