

**Public Private Partnership in**

**Integrated Development and Operation of**

**Sewage Treatment Plants and Faecal Sludge Management System under**

**Hybrid Annuity Model**

**MODEL CONCESSION AGREEMENT**

**\*\* [Month], 20\*\***

***[Executing Agency]*, Government of [Name of the State]**

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**CONCESSION AGREEMENT**

This Concession Agreement (**Agreement**) is   

***[YEAR]*** at -------------:

AMONGST

1. ***[Executing Agency]*,** a statutory body constituted under the ***[Act under which the Executing Agency is established]*** with its registered office at ***[Address of Executing Agency]***. (hereinafter referred to as ***[Executing Agency]***, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. ***[Name of the State / National Level Agency, if any]***1, a statutory body constituted ,

with its registered office at ---------------- (hereinafter referred to as , which expression

shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. [ [***insert name of the Concessionaire***], a company organized, incorporated, registered and existing under the Companies Act, with its registered office at

[***insert address***] acting through

, [***insert name of the authorised signatory and his/her designation***] duly authorized by resolution dated

***[insert date of the Board Resolution***] (hereinafter referred to as the **Concessionaire**, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns)

***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]*** and the Concessionaire shall collectively be referred to as the **Parties** and individually as a **Party**.

WHEREAS:

1. (Brief about the genesis of the project).
2. ***[Executing Agency]*** has the power to ***[Powers & Authority with the Executing Agency]*** in state of ***[Name of State where the Executing Agency is established]***. With a view to implement the (Name of the project/scheme), ***[Executing Agency]***in association with

the ***[Name of the State / National Level Agency, if any]***, has decided to undertake integrated development, operation and maintenance of Sewage Treatment Plant(s) (the ) and Faecal Sludge Treatment Plant(s) (the ) and the collection and transportation of faecal sludge, with a proposed Design Capacity of ***[Capacity of STP in MLD]*** MLD of STP and [***Capacity of FSTP in MLD***] MLD of FSTP, along with other Facilities and Associated Infrastructure at ***[Location(s)]***, on a PPP basis, through a hybrid annuity model (the ).

1. For this purpose, ***[Executing Agency]*** intends to engage a concessionaire who will design, develop, part-finance, construct, operate and maintain the Facilities on the ***[Location(s)]*** Facilities Sites, and after the expiry of the Term, transfer the Facilities **DBFOT ** to ***[Executing Agency]*** ).

1 If there is a State Level/National Level intermediate agency funding the project and such an entity is part of the contract/procurement process the name of that agency can be inserted here. Otherwise all references to the National/State Level agency in the document are to be deleted.

1. The ***[Executing Agency]*** had accordingly invited proposals under its {Request for Proposals/ Request for Qualifications} No. \_ ]2   **Request for Proposals**/**Request for Qualification RFP/RFQ** ) for shortlisting of bidders for undertaking the development, operation and maintenance of the Project on DBFOT basis and had shortlisted certain bidders including *inter alia*, the {the selected bidder/consortium

**Consortium **



**Lead**



**Member **

1. Pursuant to the terms of the RFP, ***[Executing Agency]*** received proposals from various bidders, including a proposal submitted by the Selected Bidder on ***[insert date]***.
2. Following a process of evaluation of qualification proposals and financial proposals submitted by the bidders (including the Selected Bidder), ***[Executing Agency]*** has on ***[insert date]*** accepted the proposal submitted by the Selected Bidder for the development of the Project. Subsequently, ***[Executing Agency]*** has issued the letter of award dated ***[insert date]*** to the

).

1. The Selected Bidder has accepted the LOA and has agreed to undertake the Project in accordance with the terms of this Agreement.
2. The Selected Bidder has incorporated a special purpose vehicle to act as the Concessionaire, to implement the Project and perform the obligations and exercise the rights of the Concessionaire, including the obligation to enter into this Agreement.

J. ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** have agreed to enter into this Agreement with the Concessionaire for implementation of the Project, subject to and on the terms and conditions set out in this Agreement.

IT IS AGREED as follows:

2To be inserted upon issuance of the RFP/ RFQ.



* 1. **Definitions**

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| **Acres** | means a unit of land area equal to 43,560 sq.ft. |
| **Additional Performance Security.** | means a performance security that must be submitted by the Selected Bidder to ***[Executing Agency]*,** together with the Performance Security and ESHS Performance Security to secure the obligations of the Concessionaire/Bidder in  relation to the Clause 16.5 of the RFP document. |
| **Adjoining Property** | means any land and/or property adjoining or adjacent or any part of the Site, including all conduits, roads, footpaths, walls, fences, buildings and other erections, structures and other apparatus on, under or within such land and/or  property. |
| **Adjusted DG Set**  **Units** | has the meaning ascribed to it in Clause 9.4(g)(ii)(B)(II). |
| **Adjusted Equity** | shall mean the Equity funded in Indian Rupees and adjusted on the first day of  **Reference Date** ), in the manner set forth below, to reflect the change in its value on account of depreciation and variations in WPI, and for any Reference Date occurring:   1. on or before COD of the Facilities, the Adjusted Equity shall be a sum equal to the Equity funded in Indian Rupees and expended on the Project, revised to the extent of one half of the variation in WPI occurring between the first day of the month of Effective Date and the Reference Date; 2. from COD and until the [4th (fourth)] anniversary thereof, an amount equal to the Adjusted Equity as on Project COD shall be deemed to be the base  **Base Adjusted Equity** ) and the Adjusted Equity hereunder shall be a sum equal to the Base Adjusted Equity, revised at the commencement of each month following Project COD to the extent of variation in WPI occurring between COD and the Reference Date; and 3. anytime after the [4th (fourth)] anniversary of COD, the Adjusted Equity hereunder shall be a sum equal to the Base Adjusted Equity, reduced by [x% (x per cent)]3 thereof at the commencement of each month following the [4th (fourth)] anniversary of COD and the amount so arrived at shall be revised to the extent of variation in WPI occurring between COD and the Reference Date;   For the avoidance of doubt, the Adjusted Equity shall, in the event of Termination, be computed as on the Reference Date immediately preceding the Transfer Date; provided that no reduction in the Adjusted Equity shall be made for a period equal to the duration, if any, for which the Term is extended, but the revision on account of WPI shall continue to be made; |
| **Affected Party** | means the Party affected by a Force Majeure Event. |

3 This number may be arrived at upon dividing 100 by the number of months comprising the Term rounded off to two decimal points.

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| **Applicable Laws** | means the Constitution of India and all and any laws, enacted or brought into force and effect by the GoI, any State Government (including the ***Go[xx]***), any Government Authority or any local government having jurisdiction over the Parties, the Site or the Project, including rules, regulations and notifications made thereunder, and judgments, decrees, injunctions, writs and orders of any court of record, as may be applicable to the execution of this Agreement and the performance of the respective rights and obligations of the Parties, as may be in force and effect during the subsistence of this Agreement. For the avoidance  of doubt, and without in any way limiting the generality of thefore going, Applicable Laws shall include the EPA, the EPA Rules and the***[Act under which***  ***the Executing Agency is established]*** Act. |
| **Applicable Permits** | means any permissions, clearances, concessions, authorizations, consents, licenses, permits, rulings, exemptions, no objections, resolutions, filings, orders, notarizations, registrations or approvals of whatsoever nature that are required to be obtained from time to time in connection with the Project, and for generally performing the obligations contemplated by this Agreement in accordance with  the Applicable Laws, as set out in Schedule 8. |
| **Appointed Date** | means the date of signing of this Agreement. |
| **Arbitration Act** | means the Arbitration and Conciliation Act, 1996, as amended from time to time. |
| **Article** | means an article of this Agreement. |
| **Associate** | means, in relation to the Concessionaire, [the Selected Bidder or a Member of the Selected Bidder], a Person who Controls, or is Controlled by, or is under the common Control of the same Person who controls the Concessionaire, the  Selected Bidder or Member of the Selected Bidder, as the case may be. |
| **Associated Infrastructure** | means infrastructure facilities associated with operation of ***[Location]*** STP(s) and ***[Location]*** FSTP(s), including but not limited to Sewage pumping stations (including main pumping stations, intermediate pumping stations and any other pumping stations) and the rising mains, as described in greater details in technical specifications of each STP and FSTP in relevant Facilities Schedule, and the GPS-enabled vehicles, machinery, equipment and facilities for the entire sanitation value chain with containment, extraction, door-to-door collection, transportation, treatment, and disposal / re-use of all faecal sludge, septage and other liquid waste and their by-products and end-products, which need to be constructed and/or operated and maintained by the Concessionaire in accordance with this Agreement, and complete such infrastructure as lighting, ancillary infrastructure, other functional building such as administrative building etc., if  any, for the STP(s) and FSTP(s). |
| **Availability** | means the availability of the Facilities to convey, accept and treat the Sewage, as  determined in accordance with Clause 8.12(a)(i) and the term '**Available**' shall be construed accordingly. |
| **Availability**  **Liquidated Damages** | means the liquidated damages payable by the Concessionaire to the ***[Executing***  ***Agency]*** for failure to achieve the Guaranteed Availability, in accordance with Clause 8.12(a)(v). |
| **Basic Engineering Designs** | means the following designs and documents to be submitted by the Concessionaire and approved by the ***[Executing Agency]*** as a Condition Precedent:  (a) process description, process calculations, |

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|  | 1. hydraulic calculations; 2. list of design codes and standards; 3. master drawing schedule; 4. drainage design; 5. STP(s)/FSTP(s) Facilities layout; 6. process flow diagram; 7. hydraulic flow diagram; 8. mass balance diagram; 9. process and instrumentation diagram; 10. tentative single line diagram; 11. electrical load list. |
| **Bid** | means the bid consisting of the Qualification Proposal and the Financial Proposal  submitted by a Bidder for qualification and award of the Project. |
| **Bid Due Date** | means the last date of submission of the Bids as set out in the RFP. |
| **Bid Process** | means the single-stage bidding process, with two sub-stages, undertaken by the ***[Executing Agency]*** to award the Project to the Selected Bidder on the terms and conditions set out in the RFP. The Bid Process commenced with the issuance of  the RFP and ends on the Appointed Date. |
| **Bid Price** | means the price calculated for each Bidder, based on the values provided by such Bidder in the Bid Price Sheet, as a part of its Financial Proposal, to design, finance, develop, construct, rehabilitate, operate, and maintain the ***[Location]***  Facilities. |
| **Bid Project Cost** | means INR [ ] (Rupees [ ]), being the cost of construction of the ***[Location]***Facilities, as quoted by the Selected Bidder in its Bid, which includes the interest during construction, Taxes and all  other pre-operative expenses in relation to the ***[Location]*** Facilities. |
| **BOD** | means biochemical oxygen demand. |
| **Business Day** | means any day other than Saturday, Sunday or any public holiday, on which the  ***[Executing Agency]*** and the banks are open for business in ***[Location]*** |
| **Capex Annuity** | means the amount payable to the Concessionaire per quarter during the O&M Period, towards reimbursement of [60% (sixty per cent)] of the ***[Location]***  Facilities Completion Cost. |
| **Capital** | means, in respect of the Concessionaire, the total capital of the Concessionaire  that will be raised by the issuance of equity shares, preference shares and convertible instruments. |
| **Change in Law** | means the occurrence of any of the following events after the Bid Due Date:   1. the modification, amendment, variation, alteration or repeal of any existing Applicable Law; 2. the enactment of any new Applicable Law or the imposition, adoption or issuance of any new Applicable Law by any Government Authority; 3. changes in the interpretation, application or enforcement of any Applicable Law or judgment by any court/Government Authority; 4. the introduction of a requirement for the Concessionaire to obtain any new Applicable Permit or the unlawful revocation of an Applicable Permit; or 5. the introduction of any new Tax (including goods and services tax) or a   change in the rate of an existing Tax. |

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|  | It is clarified that Change in Law shall not include any change in the (Indian) Income Tax Act, 1961 with regard to the taxes on the income of the  Concessionaire. |
| **Clause** | means a clause of this Concession Agreement. |
| **COD Certificate** | means the certificate issued by the ***[Executing Agency]*** to the Concessionaire upon issuance or deemed issuance of the Trial Operations Completion Certificates for the ***[Location]***Facilities and satisfaction of the conditions set out  in Clause 7.15(a). |
| **Commercial Operations Date**  or **COD** | means the date on which the COD Certificate is issued or deemed to be issued to the Concessionaire in accordance with Clause 7.15(a). |
| **Companies Act** | means the (Indian) Companies Act, 1956 or the (Indian) Companies Act, 2013,  as amended from time to time, as the context may require. |
| **Completion Cost** | means the cost of completing the construction of the ***[Location]***Facilities, as  calculated in accordance with Clause 9.4(b). |
| **Concessionaire** | has the meaning ascribed to it in the array of Parties. |
| **Concessionaire**  **Applicable Permits** | means the Applicable Permits which are required to be obtained and maintained  by the Concessionaire to develop, operate and maintain the Facilities, as set out in Schedule 8. |
| **Concessionaire**  **Event of Default** | has the meaning ascribed to it in Clause 16.1. |
| **Concessionaire Related Parties** | means any of the following:   1. the Selected Bidder or Associates of the Selected Bidder; 2. an officer, servant, employee or agent of the Concessionaire acting in that capacity; 3. any Subcontractor engaged by the Concessionaire and their directors, officers, servants, employees or agents acting in that capacity; or 4. any Person acting on behalf of the Concessionaire. |
| **Concessionaire's Representative** | means the Person nominated by the Concessionaire, from time to time, to act on its behalf and liaise with ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** for the purposes of this Agreement and notified as such in writing to ***[Executing Agency]*** and ***[Name of the State / National Level Agency,***  ***if any]***. |
| **Conditions Precedent** | means collectively, the obligations of the Concessionaire that are set out at Clause 3.2, the obligations of ***[Executing Agency]*** that are set out at Clause 3.3 and the obligations of ***[Name of the State / National Level Agency, if any]*** that  are set out at Clause 3.4, and '**Condition Precedent**' means any one of these. |
| **Confidential Information** | means any part of this Agreement, or any information contained therein or any material provided to any Party pursuant to this Agreement, all of which information shall be deemed to be confidential, except to the extent that this  Agreement otherwise requires. |
| **Construction Completion Certificate** | means the certificate issued by ***[Executing Agency]*** to the Concessionaire to certify completion of construction of the ***[Location]*** Facilities and the satisfaction of all other conditions required to be fulfilled by the Concessionaire  in accordance with Clause 7.13(c). |
| **Construction**  **Completion Date** | means the date on which the ***[Location]*** Facilities Construction Completion  Certificate is issued or deemed to be issued to the Concessionaire, in accordance |

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|  | with Clause 7.13(c) (iii), and the reference to **Construction Completion Date**  shall be construed accordingly. |
| **Construction Payments** | means, for each Facilities, the payments to be made to the Concessionaire during the Construction Period, upon satisfactory completion of the Payment Milestones, which shall, in aggregate, be equivalent to 40% of the Bid Project Cost, as adjusted from time to time to reflect the variation in the Construction  Price Index. |
| **Construction**  **Period** | has the meaning ascribed to it in Clause 7.1 |
| **Construction Plan** | means the detailed construction plan for the ***[Location]*** Facilities to be prepared by the Concessionaire, which will set out the work to be performed by the Concessionaire to achieve each of the ***[Location]*** Facilities Payment Milestones, in a manner such that the Facilities are completed on or prior to the Scheduled Construction Completion Date. The Construction Plan shall be approved by  ***[Executing Agency]*** in accordance with Clause 7.3. |
| **Construction Price Index** | shall comprise:   1. 70% of WPI; and 2. 30% of CPI(IW),   which constituents may be substituted by such alternative index or indices as the Parties may mutually agree. |
| **Control** | means, with respect to a Person:   1. the ownership, directly or indirectly, of more than 50% of the voting shares of such Person; or 2. the power, directly or indirectly, to direct or influence the management and policies of such Person by operation of law, contract or otherwise,   and the term '**Controlled**' shall be construed accordingly. |
| **Cost** | means all documented expenditure reasonably incurred by the Concessionaire, whether on or off the Site, including overhead and similar charges, but does not  include profit. |
| **CP Long-Stop**  **Date** | has the meaning ascribed to it in Clause 3.5(a) |
| **CPI(IW)** | means the Consumer Price Index for Industrial Workers published by the Labour Bureau, GoI and shall include any index which substitutes the CPI(IW), and any reference to CPI(IW) shall, unless the context otherwise requires, be construed as  a reference to the CPI(IW) published on the last date of the preceding quarter. |
| **Debt Due** | means the aggregate of the following sums expressed in Rupees outstanding on the date of issuance of the Notice of Intent to Terminate:   1. the principal amount of the debt provided by the Lenders under the Financing Documents for financing 45% of the Bid Project Cost but excluding any part of the principal that had fallen due for repayment 2 years prior to the date of the Notice of Intent to Terminate, as set out in the Financial Package; 2. all accrued interest, financing fees and charges payable under the Financing Documents on, or in respect of, the debt referred to in (a) above until the date of the Notice of Intent to Terminate but excluding    1. any interest, fees or charges that had fallen due 1 year prior to the |

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|  | date of the Notice of Intent to Terminate, (ii) any penal interest or charges payable under the Financing Documents to any Lender, and (iii) any pre-payment charges in relation to accelerated repayment of debt except where such charges have arisen due to an ***[Executing Agency]*** Event of Default or an ***[Name of the State / National Level Agency, if any]*** Event of Default; and  (c) any Subordinated Debt which is included in the Financial Package and disbursed by Lenders for financing the Bid Project Cost;  provided that if all or any part of the Debt Due is convertible into equity at the option of Lenders and/or the Concessionaire, it shall for the purposes of this Agreement be deemed to be Debt Due even after such conversion and the principal shall be dealt with as if such conversion had not been undertaken.  For the purpose of calculating Debt Due:   1. the aggregate of the principal amounts of the debt provided by the Lenders under the Financing Documents shall, in no event, exceed 45% of the Bid Project Cost;   and   1. any amount of Debt Due in foreign currency as on the date of the Notice of Intent to Terminate shall be converted to Rupees at the exchange rate published on the official website of the Reserve Bank of India as at 12   noon on the relevant date. |
| **Default Liquidated**  **Damages** | means the Delay Liquidated Damages, Availability Liquidated Damages,  Performance Liquidated Damages, and the Power Consumption Liquidated Damages. |
| **Delay Event** | has the meaning ascribed to it in Clause 7.11(b). |
| **Delay Liquidated**  **Damages** | has the meaning ascribed to it in Clause 7.12(a). |
| **Design Capacity** | means the average flow of Sewage and Faecal Sludge / Septage that the ***[Location]*** Facilities should be designed to handle and treat in a day, which, for the ***[Location]*** Facilities shall be ***[Capacity of the proposed STP(s) and FSTP(s)***  ***in MLD]*** MLD. |
| **Designs and**  **Drawings** | means, collectively, the Phase I Designs and Drawings and the Phase II Designs  and Drawings. |
| **DG Sets** | means the backup diesel generators set maintained by the Concessionaire at the  Site, to ensure continuous supply of power for the operation of the Facilities, when the supply of power from the grid is not available. |
| **Digested Sludge** | means the sludge which is obtained after the treatment and digestion of the  Sewage and Faecal Sludge / Septage at the ***[Location]***STP(s) and FSTP(s). |
| **Direct Political Force Majeure**  **Events** | has the meaning ascribed to it in Clause 14.1(b)(iii). |
| **Discharge Points** | means the points at which the Treated Effluents from the STP(s) and FSTP(s) will  be discharged, as set out in the Schedule 12 (Technical Specifications), and |

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|  | 'Discharge Point' shall mean any of these. |
| **Discharge Standards** | means, for each ***[Location]*** Facilities, the minimum standards set out in the  Technical Specifications that the Treated Effluent and Digested Sludge must comply with. |
| **Dispute** | has the meaning ascribed to it in Clause 21.1. |
| **Dispute Meeting** | has the meaning ascribed to it in Clause 21.1. |
| **Dispute Notice** | has the meaning ascribed to it in Clause 21.1. |
| **Effective Date** | means the date on which all the Conditions Precedent have been satisfied by  ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]*** and the Concessionaire in accordance with this Agreement. |
| **Emergency** | means a condition or situation that endangers, or which in the reasonable opinion of ***[Executing Agency]***, the Project Engineer or the Concessionaire, may endanger the environment or lives or security of people at or around the Site or that poses an imminent threat of material damage to any property (including the  Facilities) at or around the Site. |
| **Encumbrance(s)** | means mortgage, charge, pledge, lien (statutory or otherwise), assignment by way of security, hypothecation, right of set-off, trust, priority, retention of title or ownership or other security interest and any other agreement or arrangement  having substantially the same effect. |
| **EPA** | means the Environment (Protection) Act, 1986, as amended from time to time. |
| **EPA Rules** | means the Environment (Protection) Rules, 1986, as amended from time to time. |
| **Equity** | means the sum expressed in INR, i.e. Indian National Rupee, representing the paid-up equity share capital of the Concessionaire for meeting the equity component of its financial obligations under this Agreement and the Financing Documents, which, for the purpose of this Agreement, shall include convertible instruments that shall compulsorily convert into equity share capital and any  loans provided by any shareholder of the Concessionaire. |
| **Escrow Account** | means the interest-bearing account opened by ***[Name of the State / National***  ***Level Agency, if any]*** with the Escrow Bank in accordance with the Escrow Agreement, which shall be operational until the expiry of the Term. |
| **Escrow Agreement** | means the agreement to be executed among ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]***, the Concessionaire, and the Escrow Bank in relation to the opening and operations of the Escrow Account, in the form set  out at Schedule 3. |
| **Escrow Bank** | means the Scheduled Bank with which ***[Name of the State / National Level***  ***Agency, if any]*** opens the Escrow Account, pursuant to the Escrow Agreement. |
| **ESHS** | means Environment, Social, Health and Safety requirements, including any requirements, which the Concessionaire is required to comply with in developing, renovating, operating and maintaining the Facilities, as set out in  Schedule 9. |
| **ESHS**  **Documents** | means, collectively, the Safeguard Documents and Safety Documents prepared by the Concessionaire and approved by ***[Executing Agency]*** in accordance with  Clause 7.4. |
| **ESHS**  **Performance Security** | has the meaning ascribed to it in Clause 5.1. |
| **ESMF** | means the Environment and Social Management Framework agreed with the ----- |

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|  | ---------(name of the agency if any)4, available at [http://----------------------](http://----------------------/) . |
| **Event of Default** | means***[Executing Agency]*** Event of Default, ***[Name of the State / National***  ***Level Agency, if any]*** Event of Default or a Concessionaire Event of Default, as the context may require. |
| **Executing**  **Agency** | means the ***[Executing Agency]*** , a statutory body constituted under ***[Act under***  ***which the Executing Agency was constituted]***. |
| ***[Executing Agency]* Applicable**  **Permits** | means the Applicable Permits which are required to be obtained by ***[Executing Agency]*** to undertake the Project, as set out in Schedule 8. |
| ***[Executing Agency]* Event of**  **Default** | has the meaning ascribed to it in Clause 16.3. |
| ***[Executing Agency]* Related Parties** | means any of the following:   1. an officer, servant, employee or agent of ***[Executing Agency]***, acting in that capacity; 2. any contractor or subcontractor of ***[Executing Agency]*** and their directors, officers, servants, employees or agents, acting in that capacity; or 3. any Person acting on behalf of ***[Executing Agency]***.   For the avoidance a doubt, '***[Executing Agency]*** Related Parties' does not include the Concessionaire or ***[Name of the State / National Level Agency, if any]***. |
| ***[Executing Agency]*'s Representative** | means any officer nominated by ***[Executing Agency]***, from time to time, to act on its behalf and liaise with the Concessionaire and ***[Name of the State / National Level Agency, if any]*** for the purposes of this Agreement and notified as such in writing to the Concessionaire and ***[Name of the State / National Level***  ***Agency, if any]*** in accordance with the Clause 7.8 (d). |
| **Expiry Date** | means the date occurring after the expiry of [15 (fifteen)] years from the COD |
| **Facilities** | (or the ***[Location]*** Facilities) means collectively, the ***[Location]*** STP(s), the ***[Location]*** FSTP(s), the online monitoring system for STP(s), Sewage pumping station(s) and FSTP(s), the on-site testing laboratory facilities, and such other facilities associated with the ***[Location]*** STP(s) and ***[Location]*** FSTP(s), and its Associated Infrastructure, or under any schedule, required to be set up by the Concessionaire, as described in greater detail in the Scope of Work and Technical Specifications, and infrastructure facilities associated with ***[Location]*** STP(s) and ***[Location]*** FSTP(s), including but not limited to Sewage pumping stations (including main pumping stations, intermediate pumping stations and any other pumping stations), the rising mains, plant lighting, ancillary power requirement, power plant if provided or existing, other non-functional buildings such as administration building, staff quarters, common areas etc., as described in greater details in technical specifications of each STP/FSTP in relevant Facilities Schedule, which need to be constructed and/or renovated and/or operated and maintained by the Concessionaire in accordance with this Agreement. |

4Delete if not applicable

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| **Faecal Sludge** | means raw or partially digested, in a slurry or semisolid form, the collection, storage or treatment of combinations of excreta and black water, with or without grey water. It is the solid or settled contents of pit latrines and septic tanks. The physical, chemical and biological qualities of faecal sludge are influenced by the duration of storage, temperature, soil condition, and intrusion of groundwater or surface water in septic tanks or pits, performance of septic tanks, and tank emptying technology and pattern. Faecal sludge is the solid or settled contents of pit latrines and septic tanks. Faecal Sludge comes from onsite sanitation systems. Examples of onsite technologies include pit latrines, non-sewered public ablution  blocks, septic tanks, aqua privies, and dry toilets. |
| **Financial Assistance** | means all funded and non-funded financial assistance, including loans, advances and guarantees or any re-financing that the Concessionaire may avail of for the  Project from the Lenders. |
| **Financial**  **Capacity** | means the financial capacity and strength of the ***[Selected Bidder/Member(s)]5***  determined in accordance with the RFP. |
| **Financial Close** | means, the date on which the Financing Documents become effective, the conditions precedent under the Financing Documents for disbursements are  fulfilled and the Concessionaire has access to the Financial Assistance. |
| **Financial Package** | means the financing package indicating the means of financing the Facilities, and includes all Financial Assistance specified in the Financing Documents, the  Equity and the Subordinated Debt, if any. |
| **Financial**  **Proposal** | means the financial proposal submitted by the Selected Bidder in accordance  with the RFP for undertaking the Project. |
| **Financial Year** | means each 12 (twelve) month period commencing on 1 April of one calendar year and ending on 31st (thirty first) March of the next calendar year; and if different for a company, then the 12 (twelve) month period for which such  company files its statutory audited accounts in the normal course of its business. |
| **Financing Documents** | means, collectively, the documents entered into or to be entered into by the Concessionaire with the Lenders, in respect of all funded and non-funded financial assistance, including loans, advances and or any refinancing that the Concessionaire may avail of for the Project from the Lenders and includes any  document providing Security to the Lenders. |
| **First Breach** | has the meaning ascribed to it in Clause 8.12(b)(iii)(A). |
| **First Breach**  **Notice** | has the meaning ascribed to it in Clause 8.12(b)(iii)(A). |
| **FM Notice** | has the meaning ascribed to it in Clause 14.2(a). |
| **Force Majeure**  **Event** | means a Non-Political Force Majeure Event, an Indirect Political Force Majeure  Event or a Direct Political Force Majeure Event, as the case may be. |
| **Forced Unavailability** | means an interruption of or a reduction in the Availability of any Facilities that is the result of:   1. a maximum capacity utilization of such Facilities, as notified by the Concessionaire to ***[Executing Agency]*** in accordance with Clause 8.9; 2. a suspension of the performance of the O&M services for such Facilities   pursuant to Clause 15.1(a)(i) or Clause 15.2(a)(i), to the extent any such event is not attributable to the Concessionaire; or |

5 Delete Member(s) if the Selected Bidder is a single entity.

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|  | 1. a suspension of the operation of any Facilities pursuant to any order or instruction from the relevant Government Authority restricting the discharge of the Treated Effluents from such Facilities at the relevant Discharge Point; or 2. unavailability or breakdown of the Supporting Infrastructure for such   Facilities. |
| **FSTP** | means a faecal sludge treatment plant |
| **FSTP By-**  **Products** | means the by-products of the treatment process after the Faecal Sludge/Septage has passed through the Facilities, comprising the Digested Sludge, the Residual  Grit and the Screenings. |
| **Fuel Price** | means the prevailing price of diesel at Indian Oil Corporation or Hindustan Petroleum Corporation Limited's retail outlets in ***[Location]***, as determined on  the 15th(fifteenth) day of a month. |
| **Fundamental Change in Law** | means any Change in Law that:   1. renders unenforceable, illegal, invalid or void any material right or material obligation of the Concessionaire under this Agreement; or 2. renders a material part of this Agreement invalid, illegal or unenforceable; or 3. results in the Concessionaire being deprived of the whole or a substantial   part of the benefit of this Agreement. |
| **GoI** | means the Government of India. |
| **Good Industry Practices** | means the exercise of such degree of skill, diligence and prudence, and those practices, methods, specifications and standards of equipment, safety and performance, as may change from time to time and which would reasonably and ordinarily be expected to be used by a skilled and experienced developer engaged in construction, management, and maintenance of STP in India of the  type and size similar to the Facilities. |
| **Go*[XX]*** | means the Government of ***[Name of the State of STP(s)/FSTP(s) Location]***. |
| **Government Authority** | means the GoI, any State Government (including the Go***[XX6]***), any local government or any other ministry, governmental department, commission, board, body, bureau, agency, authority, instrumentality, inspectorate, statutory corporation or body corporate over which the GoI or the Go***[XX]*** exercises control, court, tribunal or other judicial or administrative body or official or person, having jurisdiction over the Concessionaire, the Site, the Project and the performance of obligations and exercise of the rights of the Parties in accordance  with the this Agreement. |
| **Grace Period** | has the meaning ascribed to it in Clause 7.12(e). |
| **Guaranteed**  **Availability** | has the meaning ascribed to it in Clause 8.12(a)(i). |
| **Guaranteed Energy Consumption** | means the maximum number of units of power (in kWh) per MLD quoted by the Selected Bidder in the Financial Proposal, which it expects to consume during the O&M Period (other than any units expected to be generated and consumed from the Power Plant), to operate and maintain the ***[Location]*** Facilities, at varying volumes and BOD of Sewage/Faecal Sludge/Septage. The Guaranteed  Energy Consumption for any quarter during the O&M Period will be determined |

6Name of the State Government

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|  | on the basis of the number of units of power (in kWh) per MLD quoted by the Selected Bidder in the Financial Proposal for the average volume and BOD of Sewage and Faecal Sludge and Septage treated at the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) in such quarter (such average to be calculated in accordance  with the KPI Adherence Report). |
| **Hand-back Conditions** | mean the condition in which the Site, the Facilities, and the Power Plant, if any, shall be handed back to ***[Executing Agency]*** or any entity nominated by ***[Executing Agency]*** on expiry or early termination of this Agreement, which is consistent with the due performance of the Concessionaire's obligations under this Agreement and are described in greater detail in the Technical  Specifications. |
| **Hand-back Requirements** | means the obligations of the Concessionaire in relation to transfer of the  Facilities upon expiry or early termination of the Project, as set out in Clause 19.3. |
| **Indirect Political**  **Force Majeure Events** | has the meaning ascribed to it in Clause 14.1(b)(ii). |
| **Influent Standards** | means the permissible standards and characteristics for the incoming Sewage for  each STP, and incoming Faecal Sludge/Septagefpr each FSTP, set out in the Technical Specifications. |
| **Inlet Point** | means the point mutually agreed to between ***[Executing Agency]*** and the Concessionaire at the ***[Location]*** STP and ***[Location]*** FSTP where: (a) the Sewage sample or Faecal Sludge/Septage sample, as the case may be, shall be drawn to test compliance with the Influent Standards; and (b) meters shall be installed for the purpose of determining the volume and concentration of the Sewage/Faecal Sludge/Septage, as the case may be, delivered at the ***[Location]***  Facilities. |
| **Intellectual Property Rights** | means patents, copyrights, database rights, design rights, trade-marks, service marks, trade names, domain names, rights in reputation, rights in undisclosed or confidential information (such as know-how, trade secrets and inventions, whether patentable or not), and other rights of a like nature (whether registered or unregistered) and all applications for such rights as may exist anywhere in the  world. |
| **Invoice** | means an invoice for payment of: (a) the Construction Payments during the Construction Period; or (b) the Capex Annuity (along with interest), the O&M Charges and the Power Charges during the O&M Period, submitted by the Concessionaire to ***[Executing Agency]*** (with a copy to ***[Name of the State /***  ***National Level Agency, if any]***) in accordance with Article 9. |
| **KPI Adherence**  **Report** | has the meaning ascribed to it in Clause 8.12(b)(vi). |
| **KPIs** | means the key performance indicators set out in Schedule 10, which the Facilities  must achieve during the O&M Period. |
| **Lead Member** | [means the Member nominated by the Members of the Selected Bidder to act as  the lead member in accordance with the RFP.]7 |
| **Lenders** | includes banks, financial institutions, funds and agents or trustees of debenture |

7 To be deleted if the Selected Bidder is not a Consortium.

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|  | holders, including their successors and assignees, who have agreed to guarantee or provide Financial Assistance to the Concessionaire under the Financing Documents but does not include any shareholder or Associates of the  Concessionaire who have provided any shareholder loans to the Concessionaire. |
| **Liquidated Damages** | means the Delay Liquidated Damages, the Availability Liquidated Damages, the Performance Liquidated Damages and the Power Consumption Liquidated  Damages. |
| **LOA** | has the meaning ascribed to it in Recital F. |
| **[Location] FSTP** | means the FSTP of ***[Capacity of Proposed FSTP]*** MLD to be set up at the  ***[Location]***Facilities Sites, as part of the Project. |
| **[Location] STP** | means the STP of ***[Capacity of Proposed STP]*** MLD to be set up at the  ***[Location]***Facilities Sites, as part of the Project. |
| **Material Adverse Effect** | means the effect of any act or event, which materially and adversely affects the ability of any Party to exercise its rights or perform any of its obligations under and in accordance with this Agreement and which act or event causes a material  financial burden or loss to any Party. |
| **Member** | [means, where the Selected Bidder is a Consortium, a member of the Selected  Bidder.]8 |
| **Milestone Completion Certificate** | means, in respect of any Payment Milestone, a certificate issued by ***[Executing Agency]*** in accordance with Clause 7.13(a), to certify that such Payment Milestone has been achieved in accordance with the requirements of this  Agreement. |
| **Minimum**  **Escrow Balance** | has the meaning ascribed to it in Clause 9.5(b). |
| **Minor Casualty** | means any fire or other casualty that results in physical damage to the ***[Location]*** Facilities to the extent that the total cost (as estimated by the Project Engineer) of repairing and/or replacing the damaged portion of the ***[Location]*** Facilities as the case may be, to the same condition as previously existed would not exceed the  amount of [INR 25, 00,000 (Rupees twenty five lakhs)]. |
| **MLD** | means million liters per day. |
| **Mobilization Advance** | means an amount equivalent to 10% of the ***[Location]*** Facilities Bid Project Cost that is to be paid in advance to the Concessionaire for mobilization and execution of the construction works for the ***[Location]*** Facilities in accordance with Clause  9.3(d). |
| **Mobilization Advance**  **Guarantee** | has the meaning ascribed to it in Clause 5.21. |
| **Mobile Associated Infrastructure** | Means and includes (but not limited to) the GPS-enabled vehicles, machinery, equipment and facilities for the extraction, door-to-door collection, containment, transportation, treatment, and disposal / re-use of Faecal Sludge/ Septage, which are movable assets and do not form part of the Hand-back Conditions and Hand-  back Requirements. |
| **Mo----** | means the Ministry of 9 |
| **Net Worth** | means the net worth of a Company, which shall be determined as follows, in case |

8 To be deleted if the Selected Bidder is not a Consortium.

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|  | of a:   1. ***Company****, means*    1. subscribed and paid up equity share capital; and    2. reserves   **LESS**   * 1. revaluation reserves;   2. miscellaneous expenditure not written off;   3. reserves not available for distribution to equity shareholders; and   4. aggregate value of accumulated losses.  1. ***trust*** *or* ***society***,means the sum of available corpus and reserves; 2. ***partnership firm***, means the sum of the partners' capital account and undistributed profits; 3. ***limited liability partnership***, means the sum of partners' capital account and undistributed profits as per the 'Statement of Account' prepared as per Limited Liability Partnership Rules, 2009; 4. ***sole proprietorship***, means the value of all assets minus liabilities of the proprietorship but does not include the personal assets or liabilities of the sole proprietor; and 5. ***individual***,means the sum of the value of all unencumbered assets owned by the individual minus the sum of the value of all liabilities of the   individual. |
| ***[Name of the State / National Level Agency, if***  ***any]*** | has the meaning ascribed to it in array of Parties. |
| ***[Name of the State / National Level Agency, if any]* Event of**  **Default** | has the meaning ascribed to it in Clause 16.4. |
| ***[Name of the State / National Level Agency, if any]* Related Parties** | means any of the following:   1. an officer, servant, employee or agent of ***[Name of the State / National Level Agency, if any]***, acting in that capacity; 2. any contractor or subcontractor of ***[Name of the State / National Level Agency, if any]*** and their directors, officers, servants, employees or agents, acting in that capacity; or 3. any Person acting on behalf of ***[Name of the State / National Level Agency, if any]***.   For the avoidance a doubt, '***[Name of the State / National Level Agency, if any]***  Related Parties' does not include the Concessionaire or ***[Executing Agency]*** |
| ***[Name of the State / National Level Agency, if any]*'s**  **Representative** | means any officer nominated by ***[Name of the State / National Level Agency, if any]***, from time to time, to act on its behalf and liaise with the Concessionaire and ***[Executing Agency]*** for the purposes of this Agreement and notified as such in writing to the Concessionaire and ***[Executing Agency]*** in accordance with  Clause 7.9 (c). |

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| **Nominated FSTP Sub-Contractor10** | means a sub-contractor nominated by the Concessionaire, in accordance with Clause 4.1(a)(F)(ii) and 4.1(b)(ii) of this RFP, for construction and operation and  maintenance of FSTP(s) for the Project. |
| **Nominated STP Sub-Contractor11** | means a sub-contractor nominated by the Concessionaire, in accordance with Clause 4.1(a)(F)(ii) and 4.1(b)(ii) of this RFP, for construction and operation and  maintenance of STP(s) for the Project. |
| **Non-Political Force Majeure**  **Event** | has the meaning ascribed to it in Clause 14.1(b)(i). |
| **Notice of**  **Arbitration** | has the meaning ascribed to it in Clause 21.2.1 |
| **Notice of Intent to Terminate** | means a notice of intent to terminate issued by ***[Executing Agency]*** in case of a Concessionaire Event of Default (in accordance with Clause 16.2) or a notice of intent to terminate issued by the Concessionaire in case of a ***[Executing Agency]*** Event of Default or an ***[Name of the State / National Level Agency, if any]*** Event of Default (in accordance with Clause 16.5), stating its intention to  terminate this Agreement. |
| **O&M** | means operation and maintenance. |
| **O&M Charges** | means the amount required by the Concessionaire per quarter to operate and maintain the ***[Location]*** Facilities, excluding the Power Charges, during the O&M Period. The O&M charges for the first quarter after the COD will be determined on the basis of the O&M charges quoted by the Selected Bidder (in the Financial Proposal) for the first month from the COD, which amount shall  then be adjusted to reflect the variation in the O&M Price Index. |
| **O&M Manual** | means the manual, required to be prepared by the Concessionaire and approved by ***[Executing Agency]*** for the operation and maintenance of the Facilities in  accordance with Clause 8.2. |
| **O&M Payments** | means, for each Facilities, collectively the: (a) Capex Annuity; (b) interest on the reducing balance of [60% (sixty per cent)] of the Completion Cost; (c) O&M Charges; and (d) Power Charges (subject to the cap of the Power Charges based on the ***[Location]*** Facilities Guaranteed Energy Consumption), to be paid by ***[Name of the State / National Level Agency, if any]*** to the Concessionaire  during the O&M Period, in accordance with this Agreement. |
| **O&M Period** | means the period commencing from the COD and ending on the Expiry Date,  during which the Concessionaire is required to operate and maintain the Facilities. |
| **O&M Price Index** | shall comprise:   1. 70% of CPI(IW); and 2. 30% of WPI,   which constituents may be substituted by such alternative index or indices as the Parties may mutually agree. |
| **O&M Security** | has the meaning ascribed to it in Clause 5.5. |
| **Online**  **Monitoring System** | means the monitoring system(s) to be set up by the Concessionaire as part of the  Facilities for continuous monitoring of the volume, specifications and characteristics of the Sewage, Faecal Sludge/Septage and the Treated Effluent. |

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| **Outlet Point** | means the outlet of the ***[Location]*** STP and ***[Location]*** FSTP where the sample  of the Treated Effluent shall be drawn periodically to test compliance with the Discharge Standards. |
| **Payment**  **Certificate** | has the meaning ascribed to it in Clause 9.3(e)(v) for Construction Payments and  Clause 9.4(k) for O&M Payments. |
| **Payment Milestones** | means the milestones listed in Clause 9.3(e) for release of the Construction    them, as the context may require. |
| **Performance Liquidated**  **Damages** | means the liquidated damages payable by the Concessionaire to ***[Executing Agency]*** for a failure to meet the Discharge Standards, in accordance with Clause  8.12(b)(iii). |
| **Performance**  **Security** | has the meaning ascribed to it in Clause 5.1. |
| **Person** | means any individual, company, corporation, partnership, joint venture, trust, society, sole proprietor, limited liability partnership, co-operative society,  government company, unincorporated organization or any other legal entity. |
| **Phase I Designs and Drawings** | means: (a) the Basic Engineering Designs; (b) the Screening Report and (c) the detailed 'good for construction' designs and drawings, technical information, plans, samples, patterns, models and specifications for the works required for  achieving the first Payment Milestone. |
| **Phase II Designs and Drawings** | means the detailed 'good for construction' designs and drawings, technical information, plans, samples, patterns, models and specifications for the works  required for achieving the second, third and fourth Payment Milestones. |
| **Power Charges** | means the cost of the power consumed by the Concessionaire to operate and maintain the ***[Location]*** Facilities during the O&M Period, which will be calculated on the basis of the prevailing Power Unit Rate, the Fuel Price, to the extent applicable and such other applicable charges as per the guidelines of the  relevant Government Authorities. |
| **Power Consumption Liquidated**  **Damages** | has the meaning ascribed to it in Clause 9.4(g)(ii)(C). |
| **Power Outage** | means any interruption in the supply of electricity from the grid or any Diesel-  Generators (DG) Sets maintained by the Concessionaire at the Site, which disrupts the continuous operation of any Facilities. |
| **Power Plant** | means a biogas power plant or a rooftop solar plant that the Concessionaire is  decides to set up at the relevant Site as part of the Project, for production of clean energy. |
| **Power Unit Rate** | means the cost per unit of power drawn from the grid (through the relevant distribution licensee for the Site), which will be the prevailing tariff per unit of power charged by the relevant distribution licensee in the relevant month during  the O&M Period. |
| **PPP** | means public private partnership. |
| **Price Index** | means, for the Construction Payments, the Construction Price Index, and for the  O&M Payments, the O&M Price Index. |
| **Price Index**  **Multiple** | means, the variation multiple in the Price Index occurring between the Reference  Index Date preceding the Bid Due Date and the Reference Index Date preceding |

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|  | the date of the Invoice, which is calculated by dividing the Price Index on the Reference Index Date preceding the date of the Invoice by the Price Index on the Reference Index Date preceding the Bid Due Date.  For the avoidance of doubt and by way of illustration, if (a) the Price Index on the Reference Index Date preceding the Bid Due Date, say 30 May, 2018, is 200;  (b) the Invoice is submitted on 15 April, 2020; and (c) the Price Index as on 31 March, 2020 is 210, then the Price Index Multiple for determination of the  amount due in respect of such Invoice shall be 1.05. |
| **Project** | has the meaning ascribed to it in Recital C. |
| **Project Engineer** | means the engineering firm appointed by ***[Name of the State / National Level***  ***Agency, if any]*** in accordance with Article 6 of this agreement. |
| **Proposed Technology** | means the proven technology(ies) proposed to be used by the Concessionaire to develop the ***[Location]*** STP(s) and ***[Location]*** FSTP(s), as specified by the  Concessionaire in its Designs and Drawings. |
| **Qualifying Change in Law** | means any Change in Law, which:   1. is directly applicable to the Project; 2. impacts the Cost or time for undertaking the Project; and 3. which was not reasonably foreseeable by the Concessionaire as on the Bid Due Date. |
| **Reference Index Date** | means, in respect of a specified date, the last date of the preceding month with reference to which the Construction Price Index or the O&M Price Index is  revised. |
| **Residual Grit** | means the grit which is obtained as residual matter after the treatment of the  Sewage at the ***[Location]*** STP(s) and ***[Location]*** FSTP(s). |
| **RFP** | has the meaning ascribed to it in Recital E. |
| **Rupee** or **Rs.** or  **INR** | means Indian National Rupee. |
| **Safeguard**  **Documents** | has the meaning ascribed to it in Clause 7.4(c)(i) |
| **Safety**  **Documents** | has the meaning ascribed to it in Clause 7.4(c)(ii) |
| **SBI MCLR** | means the prevailing marginal cost of fund-based lending rate for a tenor of 1  year, notified by the State Bank of India. |
| **Schedule** | means a schedule of this Agreement. |
| **Scheduled Bank** | means a bank as defined under section 2(e) of the Reserve Bank of India Act,  1934, as amended from time to time. |
| **Scheduled COD** | means the date which is 3 (three) months from the Construction Completion Date  of the ***[Location]*** Facilities, by which the Concessionaire is required to achieve the COD. |
| **Scheduled Construction**  **Completion Date** | means the date which is 21 (twenty one) months from the Effective Date, by which the Concessionaire is required to complete the construction of the  Facilities. |
| **Scheduled Maintenance** | means a planned maintenance of any Facilities that:   1. has been scheduled and allowed by ***[Executing Agency]*** in accordance with the Scheduled Maintenance Programme; and 2. is for inspection, testing, preventive and corrective maintenance, repairs, |

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|  | replacement or improvement of such Facilities, as the case may be. |
| **Scheduled Maintenance Programme** | means, for each year of the O&M Period, the schedule for undertaking preventive and corrective maintenance of the Facilities, as prepared by the Concessionaire and approved by ***[Executing Agency]*** in accordance with Clause  8.11(f). |
| **Scheduled Payment Milestone**  **Completion Date** | means the scheduled date of completion of the construction work corresponding to the relevant Payment Milestone. |
| **Scope of Work** | means the scope of work for construction and O&M of the Facilities as set out in  Schedule 1. |
| **Screening Report** | means, for each Facilities, the environmental and social design safeguards screening report prepared by the Concessionaire and submitted to the Executing Agency for its review as part of the Phase I Designs and Drawings, in the format  set out in Part 6 of Schedule 9. |
| **Screenings** | means solids such as fibres, plastic and other products or things, which need to  be removed from the Sewage and Faecal Sludge/Septage, prior to the treatment of Sewage at the ***[Location]*** STP(s) and ***[Location]*** FSTP(s). |
| **Second Breach** | has the meaning ascribed to it in Clause 8.12(b)(iii)(B). |
| **Second Breach**  **Notice** | has the meaning ascribed to it in Clause 8.12(b)(iii)(B). |
| **Security** | means andincludes any Encumbrance, or any other agreement or arrangement  having substantially the same economic effect. |
| **Selected Bidder** | means the Bidder selected by ***[Executing Agency]*** for award of the Project. |
| **Septage** | means the liquid and solid material that is pumped from a septic tank, cesspool, or such onsite treatment Facilities after it has accumulated over a period of time. Usually, septic tank retains 60% - 70% of the solids, oil, and grease that enter it. The scum accumulates on the top and the sludge settles to the bottom comprising 20% - 50% of the total septic tank volume when pumped. Offensive odour and appearance are the most prominent characteristics of Septage. It is a host of many disease-causing organisms along with the contamination of significant level of grease, grit, hair, and debris. Septage is the combination of scum, sludge, and liquid that accumulates in septic tanks. The effluent from the septic tank can be collected in a network of drains and/or sewers and treated in a treatment plant designed appropriately. The accumulating sludge at the bottom of the septic tank however, has to be also removed and treated once it has reached the designed depth or at the end of the designed desludging frequency whichever occurs earlier. Such a removal is possible only by trucks. While sucking out the sludge, the liquid in the septic tank will also be sucked out. Such a mixture is referred to as septage. |
| **Sewage** | means the sewage that is in liquid, solid or semi-solid form and brought for  treatment to the Facilities. |
| **Site** | (or the ***[Location]***Facilities Sites) means the location for the ***[Location]*** Facilities, admeasuring ***[Area Available for Construction of STP/FSTP Facilities]*** in ***[Location]***, as set out in more detail in the ***[Location]*** Project  Information Memorandum provided. |
| **Sq. ft.** | means square feet. |

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| **STP** | means a sewage treatment plant. |
| **STP By-Products** | means the by-products of the treatment process after the Sewage has passed  through the Facilities comprising the Digested Sludge, the Residual Grit and the Screenings. |
| **Subcontract** | means a contract entered into by the Concessionaire to subcontract any part of its  scope of work in relation to the Project under this Agreement. |
| **Subcontractor** | means the Concessionaire's counterparty under any Subcontract. |
| **Subordinated Debt** | the aggregate of the following sums expressed in Indian Rupees or in the currency of debt, as the case may be, outstanding as on the Transfer Date:   1. the principal amount of debt provided by lenders or the Concessionaire's shareholders for meeting the Total Project Cost and subordinated to the financial assistance provided by the Senior Lenders; and 2. all accrued interest on the debt referred to in sub-Article (a) above but restricted to the lesser of actual interest rate and a rate equal to [5% (five per cent)] above the Bank Rate in case of loans denominated in Indian Rupees and lesser of the actual interest rate and [6 (six) month] LIBOR (London Inter-Bank Offer Rate) plus [2% (two per cent)] in case of loans denominated in foreign currency, but does not include any interest that had fallen due 1 (one) year prior to the Transfer Date;   provided that if all or any part of the Subordinated Debt is convertible into Equity at the option of the lenders and/or the Concessionaire's shareholders, it shall for the purposes of this Agreement be deemed to be Subordinated Debt even after such conversion and the principal thereof shall be dealt with as if such conversion had not been undertaken; |
| **Sub-contractor Undertaking12** | means an irrevocable and duly notarized undertaking submitted by the  Nominated STP / FSTP Sub-Contractor on a stamp paper, submitted as part of the Bid. |
| **Substitution Agreement** | means the substitution agreement to be executed by ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]***, the Concessionaire and the  Lenders, in the format set out in Schedule 2. |
| **Supporting Infrastructure** | means the supporting infrastructure facilities required for the operation of the  ***[Location]*** Facilities, which will be provided, operated and maintained by  ***[Executing Agency]*** during the Term. |
| **Taxes** | means all taxes, levies, imposts, cesses, duties and other forms of taxation, including (but without limitation) income tax, sales tax, goods and service tax, value added tax, service tax, octroi, entry tax, corporation profits tax, advance corporation tax, capital gains tax, residential and property tax, customs and other import and export duties, excise duties, stamp duty or capital duty, and any interest, surcharge, penalty or fine in connection therewith which may be payable by the Concessionaire or the Subcontractors and the term **Tax** shall be  construed accordingly. |

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| **Technical**  **Capacity** | means the technical capacity and experience of the ***[Selected***  ***Bidder/Member(s)]13*** determined in accordance with the RFP. |
| **Technical**  **Specifications** | means the technical specifications for design, construction, operation and  maintenance of the Facilities, as set out in Schedule 12. |
| **Technology**  **Performance Security14** | has the meaning ascribed to it in Clause 5.24 |
| **Term** | has the meaning ascribed to it in Clause 3.7. |
| **Termination Compensation** | means the compensation payable by ***[Name of the State / National Level Agency, if any]*** upon termination of this Agreement, in accordance with Article  18. |
| **Third Breach** | has the meaning ascribed to it in Clause 8.12(b)(iii)(C). |
| **Third Breach**  **Notice** | has the meaning ascribed to it in Clause 8.12(b)(iii)(C). |
| **Threshold Limit** | has the meaning ascribed to it in Clause 13.2(e)(i). |
| **Total Casualty** | means any fire or other casualty that results in physical damage to the ***[Location]*** Facilities, to the extent that the total cost of repairing, replacing or restoring the damaged portion of the ***[Location]*** Facilities (as determined by the Project Engineer), to the same condition as existed previously, would be more than 25%  (twenty five per cent)of the total replacement cost of the Facilities. |
| **Treated Effluent** | means the water which is obtained after the treatment of the Sewage at the  ***[Location]*** STP. |
| **Trial Operations** | means the operation of the ***[Location]*** Facilities on a trial basis for a period of 3  (three) months from the Construction Completion Date or such longer period as may be determined in accordance with Clause 7.14. |
| **Trial Operations**  **Completion Certificate** | means the certificate issued by ***[Executing Agency]*** to the Concessionaire upon successful completion of the Trial Operations of the ***[Location]*** Facilities. |
| **Trial Operation**  **Procedures** | means the procedures for conducting the Trial Operations, as set out in the  Technical Specifications, Schedule 12. |
| **Unscheduled**  **Outage** | means an interruption of or a reduction in the Availability of any Facilities that is  not the result of a Forced Unavailability. |
| ***[Name of State of STP Location]***  **Act** | ***[Name of Act of State of STP Location]*** as may be amended from time to time. |
| **Variation** | means any alteration in the Scope of Work, Technical Specifications or the  Designs and Drawings, as instructed by ***[Executing Agency]*** or proposed by the Concessionaire, in accordance with Article 20. |
| **Variation Order** | means an order issued by ***[Executing Agency]*** certifying its approval of a proposed Variation and recording the terms and condition on which the proposed  Variation is required to be implemented. |
| **Waste Disposal Site** | means the site identified by ***[Executing Agency]*** for disposal of the STP By- Products, FSTP By-Products, and other waste material (including silt) from the  ***[Location]*** STP. |

13 Delete Member(s) if the Selected Bidder is a single entity.

14To be deleted if not applicable

|  |  |
| --- | --- |
| **Website** | means the web portal of ***[Executing Agency]***, available at the url: [http://---------](http://---------/) |
| **Wilful**  **Misconduct** | means an intentional or reckless breach or disregard by a Party of any of its  obligations under this Agreement. |
| **WPI** | means the Wholesale Price Index for all commodities as published by the Ministry of Commerce and Industry, GOI and shall include any index which substitutes the WPI, and any reference to WPI shall, unless the context otherwise requires, be construed as a reference to the WPI published for the period ending  with the preceding month. |

* 1. **Rules of Interpretation**

In this Agreement, unless the context otherwise requires:

* + 1. Any reference to a statutory provision shall include such provision as modified or re- enacted or consolidated from time to time.
    2. The words importing the singular shall mean the plural and vice-versa; and words importing the masculine shall include the feminine and neuter and vice-versa.
    3. Headings in this Agreement are for convenience of reference only.
    4. The references to the word 'include' or 'including' or to the phrase 'in particular', shall be construed without limitation.
    5. References to any date or time of day are to Indian Standard Time; any reference to day shall mean a reference to a calendar day; any reference to a month shall mean a reference to a calendar month, any reference to a year shall mean a reference to a calendar year.
    6. The references to any agreement, deed or other instrument shall be construed as a reference to such agreement, deed, or other instrument as may be amended, varied, supplemented or novated, from time to time.
    7. Unless otherwise provided, any late payment charges to be calculated and payable under this Agreement shall accrue *pro rata* on a monthly basis and from the respective due dates as provided for in this Agreement.
    8. A requirement that a payment be made on a day which is not a Business Day shall be construed as a requirement that the payment be made on the next Business Day.
    9. Whenever provision is made for the giving or issuing of any notice, endorsement, consent, approval, permission, certificate or determination by any Person, such notice, etc., shall be reasonably given, shall not be unreasonably withheld or delayed and shall be in writing and the words 'notify', 'endorse', 'approve', 'permit', 'certify' or 'determine' shall be construed accordingly. Where any notice, consent or approval is to be given by any Party, the notice, consent or approval shall be given on their behalf only by any

authorized persons.

* + 1. The words written and in writing include a facsimile transmission and any means of reproducing works in a tangible and permanently visible form.
    2. The terms of the RFP form an integral part of this Agreement and will be in full force and effect as though they were expressly set out in the body of this Agreement. In the event of any discrepancy between this Agreement and the RFP, the provisions set out in this Agreement shall prevail.
    3. The provisions of the Articles, Clauses and the Schedules of this Agreement shall be interpreted in such a manner that will ensure that there is no inconsistency in interpretation between the intent expressed in the Articles, Clauses and the Schedules.
    4. In the event of any ambiguities or discrepancies within this Agreement, the following shall apply:
       1. between two Clauses of this Agreement, the provisions of the specific Clause relevant to the issue under consideration shall prevail over those in other Clauses;
       2. between the requirements of two or more Schedules of this Agreement, the provisions of the specific Schedule relevant to the issue under consideration shall prevail over the more general; and
       3. between the Clauses and the Schedules, unless specified otherwise, the Clauses shall prevail over the Schedules.
    5. In the event of any discrepancy between various documents issued by or provided to ***[Executing Agency]*** as a part of the Bid Process, the following order of priority shall apply:
       1. this Concession Agreement;
       2. the Schedules to the Concession Agreement;
       3. the Financial Proposal submitted by the Selected Bidder;
       4. the LOA issued to the Selected Bidder;
       5. the written clarifications, if any, issued to the bidders; and
       6. the RFP.
    6. Subject to the provisions of this Agreement, the Concessionaire shall be responsible to and indemnify, ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** for the acts and omissions of the Concessionaire Related Parties as if they were the acts and omissions of the Concessionaire and ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** shall be responsible to and indemnify the Concessionaire for the acts and omissions of ***[Executing Agency]*** Related Parties and the ***[Name of the State / National Level Agency, if any]*** Related Parties, respectively, as if they were the acts and omissions of ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]***, as the case may be.
    7. Neither the giving of any approval or consent, the review, knowledge or acknowledgement of the terms of any document by or on behalf of ***[Executing***

***Agency]***or ***[Name of the State / National Level Agency, if any]***, nor the failure to do so, shall, unless expressly stated in this Agreement, relieve the Concessionaire of any of its obligations under this Agreement or of any duty which it may have under this Agreement to ensure the correctness, accuracy or suitability of the matter or thing which is the subject of the approval, consent, review, knowledge or acknowledgement.

* + 1. The rule of construction, if any, that an agreement should be interpreted against the Party responsible for the drafting and preparation thereof shall not apply to this Agreement.
    2. The Parties acknowledge that damages for specific defaults prescribed under this Agreement (including the Delay Liquidated Damages, the Performance Liquidated Damages, the Availability Liquidated Damages, and the Power Consumption Liquidated Damages) are a genuine pre-estimate of and reasonable compensation for the loss and damage that shall be suffered by the non-defaulting Party due to failure of the defaulting Party to perform its obligations in accordance with this Agreement, and are not in the nature of a penalty.
  1. **Units of Measurement**

All measurements and calculations shall be in the metric system and calculations done to 4 decimal places, with the 5th digit of 5 or above being rounded up and below being rounded down.

**ARTICLE 2**

**SCOPE OF THE PROJECT AND GRANT OF THE CONCESSION**

* 1. **Scope of the Project**

The scope of the Project shall be as set out in Schedule 1 and shall include:

* + 1. designing, part-financing, constructing and completing the Facilities by the Scheduled Construction Completion Date, in accordance with Applicable Laws, Applicable Permits, Technical Specifications, Designs and Drawings, the Construction Plan, the ESHS Documents and Good Industry Practices;
    2. operating and maintaining the Facilities in accordance with Applicable Laws, Applicable Permits, Technical Specifications, Designs and Drawings, the O&M Manual, the ESHS Documents and Good Industry Practices to ensure compliance with the KPIs;
    3. disposal/sale of by-products and treated effluent; and
    4. hand-back of the Facilities (excluding the Mobile Associated Infrastructure) upon expiry or early termination of this Agreement in accordance with the Hand-back Conditions and the Hand-back Requirements.
  1. **Grant of Concession**
     1. On and from the Effective Date and subject to the terms of this Agreement, Applicable Laws and Applicable Permits, ***[Executing Agency]*** grants to the Concessionaire the exclusive right to:
        1. design, part-finance, construct and complete the Facilities; and
        2. upon completion of construction of the Facilities, operate and maintain the Facilities during the O&M Period.

Notwithstanding anything contained herein, to the extent of applicability of Clause 7.1, the Concessionaire shall be entitled to access the Site prior to the Effective Date.

* + 1. The grant of the concession set out in Clause 2.2(a) shall oblige or entitle the Concessionaire, as the case may be, to the following:
       1. access to the Site from the Effective Date, for the sole purpose of implementing the Project, provided, however, to the extent of applicability of Clause 7.1, the Concessionaire shall be entitled to access the Site prior to the Effective Date;
       2. apply for and obtain all the Concessionaire Applicable Permits and utilities required to undertake the Project;
       3. raise funds (through both debt and equity financing) to finance [60% (sixty per

cent)] of the Bid Project Cost;

* + - 1. complete the construction of the Facilities on or before the Scheduled Construction Completion Date;
      2. upon completion of construction of the Facilities, undertake Trial Operations;
      3. upon successful completion of the Trial Operations, operate and maintain the Facilities until Expiry Date;
      4. receive, treat and process Sewage up to the Design Capacity;
      5. store, treat, market, sell or dispose of the STP By-Products and FSTP By- Products subject to and in accordance with this Agreement;
      6. store, treat or dispose of the Treated Effluent subject to and in accordance with this Agreement;
      7. transfer the Facilities (excluding the Mobile Associated Infrastructure) to ***[Executing Agency]*** upon the expiry of the Term or termination of this Agreement, after rectification of any defects in the Facilities, in accordance with the Hand-back Conditions and the Hand-back Requirements;
      8. receive the Construction Payments during the Construction Period and the O&M Payments during the O&M Period, subject to compliance with the terms and performance of the obligations under this Agreement;
      9. appoint Subcontractors, agents, advisors and consultants and enter into Subcontracts to undertake the Project, with the prior approval of ***[Executing Agency]***;
      10. [construct a biogas Power Plant at ***[Location]***Facilities Sites.]15
      11. [construct a solar rooftop Power Plant at the ***[Location]***Facilities Sites, at its sole option and discretion];
      12. develop, operate and maintain faecal sludge collection and transportation system, including vehicles, contractors, human resources, complaint centre and helpline, etc.;
      13. collect nominal user fee as mutually decided between the Concessionaire and the ***[Executing Agency]***for extraction/suction/clearing of septic tanks of households, offices, commercial spaces, etc., on call/complaint basis.
  1. **Description of the Facilities**

15 Delete if not applicable

* + 1. The Facilities shall include the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) along with the Associated Infrastructure, the Online Monitoring Systems, the on-site testing laboratory facilities, temporary storage facilities for the Digested Sludge and all other such facilities necessary or associated with the STP and FSTP for treatment, processing and disposal of the Sewage and Faecal Sludge/Septage, as the case may be, as described in greater detail in Schedule 1 (*Scope of Work*) and Schedule 12 (*Technical Specifications*).
    2. The Concessionaire shall operate the Facilities and treat the Sewage and the Faecal Sludge/Septage in a manner such that the KPIs are achieved, and the Treated Effluent and Digested Sludge comply with the Discharge Standards.
    3. The STP By-Products and FSTP By-Products will be bifurcated into the Screenings, the Digested Sludge and the Residual Grit. The Concessionaire will be required to dispose the STP By-Products and FSTP By-Products and silt as follows:
       1. the Residual Grit, the Screenings, and the silt will be disposed at the relevant Waste Disposal Site to be identified by ***[Executing Agency]*** within a radius of 10 km from the relevant Site, in accordance with the Technical Specifications; and
       2. The Concessionaire shall dry the Digested Sludge at a sludge handling Facilities available at or to be provided by the Concessionaire at the relevant Site. The Concessionaire shall, subject to compliance with Applicable Laws and Applicable Permits, be free to sell the Digested Sludge, at such price and to such Persons as it may deem fit or dispose the Digested Sludge at the Waste Disposal Sites. Provided that if the Concessionaire sells the Digested Sludge to any third party, the Concessionaire shall be required to share 10% (ten per cent) of the revenues from such sale with***[Executing Agency]***.
    4. The Concessionaire shall transfer the Treated Effluent to the Discharge Point, for discharge in to the ----------------16, sale to third parties or utilization for irrigation purposes. Provided that if the Concessionaire sells the Treated Effluent to any third party, the Concessionaire shall be required to share [10% (ten per cent)] of the revenues from such sale with ***[Executing Agency]***.
  1. **Use of Proposed Technology**
     1. The Concessionaire shall design and develop the ***[Location]*** STP(s) and the ***[Location]*** FSTP(s) on the basis of the Proposed Technology, approved by ***[Executing Agency]*** as part of the Designs and Drawings.
     2. If the Selected Bidder is the owner of the Proposed Technology, then the Concessionaire shall enter into a technology license agreement with the Selected Bidder, under which the Selected Bidder will grant to the Concessionaire an irrevocable, perpetual, assignable, non-exclusive and royalty-free license to use the

16Name of the water body/source if any.Otherwise to be suitably modified.

Proposed Technology to develop and operate the Facilities.

* + 1. If the Selected Bidder does not own the Proposed Technology, then the Concessionaire shall, at its own cost, enter into a technology license agreement with the technology provider, under which the technology provider will grant to the Concessionaire an irrevocable, perpetual, assignable and royalty-free license to use the Proposed Technology. At no point will ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** be obliged to make any payments to the Concessionaire towards the licensing and use of the Proposed Technology.

In the event of the Selected Bidder opting for a technology other than those mentioned in the Central Public Health and Environmental Engineering Organisation (CPHEEO)Manual on Sewerage and Sewage Treatment Systems, in accordance with Clause 4.1(a)(F)(ix) of the RFP, the technology provider shall have submitted to ***[Executing Agency]***, prior to the Appointed Date, the Technology Performance Security of 5% (five per cent) of the Aggregate Bid Project Cost, which shall remain valid until 2 years from the COD. If the technology provider leaves the project before the completion of 2 years, the Technology Performance Security shall be liable to be forfeited by ***[Executing Agency]***. Any modification required to make the plant operational in the absence of the technology provider, as suggested and approved by ***[Executing Agency]***, shall be undertaken by the Selected Bidder at his own risk. Any failure to meet the requirements as mentioned in the Clause shall be considered as a Concessionaire Event of Default.

* + 1. Upon the expiry or early termination of this Agreement, the Concessionaire shall assign the license and related rights to use the Proposed Technology for the sole purpose of operating and maintaining the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) to ***[Executing Agency]*** at no additional cost to ***[Executing Agency]***.
    2. The Concessionaire shall indemnify ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** for any claims, losses, damages and costs suffered by ***[Executing Agency]*** and/or ***[Name of the State / National Level Agency, if any]*** as a result of an infringement of any third party's Intellectual Property Rights caused by the operation and use of the ***[Location]*** STP(s) and the ***[Location]*** FSTP(s).

**ARTICLE 3**

**CONDITIONS PRECEDENT, EFFECTIVENESS AND TERM**

* 1. **Effectiveness**
     1. The day on which all of the Conditions Precedent have been satisfied in accordance with this Article 3 shall be the effective date (the ).

(b) Articles 2.1, 2.2, 3, 5, 6, 10, 11.1, 12, 13, 14, 21, 22 and 23 and the related Schedules, shall come into full force and effect and be binding on the Parties on and from the Appointed Date and continue until such time as this Agreement expires or is terminated in accordance with its terms. The other provisions of this Agreement shall come into full force and effect and be binding on the Parties on and from the Effective Date and continue until such time as this Agreement expires or is terminated in accordance with its terms.

* 1. **Conditions Precedent to be satisfied by the Concessionaire**

The Concessionaire shall satisfy the following Conditions Precedent (if not already fulfilled on the Appointed Date):

* + 1. submit the Phase I Designs and Drawings to ***[Executing Agency]*** for its approval in accordance with Clause 7.2;
    2. prepare the Construction Plan within 30 (thirty) days from the Appointed Date and submit the Construction Plan to ***[Executing Agency]*** for its approval in accordance with Clause 7.3;
    3. prepare the ESHS Documents within 45 (forty-five) days from the Appointed Date and submit the ESHS Documents to ***[Executing Agency]*** for its approval in accordance with Clause 7.4;
    4. obtain all Concessionaire Applicable Permits that are required for achieving Financial Close and for commencement of construction of the Facilities at its own cost and expense and if such Concessionaire Applicable Permits are subject to any conditions, then, to the extent relevant, comply with all such conditions, such that the Concessionaire Applicable Permits are and shall be kept in full force and effect for the entire Construction Period, or such longer period as may be required under Applicable Laws;
    5. execute and provide a copy to ***[Executing Agency]*** of the technology license agreement(s) executed with the Selected Bidder or the third party technology supplier for setting up the ***[Location]*** STP(s) and the ***[Location]*** FSTP(s).
    6. submit to ***[Executing Agency]*** certified true copies of all resolutions adopted by the board of directors of the Concessionaire authorising execution, delivery and performance of this Agreement, Substitution Agreement and the Escrow Agreement by the Concessionaire;
    7. execute the Substitution Agreement with ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]*** and the Lenders in the agreed form set out in Schedule 2;
    8. achieve Financial Close and submit a copy of the Financing Documents and the Financial Package to ***[Executing Agency]***, duly certified by a director of the Concessionaire;
    9. [execute a shareholders' agreement amongst the shareholders of the Concessionaire, and deliver to ***[Executing Agency]*** a certified true copy of the shareholders' agreement (attested by a director of the Concessionaire);]17
    10. execute the Escrow Agreement with ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]***, and the Escrow Bank in the agreed form set out in Schedule 3;
    11. submit to ***[Executing Agency]*** certified true copies of the constitutional documents of the Concessionaire;
    12. submit to ***[Executing Agency]*** a legal opinion stating that: (i) this Agreement, the Substitution Agreement and the Escrow Agreement have been duly executed and are legally valid, binding and enforceable in accordance with their terms against the Concessionaire; and (ii) all actions, conditions and things required by Applicable Laws to be taken, fulfilled and done (including the obtaining of any necessary Concessionaire Applicable Permits and resolutions of the board of directors) in order for the Concessionaire to enter into and comply with its obligations under this Agreement, the Substitution Agreement and the Escrow Agreement have been taken, fulfilled or done;
    13. submit to ***[Executing Agency]*** a certificate, duly attested by a director, certifying the shareholding pattern of the Concessionaire.
  1. **Conditions Precedent to be satisfied by *[Executing Agency]***

***[Executing Agency]*** shall satisfy the following Conditions Precedent (if not already fulfilled on the Appointed Date):

* + 1. grant access to the ***[Location]***Facilities Sites and all necessary rights of way to the ***[Location]***Facilities Sites to the Concessionaire, free of Encumbrances and encroachments;
    2. to the extent relevant, obtain any change in land use permission from the relevant Government Authority to enable the Concessionaire to undertake the Project at the Site;
    3. subject to Clause 3.2(a), review and approve the Phase I Designs and Drawings in accordance with Clause 7.2;

17 This Condition Precedent to be deleted if the Selected Bidder is not a Consortium.

* + 1. subject to Clause 3.2(b), review and approve the Construction Plan in accordance with Clause 7.3;
    2. subject to Clause 3.2(c), review and approve the ESHS Documents in accordance with Clause 7.4;
    3. obtain all approvals and consents, including ***[Executing Agency]*** Applicable Permits and any approvals under Applicable Laws required for ***[Executing Agency]*** to enter into this Agreement and undertake the Project;
    4. provide access road(s) to the ***[Location]***Facilities Sites, which are capable of being used for transportation of equipment and material to the ***[Location]***Facilities Sites for the construction of the Facilities;
    5. provide adequate Supporting Infrastructure and facilitate the Concessionaire in obtaining utilities, such as water and electricity connections to commence construction of the ***[Location]*** Facilities;
    6. execute the Substitution Agreement with the Concessionaire, ***[Name of the State / National Level Agency, if any]*** and the Lenders in the agreed form set out in Schedule 2; and
    7. execute the Escrow Agreement with the Concessionaire, ***[Name of the State / National Level Agency, if any]*** and the Escrow Bank in the agreed form set out in Schedule 3.
  1. **Conditions Precedent to be satisfied by *[Name of the State / National Level Agency, if any]*18**

***[Name of the State / National Level Agency, if any]*** shall satisfy the following Conditions Precedent (if not already fulfilled on the Appointed Date):

* + 1. obtain all approvals and consents that may be required for ***[Name of the State / National Level Agency, if any]*** to enter into this Agreement and undertake the Project;
    2. appoint the Project Engineer in accordance with Article 6;
    3. execute the Substitution Agreement with the Concessionaire, ***[Executing Agency]*** and the Lenders in the agreed form set out at Schedule 2; and
    4. execute the Escrow Agreement with the Concessionaire, ***[Executing Agency]*,** and the Escrow Bank in the agreed form set out at Schedule 3 and open the Escrow Account with the Escrow Bank.

18If there is no State/National level agency involved in the Project, the conditions mentioned here in shall be added to the Conditions Precedent of the Executing Agency.

* 1. **Satisfaction of Conditions Precedent**
     1. Unless otherwise specified, each Party shall satisfy or procure the satisfaction of the Conditions Precedent that it is responsible for, within 120 (one hundred and twenty)

days from the Appointed Date (the ).



**-**

* + 1. If any Party fails to satisfy any Condition Precedent that it is required to fulfil by the CP Long-stop Date due to:
       1. a Force Majeure Event;
       2. a Qualifying Change in Law;
       3. in case of the Concessionaire, undue delay by the relevant Government Authority in granting any Concessionaire Applicable Permit, despite the Concessionaire having applied for such Concessionaire Applicable Permit within the specified timelines, on payment of the prescribed fees and having complied with the requirements of Applicable Laws in making such application; or
       4. delay by the other Parties in fulfilling any Condition Precedent required to be satisfied by them or in performing any other obligation under this Agreement, which impacts its ability to satisfy its Conditions Precedent,

then the CP Long-stop Date shall be extended on a day-for-day basis for the period of such delay, provided that the CP Long-stop Date shall not be extended beyond the date which is 6 (six) months from the Appointed Date.

* + 1. Each Party shall cooperate and use its reasonable efforts to assist the other Parties in satisfying the Conditions Precedent.
    2. Upon request in writing by either Party, the other Party may grant waiver from satisfaction of any Condition Precedent and to the extent of such waiver, that Condition Precedent shall be deemed to be fulfilled for the purposes of this Article 3.
  1. **Consequences of failure to satisfy Conditions Precedent**
     1. Subject to this Clause 3.6:
        1. If the Concessionaire fails to satisfy any of the Conditions Precedent that it is required to fulfill by the CP Long-stop Date, as may be extended in accordance with Clause 3.5(b), non-defaulting party may claim prescribed damages from the other party or may terminate this Agreement forthwith by issuing a notice to the other Parties.
        2. If either ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if***

***any]***19 fails to satisfy any of the Conditions Precedent that they are required to fulfill by the CP Long-stop Date, as may be extended in accordance with Clause 3.5(b), any Party may terminate this Agreement forthwith by issuing a notice to the other Parties.

* + 1. If the Concessionaire has failed to satisfy any of the Conditions Precedent required to be satisfied by it other than due to the reasons set out in Clause 3.5(b) and this Agreement is terminated in accordance with this Clause 3.6, then:
       1. ***[Executing Agency]*** shall be entitled to forfeit the Performance Securities up to the extent of Bid Security as a genuine pre-estimate of and reasonable compensation for loss and damage caused to ***[Executing Agency]*** as a result of the Concessionaire's failure to satisfy any of the Conditions Precedent and the consequent termination of this Agreement;
       2. the Concessionaire shall not be entitled to receive any payment or compensation from ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** for the costs and expenses incurred by the Concessionaire in performing any of its obligations under this Agreement (including preparing any Phase I Designs and Drawings, the Construction Plan and the ESHS Documents) prior to the termination of this Agreement;
       3. the Concessionaire shall hand over to ***[Executing Agency]*** all documents, designs, plans, data and any Confidential Information provided by ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** to the Concessionaire prior to termination of this Agreement;
       4. ***[Executing Agency]*** shall hand over to the Concessionaire the Phase I Designs and Drawings, the Construction Plan, the ESHS Documents and any other document and Confidential Information submitted by the Concessionaire to ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** prior to termination of this Agreement; and
       5. if the access to any part of the Site has been granted to the Concessionaire prior to termination of this Agreement, then upon termination of this Agreement, the Concessionaire shall clear the Site and remove all debris, hazardous materials, construction materials, equipment, temporary works, work sheds, labour camps and all other temporary installations on the Site, and thereafter, the Site will be deemed to automatically vest with ***[Executing Agency]***, free from all Encumbrances.
    2. If ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** has failed to satisfy any of the Conditions Precedent required to be satisfied by it or the Concessionaire has failed to satisfy any of the Conditions Precedent required to be satisfied by it due to the reasons set out in Clause 3.5(b), and this Agreement is terminated in accordance with this Clause 3.6, then:

19Delete if not applicable.

* + - 1. ***[Executing Agency]*** shall return the Performance Security, O&M Security and the ESHS Performance Security submitted by the Concessionaire;
      2. the Concessionaire shall hand over to ***[Executing Agency]*** all documents, designs, plans, data and any Confidential Information provided by ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** to the Concessionaire prior to termination of this Agreement;
      3. ***[Executing Agency]*** shall hand over to the Concessionaire the Phase I Designs and Drawings, the Construction Plan, the ESHS Documents and any other document and Confidential Information submitted by the Concessionaire to ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** prior to termination of this Agreement; and
      4. if the access to any part of the Site has been granted to the Concessionaire prior to termination of this Agreement, then upon termination of this Agreement, the Concessionaire shall clear the Site and remove all debris, hazardous materials, surplus construction materials, equipment, temporary works, work sheds, labour camps and all other temporary installations on the Site, and thereafter, the Site will be deemed to automatically vest with ***[Executing Agency]***, free from all Encumbrances.
    1. Upon termination of this Agreement pursuant to this Clause 3.6, other than to the extent specified in this Clause 3.6, no Party shall have any liability to the other Parties in connection with this Agreement and the Concessionaire shall not be entitled to receive any termination compensation from ***[Name of the State / National Level Agency, if any]*** or ***[Executing Agency]***.
  1. **Term**
     1. Subject to early termination in accordance with Article 14 (Force Majeure) or Article 16 (Events of Default), this Agreement shall come into full force and effect on the

).

* + 1. **[Extension of Term**

The Authority may in its sole discretion, in the event the Concessionaire does not commit any Event of Default during the last [5 (five) years] of the Term, agree to extend the Concession after the expiry of the Term on same [or modified] terms and conditions.

Provided that any such extension shall also lead to an extension of License Agreement(s) for an equal period so as to make the License Agreement co-terminus with extended Term.]

**ARTICLE 4**

**SITE AND ASSET OWNERSHIP**

* 1. **Grant of License over the Site**
     1. ***[Executing Agency]*** shall grant the Concessionaire a license over the ***[Location]***Facilities Sites along with all necessary rights of way, to enter upon, access and occupy the ***[Location]***Facilities Sites, free of all Encumbrances in accordance with this Clause 4.1, Applicable Laws, and Applicable Permits. The license granted to the Concessionaire shall include the exclusive right to:
        1. design, construct and commission the Facilities at the Site;
        2. operate and maintain the Facilities during the O&M Period;
        3. install, operate, use, maintain, and remove such equipment, devices or other structures and improvements on, over, or under the Site, as may be necessary or appropriate for the operations and activities required or permitted under this Agreement;
        4. use access roads, gates, fences and utilities at or about the Site;
        5. discharge, store, treat and manage the STP By-Products, FSTP By-Products and the Treated Effluent produced by the Facilities; and
        6. construct, use, operate, maintain, replace and repair electric lines, telecommunication lines, water supply networks and other utilities required to undertake the Project at the Site.
     2. On and from the Effective Date and subject to the provisions of this Agreement, ***[Executing Agency]*** shall grant the Concessionaire: (i) a license over the ***[Location]***Facilities Sites including the exclusive right to occupy and use the ***[Location]***Facilities Sites to construct the Facilities; and (ii) all necessary rights of way to the ***[Location]***Facilities Sites. Any charges payable for obtaining the right of way will be paid directly by ***[Executing Agency]***.

Notwithstanding anything contained herein, to the extent of applicability of Clause 7.1, the Concessionaire shall be entitled to access the Site prior to the Effective Date.

* + 1. ***[Executing Agency]*** shall provide the ***[Location]***Facilities Sites to the Concessionaire free of Encumbrances and encroachments as a Condition Precedent. If the Concessionaire discovers any hazardous substances at the time of handover of the ***[Location]***Facilities Sites by ***[Executing Agency]***, ***[Executing Agency]*** will remove such ha



acceptance of the site(s) at the time of ***[Executing Agency]*** handover/giving access to the site(s) shall be deemed to be unconditional acceptance and that there were no hazardous substance or any possible form of obstruction to the project at the time of handover of site(s) and concessionaire shall be barred from raising any such issues,

whatsoever, after the handover or having access to the site(s).

* + 1. The Concessionaire shall not without the prior written consent or approval of ***[Executing Agency]*** use the Site for any purpose other than to undertake the Project and purposes incidental thereto, as permitted under this Agreement or as may be otherwise approved by ***[Executing Agency]***.
    2. The full ownership and title over the Site shall vest with ***[Executing Agency]*** for the entire Term.
    3. ***[Executing Agency]*** warrants that the Concessionaire shall, subject to complying with the terms and conditions of this Agreement, occupy the Site, from such time that access is granted to the Concessionaire and until the expiry of the Term or early termination of this Agreement. If the Concessionaire is obstructed by any Person claiming any right, title or interest in or over the Site or any part thereof or in the event of any enforcement action including any attachment, distraint, appointment of receiver or liquidator being initiated by any Person claiming to have a charge on the Site or any part thereof, ***[Executing Agency]*** shall, if called upon by the Concessionaire, defend such claims and proceedings.
    4. Subject to any substitution rights exercised by the Lenders, the license granted by ***[Executing Agency]*** shall automatically terminate upon termination of this Agreement or expiry of the Term.
    5. The Concessionaire hereby irrevocably appoints the ***[Executing Agency]*** (or its nominee) to be its true and lawful attorney, to execute and sign in the name of the Concessionaire a transfer or surrender of the rights granted hereunder at any time after the Term has expired or has been Terminated in terms hereof, whichever is earlier, a sufficient proof of which shall be the declaration of any duly authorised officer of the ***[Executing Agency]***, and the Concessionaire consents to it being registered for this purpose.
  1. **Ownership, Right, Title and Interest in the Facilities**
     1. Without prejudice and subject to the Agreement, the ownership of the Facilities, including all improvements made therein by the Concessionaire during the Term shall at all times remain as mentioned below:
        1. That of all the immovable assets including Site and civil structures created for the Facilities shall remain with the ***[Executing Agency]***,
        2. That of the Mobile Associated Infrastructure shall remain with the Concessionaire and in accordance with the Financing Documents and first prior charge to Senior Lenders privileges.
     2. The full ownership, rights and title to the Facilities constructed or installed by the Concessionaire pursuant to this Agreement shall vest with ***[Executing Agency]*** during the entire Term and thereafter. The Concessionaire shall have the right to enter upon the

Site, access and operate the Facilities during the Term, to exercise its rights and fulfil its obligations under this Agreement.

* + 1. Except as otherwise provided inthis Agreement, the Concessionaire shall not:

1. sell or otherwise dispose or create any Security over the Facilities or any part thereof;
2. dispose any assets forming part of the Facilities, other than for the purposes of replacement due to normal wear and tear; or
3. transfer, assign or novate all of its rights and obligations under this Agreement, without the prior written consent of ***[Executing Agency]*** (such consent not being unreasonably withheld or delayed).
   1. **Site Data and Verification**
      1. ***[Executing Agency]*** has made available to the Concessionaire, the layout plans, load flow studies and all other relevant data, studies and reports in ***[Executing Agency]***'s possession in connection with the Site and the Facilities.
      2. The Concessionaire shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the implementation of the Project at the Site.
      3. The Concessionaire shall also be deemed to have inspected and examined the Site and its surroundings, analysed and verified the accuracy and reliability of the studies, reports and data provided by ***[Executing Agency]*** and any other information available with respect to the Facilities and the Site and to have satisfied itself as to all the relevant matters including:
         1. the nature of the Site, including the subsurface, hydrological, climatic and general physical conditions of the Site;
         2. the suitability of the Site for undertaking the construction and operation of the Facilities;
         3. the condition of the utilities available till the battery limits of the Site;
         4. the extent, nature and availability of labour, material, transport, accommodation, storage facilities and other facilities and resources necessary to undertake the Project;
         5. the nature of design, construction work and O&M services necessary for the performance of its obligations under this Agreement;
         6. Applicable Laws and Applicable Permits required to be obtained and maintained to undertake the Project;
         7. the risk of injury or damage to Adjoining Property and to the occupiers of such

property or any other risk;

* + - 1. the suitability and adequacy of any access roads to the Site and other utilities and facilities to be provided by the relevant Government Authority; and
      2. all other matters that may affect the performance of its obligations under this Agreement.

The Concessionaire acknowledges and agrees that if any error or discrepancy is subsequently discovered in the data made available by ***[Executing Agency]***, then, such error or discrepancy shall not entitle the Concessionaire to any extension of the Scheduled Payment Milestone Completion Date, the Scheduled Construction Completion Date and/or compensation for additional costs incurred nor shall it be open to the Concessionaire to justify any default or delay on the ground of the Concessionaire having not visited or acquitted itself with the site and Site conditions in any manner whatsoever. Further, any misinterpretation of the data, studies and reports provided by ***[Executing Agency]*** shall not relieve the Concessionaire from the performance of its obligations under this Agreement on the ground that it could not reasonably be expected to have foreseen any of the matters listed in Clause 4.3(c) (i) to

(ix) above, which affect or may affect the Project or the performance of any of its obligations under this Agreement.

* 1. **Unforeseen Site Conditions**

Without prejudice to Clause 4.3 above, if during the execution of the Project, the Concessionaire encounters any adverse physical conditions, which could not have been reasonably foreseen by acting in accordance with Good Industry Practices, the Concessionaire may seek a Variation in accordance with Clause 20.3. Upon receipt of a request for a Variation due to unforeseen Site conditions, if, in the opinion and sole discretion of ***[Executing Agency]***, such conditions could not have been reasonably foreseen by a prudent developer acting in accordance with Good Industry Practices, then ***[Executing Agency]*** shall issue a Variation Order in accordance with Article 20. Any decision of ***[Executing Agency]*** regarding the existence of any unforeseen Site conditions shall be final and binding.

* 1. **Site Related Covenants**

The Concessionaire agrees and undertakes that:

* + 1. the Concessionaire shall not transfer, alienate, assign, dispose of, sub-license or create any Security over any part of the Site or its rights and interest in the Site, other than as specifically permitted under this Agreement;
    2. the Concessionaire shall not allow any encroachment on, or unauthorized occupation of any part of the Site and in the event of any encroachment or unauthorized occupation, the Concessionaire shall immediately cause such encroachment or any unauthorized occupants to be removed from the Site. The Concessionaire shall not be entitled to any extension of time or costs incurred in removal of any encroachment or any unauthorized occupants from the Site;
    3. the grant of any rights to a Subcontractor or any other third party shall not interfere with or hinder the performance of the Concessionaire's obligations under this Agreement;
    4. the Concessionaire shall be wholly responsible for safety at and security of the Site and the Facilities;
    5. the Concessionaire shall take all necessary measures to confine its operations, personnel and equipment to the Site and not encroach on any Adjoining Property;
    6. all minerals, fossils, articles of value or antiquity, structures and other remains or things of geological or archaeological interest and other objects with historic, antique or monetary value discovered at, on or under the Site shall be dealt with in accordance with Applicable Laws and the Concessionaire shall take all necessary precautions to prevent its or its Subcontractor's personnel from removing or damaging any such article or thing. Further, immediately upon the discovery of any such article or thing of value, the Concessionaire shall inform ***[Executing Agency]*** of such discovery and carry out the instructions of ***[Executing Agency]*** in this regard;
    7. the Concessionaire shall make good any damage to any roads, footpaths, conduits, and other works on any Adjoining Property, which is caused by the Concessionaire or the Concessionaire Related Parties;
    8. the Concessionaire shall not to do or permit to be done anything which might:
    9. cause destruction, scarring or defacing of natural surroundings in the vicinity of the Site;

1. be or become a danger or nuisance or give rise to liability in tort to any owners or occupiers of the Adjoining Property or to members of the public; or
2. cause any contamination or damage to any Adjoining Property,

and the Concessionaire shall, at its own expense, take all reasonable measures and precautions to avoid any such danger, nuisance, tort, damage or interference and shall make good any damage so caused.

If the construction works and/or the O&M services cannot be carried out without interfering with the rights of the owner or occupier of any Adjoining Property, the Concessionaire shall promptly and at its own cost obtain all necessary third party consents and/or the approval of any Government Authority to undertake such construction works and/or the O&M services. ***[Executing Agency]*** shall provide all assistance to the Concessionaire for procuring such approvals.

* 1. **Access to *[Executing Agency]* Related Parties, *[Name of the State / National Level Agency, if any]* Related Parties and Government Authorities**

The Concessionaire shall ensure that ***[Executing Agency]*** Related Parties, the ***[Name of the State / National Level Agency, if any]***Related Parties and the relevant Government Authorities have access to the Site and the license granted to the Concessionaire over the Site shall always be subject to:

* + 1. the rights of ***[Executing Agency]***, ***[Executing Agency]***'s Representative, ***[Name of the State / National Level Agency, if any]***'s Representative, the Project Engineer, and other ***[Executing Agency]*** Related Parties and ***[Name of the State / National Level Agency, if any]*** Related Parties to enter upon and access the Site to inspect and monitor the progress of the Project, and for the exercise of their rights and the performance of their obligations under this Agreement, provided that ***[Executing Agency]*** and/or ***[Name of the State / National Level Agency, if any]*** shall ensure that the exercise of the inspection or monitoring rights do not impede or obstruct the construction and/or operation of the Facilities in any manner whatsoever; and
    2. the rights of the Government Authorities or other utility providers to enter upon and access the Site for laying or installing telegraph lines, electric lines or for any other public purpose.

If any physical damage is caused to the Site or the Facilities as a result of such access and use of the Site by ***[Executing Agency]***, the Project Engineer, ***[Executing Agency]*** Related Parties, the ***[Name of the State / National Level Agency, if any]*** Related Parties, Government Authorities then ***[Executing Agency]*** shall bear the costs of remedying such damage and restoring the Site and the Facilities.

**ARTICLE 5**

**PERFORMANCE SECURITIES, ESHS PERFORMANCE SECURITIES, O&M SECURITIES AND MOBILIZATION ADVANCE GUARANTEES**

* 1. **The Concessionaire [and/or Nominated STP/FSTP Sub-Contractor]20shall have submitted to *[Executing Agency]*, prior to the Appointed Date:**
     1. an unconditional and irrevocable bank guarantee for an amount equal to INR [ ] (Rupees [ ]), corresponding to

);

* + 1. an unconditional and irrevocable bank guarantee for an amount equal to INR [ ] (Rupees [ ]), corresponding to [1% (one per cent)] of the **ESHS **);

[Provided, if the experience of the Nominated STP/FSTP Sub-Contractor has been claimed for qualification in the Project, then both the Nominated STP/FSTP Sub-Contractor and the Concessionaire shall each submit 50% (fifty per cent) of the Performance Securities as mentioned in (a) above.]21

* 1. The Performance Security shall remain valid until 25 (twenty) months from the Effective Date or one month from the COD, whichever is later.
  2. The Performance Security or the amount retained by ***[Executing Agency]*** as cash security under Clause 5.10 shall be returned after the expiry of 30 (thirty) days from the COD, unless this Agreement is terminated earlier, in which case the Performance Security will be returned within 30 (thirty) days from the date of termination, subject to ***[Executing Agency]***'s right to receive any amounts from the Concessionaire under this Agreement.
  3. The ESHS Performance Security shall be valid until the Expiry Date or Termination of the Agreement, whichever is earlier. The ESHS Security shall have an initial validity period till COD, which must thereafter be renewed on a year-on-year basis, before the expiry of the 11th (eleventh) month of the relevant year, until the expiry of the O&M Period. If any of the ESHS Security is not renewed by the expiry of the 11th (eleventh) month of the relevant year, then ***[Executing Agency]*** shall be entitled to drawdown the total amount available under the ESHS Security and retain such amount as cash security until such time that the Concessionaire submits an extension or replacement of the ESHS Security.
  4. As conditions precedent to the COD, within 60 (sixty) days of the Construction Completion Date, or 30 (thirty) days before COD, whichever is earlier, the Concessionaire *[*and Nominated STP/FSTP Sub-Contractor]22an unconditional and irrevocable bank guarantee to ***[Executing Agency]*** for an amount equal to O&M Security, for an amount equal to INR [ ]] (Rupees [ ]), corresponding to 4% (four per cent) of the ***[Location]*** Facilities Bid Project Cost.[Provided, if the experience of the Nominated

20 To be deleted if not applicable. If applicable, the Concessionaire shall ensure that the Nominated STP Sub-Contractor submits performance security and ESHS performance security.

21To be deleted if not applicable

22To be deleted if not applicable

STP/FSTP Sub-Contractor has been claimed for qualification in the Project, then both the Nominated STP/FSTP Sub-Contractor and the Concessionaire shall each submit 50% (fifty per cent) of the O&M Securities as mentioned above.]23

* 1. The Concessionaire [and Nominated STP/FSTP Sub-Contractor]24shall furnish the O&M Security in the same format as provided for the Performance Security in the RFP, with necessary modifications. The Concessionaire [and/ or Nominated STP/FSTP Sub- Contractor]25shall maintain the O&M Securities in full force and effect until the expiry of the O&M Period. The O&M Securities shall have an initial validity period of 1 (one) year, which must be renewed on a year-on-year basis, before the expiry of the 11th (eleventh) month of the relevant year, until the Expiry Date or Termination of the Concession Agreement, whichever is earlier.
  2. The ESHS Performance Security shall secure the due performance of the Concessionaire's ESHS obligations during the Construction Period and the O&M Period, as set out in the approved ESHS Documents.
  3. The Performance Security shall secure the due performance of all the Concessionaire's obligations during the Construction Period and the O&M Security shall secure the due performance of all the Concessionaire's obligations during the O&M Period.
  4. The cost of procuring the Performance Security, the ESHS Performance Security and the O&M Security shall be borne solely by the Concessionaire.
  5. If the Performance Security is scheduled to expire before the COD, then the Concessionaire shall arrange for an extension of the Performance Security at least 30 (thirty) days prior to such expiration. If the Concessionaire fails to procure such extension or replacement, ***[Executing Agency]*** shall be entitled to drawdown the total amount available under the Performance Security and retain such amount as cash security until such time that the Concessionaire submits an extension or replacement of the Performance Security, that is scheduled to expire.
  6. If the ESHS Performance Security is scheduled to expire before the expiry of the O&M Period, the Concessionaire shall replace or arrange for an extension of the ESHS Performance Security at least 30(thirty) days prior to such expiration. If the Concessionaire fails to procure such extension or replacement, ***[Executing Agency]*** shall be entitled to drawdown the total amount available under the ESHS Performance Security and retain such amount as cash security until such time that the Concessionaire submits an extension or replacement of the ESHS Performance Security.
  7. If any O&M Security is not renewed by the expiry of the 11th (eleventh) month of the relevant year of the O&M Period, then ***[Executing Agency]*** shall be entitled to drawdown the total amount available under the O&M Security and retain such amount as cash security until such

23To be deleted if not applicable. If applicable, the Concessionaire shall ensure that the Nominated STPSub-Contractor submits O&M performance security.

24 To be deleted if not applicable. If applicable, the Concessionaire shall ensure that the Nominated STPSub-Contractor submits O&M performance security.

25 To be deleted if not applicable

time that the Concessionaire submits an extension or replacement of the O&M Security.

* 1. ***[Executing Agency]*** shall be entitled to utilize such retained amount in the same manner as it would utilise the Performance Security, the ESHS Performance Security or the O&M Security, as the case may be.
     1. Upon receipt of a renewed or replacement Performance Security or within 30 (thirty) days of the COD or expiry / termination of the Agreement, ***[Executing Agency]*** shall return the unutilized cash security amount for the Performance Security to the Concessionaire.
     2. Upon receipt of a renewed or replacement ESHS Performance Security or within 30 (thirty) days of the expiry / termination of the Term, ***[Executing Agency]*** shall return the unutilized cash security amount for the ESHS Performance Security to the Concessionaire.
     3. Upon receipt of a renewed or replacement O&M Security or within 30 (thirty) days of the expiry / termination of the O&M Term, ***[Executing Agency]*** shall return the unutilized cash security amount for the O&M Security to the Concessionaire.
     4. The interest earned on any retained amounts on cash security shall be the property of ***[Executing Agency]*** and ***[Executing Agency]*** shall not be required to account to the Concessionaire for any such interest.
  2. ***[Executing Agency]*** shall have the right to draw on the Performance Securities and claim up to the amount guaranteed upon the Concessionaire's failure to satisfy any Condition Precedent or honour any of its obligations, responsibilities or commitments during the Construction Period, or any amount due and payable by the Concessionaire to ***[Executing Agency]*** (including any Delay Liquidated Damages), in accordance with this Agreement.
  3. ***[Executing Agency]*** shall have the right to draw on the O&M Securities and claim up to the amount guaranteed upon the Concessionaire's failure to honour any of its obligations, responsibilities or commitments during the O&M Period, or any amount due and payable by the Concessionaire to ***[Executing Agency]*** (including any Availability Liquidated Damages, Performance Liquidated Damages, Termination Compensation and any amounts the Concessionaire is liable to pay under Clause 19.2), in accordance with this Agreement.
  4. Without prejudice to its right to draw on the Performance Securities or, as the case may be, the O&M Securities, ***[Executing Agency]*** shall have the right to draw on the ESHS Performance Securities and claim up to the amount guaranteed upon the Concessionaire's failure to honour any of its ESHS related obligations, responsibilities or commitments during the Construction Period or the O&M Period, as set out in the approved ESHS Documents, in accordance with this Agreement.
  5. ***[Executing Agency]*** shall not be required to give any prior notice to the Concessionaire of its intention to make a demand under the Performance Securities, the ESHS Performance Securities or the O&M Securities, as the case may be. However, ***[Executing Agency]*** shall provide the Concessionaire with a copy of any demand notice issued by ***[Executing***

***Agency]***under the Performance Securities, the ESHS Performance Securities or the O&M Securities, simultaneously with the issuance of the demand notice to the Scheduled Bank that has issued the relevant Performance Security, ESHS Performance Security or the O&M Security.

* 1. If ***[Executing Agency]*** makes a demand under any Performance Security and/or ESHS Performance Security and/or O&M Security, in part or in full, the Concessionaire shall immediately and in no event later than 15 (fifteen) days of such demand, restore the value of such Performance Security, ESHS Performance Security or O&M Security to the amount stated in Clause 5.1 or Clause 5.5.
  2. Within 30 (thirty)days from the COD or the termination of this Agreement, whichever is earlier, the Performance Securities or, as the case may be, the amount retained by ***[Executing Agency]*** as cash security under Clause 5.10, shall be released to the Concessionaire after the expiry of 30 (thirty)days from the COD or termination of this Agreement, subject to ***[Executing Agency] *** COD or termination of this Agreement.
  3. Upon the expiry of the O&M Period or the termination of this Agreement, whichever is earlier, the O&M Securities, the ESHS Performance Securities or, as the case may be, the amount retained by ***[Executing Agency]*** as cash security under Clause 5.11 or Clause 5.12, shall be released to the Concessionaire after the expiry of 30 (thirty) days from the Expiry Date or termination of this Agreement, subject to ***[Executing Agency]***'s right to receive any amounts from the Concessionaire before or upon such expiry or termination of this Agreement.
  4. **Mobilization Advance Guarantee**
     1. Within 30 (thirty) days of the Effective Date, the Concessionaire shall submit to ***[Executing Agency]***: (i) an unconditional and irrevocable bank guarantee for an amount equal to 110% (one hundred and ten per cent) of the Mobilization Advance for the ***[Location] *** ***[Location]* Facilities**

); and the Mobilization Advance Guarantee shall secure the Mobilization Advance paid to the Concessionaire in accordance with Clause 9.3(d). The cost of procuring the Mobilization Advance Guarantees shall be borne solely by the Concessionaire.

* + 1. The Mobilization Advance Guarantee shall remain valid until the entire Mobilization Advance secured by such Mobilization Advance Guarantee has been adjusted against the Construction Payments. However, the Concessionaire may, at its discretion, progressively reduce the value of the relevant Mobilization Advance Guarantee by the amount of the Mobilization Advance adjusted against each of the 4 (four) instalments of the Construction Payments, in accordance with Clause 9.3(d). For this purpose, the Concessionaire shall be required to furnish a replacement Mobilization Advance Guarantee of the reduced amount within 15 (fifteen) days of receipt of a Payment Certificate from ***[Executing Agency]*** on successful completion of the relevant Payment Milestone. ***[Executing Agency]*** shall return the relevant existing Mobilization Advance

Guarantee upon receipt of a replacement Mobilization Advance Guarantee from the Concessionaire.

* + 1. If any Mobilization Advance Guarantee is scheduled to expire before the entire Mobilization Advance has been adjusted, then the Concessionaire shall arrange for an extension of the relevant Mobilization Advance Guarantee at least 30 (thirty) days prior to such expiration. If the Concessionaire fails to procure such extension or replacement, ***[Executing Agency]*** shall be entitled to drawdown the total amount available under such Mobilization Advance Guarantee and retain such amount as cash security until such time that the Concessionaire submits an extension or replacement of the Mobilization Advance Guarantee.
    2. ***[Executing Agency]*** shall be entitled to utilize such retained amount in the same manner as it would utilize the Mobilization Advance Guarantee. Upon receipt of an extension or replacement Mobilization Advance Guarantee or on adjustment of the entire Mobilization Advance, ***[Executing Agency]*** shall return the unutilized cash security amount to the Concessionaire.

The interest earned on any retained amounts or cash security shall be the property of ***[Executing Agency]*** and ***[Executing Agency]*** shall not be required to account to the Concessionaire for any such interest.

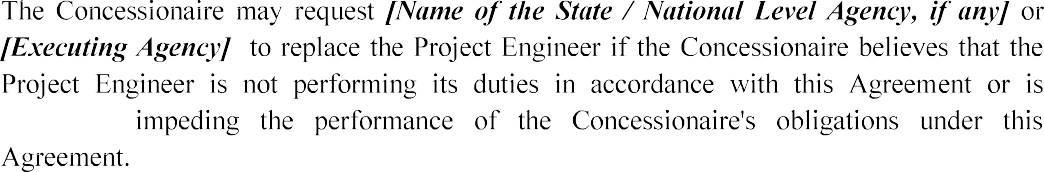
* + 1. ***[Executing Agency]*** shall have the right to draw on the Mobilization Advance Guarantees in the event of the inadequate adjustment of the Mobilization Advance in accordance with Clause 9.3(d), prior to the Construction Completion Date.
    2. ***[Executing Agency]*** shall not be required to give any prior notice to the Concessionaire of its intention to make a demand under any Mobilization Advance Guarantee. However, ***[Executing Agency]*** shall provide the Concessionaire with a copy of any demand notice issued by ***[Executing Agency]*** under a Mobilization Advance Guarantee, simultaneously with the issuance of the demand notice to the Scheduled Bank that has issued the Mobilization Advance Guarantee.
  1. **Additional Performance Security**
     1. In the event of the Selected Bidder having submitted Additional Performance Security in accordance with the RFP document, then such Additional Performance Security shall be in force till the end of Construction period if the Bid Project Cost is found to be unreasonable, and till the end of the Concession Period if O&M Charges are found to be unreasonable. Notwithstanding anything contained herein, the Additional Performance Security shall be liable to be forfeited either fully or partially by ***[Executing Agency]*** as it deems fit for the reasons mentioned in Clause 16.1 of the Concession agreement. The Additional Performance Security for the unreasonable Bid Project Cost shall be returned 30 (thirty) days after COD and the Additional Performance Security for O&M Charges shall be returned at the end of Concession Period.
     2. Change in Ownership in accordance with Clause 12 of the Concession Agreement shall be subject to the fulfillment of the requirements of Additional Performance Security as per the Clause 5.22(a) above, by the incoming Consortium Partner/Single Entity.
  2. [If the Nominated STP/FSTP Sub-Contractor, nominated under the Sub-contractor Undertaking, ceases to be associated with the Concessionaire before the completion of 2 (two) years from the COD, then, with prior approval of ***[Executing Agency]*** and/ or ***[Name of the State / National Level Agency, if any]***, the Concessionaire shall propose to substitute such entity with another sub-contractor who shall meet the qualification criteria set out in Clause 4.1(a)(B), 4.1(a)(F)(ii) and 4.1(b)(ii) of the RFP. Also, the substituted sub-contractor shall submit the Performance Securities and/or O&M Securities as per Clause 5.1 and 5.5 of this Concession Agreement.]26
  3. [The Concessionaire shall have submitted to ***[Executing Agency]***, prior to the Appointed Date, an unconditional and irrevocable bank guarantee to the ***[Executing Agency]***, issued by the Technology Provider, for an amount equal to INR [\_ ] (Rupees [ ]), corresponding to 5% (five per cent) of the Aggregate Bid Project Cost (the Technology Performance Security)]27

26 To be deleted if not applicable

27To be deleted if not applicable



* 1. ***[Name of the State / National Level Agency, if any]*** or the ***[Executing Agency]*** shall appoint a third-party engineering firm with requisite technical expertise, knowledge and experience in the design, engineering and construction of STP/FSTP as the engineer for the Project (the ). The Project Engineer shall assist ***[Executing Agency]*** in supervising the construction/renovation, operation and maintenance of the Facilities and shall support ***[Executing Agency]*** to monitor compliance with the KPIs during the O&M period. The detailed scope of work of the Project Engineer is set out in **Schedule 6**.
  2. All fees, costs, charges and expenses payable to the Project Engineer shall be borne by ***[Name of the State / National Level Agency, if any]*** or ***[Executing Agency]***.



**otherwise**

***[Name of the State / National Level Agency, if any]*** or ***[Executing Agency]***may replace the Project Engineer in any of the following circumstances:

* + 1. if it has reason to believe that the Project Engineer has not discharged its duties in accordance with this Article 6 and/or Schedule 6; or
    2. has received a formal complaint from the Concessionaire. In such a case ***[Name of the State / National Level Agency, if any]*** or ***[Executing Agency]*** will make necessary investigations and it is established that the Project Engineer has not discharged its duties in accordance with this Article 6 and/or Schedule 6; or
    3. if the Project Engineer submits its resignation.
  1. In appointing any replacement of the Project Engineer, ***[Name of the State / National Level Agency, if any]*** or ***[Executing Agency]*** shall comply with this Article 6 and Schedule 6.
  2. The Project Engineer shall be required to act independently, reasonably, fairly and expeditiously to ensure: (a) the timely completion of construction of the Facilities on or before the Scheduled Construction Completion Date and (b) compliance with the KPIs during the O&M Period.
  3. During the Construction Period, the Project Engineer shall inspect the Facilities at least once a month and prepare an inspection report, setting out the progress of the construction of the Facilities, defects or deficiencies, if any, and status of compliance with the Construction Plan, Technical Specifications and Designs and Drawings. The Project Engineer shall send the report to ***[Executing Agency]*** and the Concessionaire within 7 (seven) days of such inspection, pursuant to which, the Concessionaire shall be required to rectify the defects or deficiencies, if any, identified by the Project Engineer.
  4. During the O&M Period, the Project Engineer shall inspect the Facilities at least once a month and prepare an inspection report, setting out the defects or deficiencies, if any, and status of compliance with the KPIs (including specifically, the Influent Standards and the Discharge Standards). The Project Engineer shall send the report to ***[Executing Agency]*** and the Concessionaire within 7 (seven) days of such inspection, pursuant to which, the Concessionaire shall be required to rectify the defects or deficiencies, if any, identified by the Project Engineer. The Project Engineer shall also have the right to verify the results of the tests undertaken by the Concessionaire at any time during the O&M Period at the Inlet Point and the Outlet Point to determine the standard of the Sewage/Faecal Sludge/Septage, the STP By-Products, the FSTP By-Products, and the Treated Effluent.
  5. Except as specifically provided in this Agreement, the Project Engineer shall have no authority, whether express or implied, to amend, vary or curtail any of the rights or obligations of the Parties.
  6. The Project Engineer shall at all times during the Term have the right to enter upon and access the Site. The Concessionaire shall have the right to accompany the Project Engineer during its inspection of the Facilities.
  7. The Project Engineer shall, at all times, have the right to attend any meetings held by the Concessionaire to review the progress of the construction or O&M of the Facilities, and to provide its comments/suggestions regarding the progress as well as the manner in which the construction works, or O&M services is being undertaken. Neither any comments/suggestions provided by the Project Engineer nor any failure to provide comments/suggestions shall be deemed to be an acceptance of the construction works or the O&M services or a waiver of the Concessionaire's obligations to implement the Project, in accordance with this Agreement, the Technical Specifications, the Designs and Drawings, the ESHS Documents, and all Applicable Laws and Applicable Permits.
  8. The Concessionaire agrees that notwithstanding any review by the Project Engineer of any or all of the construction works or O&M services, the Concessionaire shall bear all risk, responsibility and liability for the quality, adequacy and suitability of the Facilities.



* 1. **Commencement and Duration**

The period for construction of the Facilities shall commence on and from the Effective Date and shall continue ).

Notwithstanding anything to the contrary in this Agreement, the Concessionaire shall, prior to the Effective Date, be entitled to commence:

* + 1. soil or geophysical investigation or testing at the Site; and
    2. appointment of Subcontractors for the construction works for the Facilities, with the prior approval of ***[Executing Agency]*.**
  1. **Designs and Drawings**
     1. Phase I Designs and Drawings
        1. *Basic Engineering Designs*
           1. The Concessionaire shall prepare the Basic Engineering Designs in accordance with the Technical Specifications, Applicable Laws and Applicable Permits. If the Concessionaire proposes to set up the Power Plant, the Concessionaire shall also submit the Basic Engineering Designs for the Power Plant. The Basic Engineering Designs shall be drawn to scale, with accurate dimensions, to minimize construction delays, disputes and cost overruns and to ensure smooth construction of the Facilities. The Facilities should be designed in a manner such that the Concessionaire can obtain consent to operate from the ***[State Pollution Control Board]*** for the operation of the Facilities. The Basic Engineering Designs should also specify the Proposed Technology for the ***[Location]*** STP(s) and ***[Location]*** FSTP(s).
           2. Within 30 (thirty) days from the Appointed Date, the Concessionaire shall submit 4 (four) hard copies and 1 (one) soft copy on a compact disc of the draft Basic Engineering Designs to ***[Executing Agency]*** for its review and approval.
           3. ***[Executing Agency]*** shall forward the Basic Engineering Designs to the Project Engineer and the Indian Institute of Technology (IIT)/ an institute with equivalent repute and credibility, for their review and comments.
           4. ***[Executing Agency]*** shall provide comments if any, on the draft Basic Engineering Designs (including any comments from IIT and the Project Engineer) to the Concessionaire or notify the Concessionaire of its approval of the draft Basic Engineering Designs within 20 (twenty) days from the date of receipt of the draft Basic Engineering Designs. ***[Executing Agency]*** may require the Concessionaire to amend or modify the draft Basic Engineering

Designs if ***[Executing Agency]***, IIT/other institute, or the Project Engineer identifies any deficiencies, inaccuracies or shortcomings in the draft Basic Engineering Designs. If the Concessionaire receives any comments, suggestions or instructions to modify the draft Basic Engineering Designs from ***[Executing Agency]***, then the Concessionaire shall modify the draft Basic Engineering Designs to correct any such shortcomings, inaccuracies or deficiencies and/or address, in writing, ***[Executing Agency]***'s/ IIT's (or other

Designs and submit the revised Basic Engineering Designs to ***[Executing Agency]*** for its approval within 10 (ten) days of receipt of comments. The process set out in this Clause 7.2(a)(i) shall continue until the Basic Engineering Designs are certified by IIT/ other institute and are approved by ***[Executing Agency]*** in accordance with this Clause 7.2(a)(i)(C) and Clause 7.2(a)(i)(D).For the avoidance of doubt, approval of Basic Engineering Designs by the ***[Executing Agency]***/ IIT (or other institute)/ the Project Engineer shall not relieve the Concessionaire of its obligations to prepare the Basic Engineering Design in accordance with Technical Specifications, Applicable Laws and Applicable Permits.

* + - 1. *Screening Report*
         1. The Concessionaire shall prepare the Screening Report in accordance with the ESMF and as per the format set out in Schedule 8.
         2. Within 30 (thirty) days from the Appointed Date, the Concessionaire shall submit 4 hard copies and 1 soft copy of the draft Screening Report on a compact disc to the Executing Agency for its review and approval.
         3. The ***[Executing Agency]*** shall forward the draft Screening Report to the Project Engineer for its review and comments.
         4. The ***[Executing Agency]*** shall provide comments if any, on the draft Screening Report (including any comments from the Project Engineer) to the Concessionaire or notify the Concessionaire of its approval of the draft Screening Report within 20 (twenty) days from the date of receipt of the draft Screening Report. The ***[Executing Agency]*** may require the Concessionaire to amend or modify the draft Screening Report if the ***[Executing Agency]*** identifies any deficiencies, inaccuracies or shortcomings in the draft Screening Report. If the Concessionaire receives any comments, suggestions or instructions to modify the draft Screening Report from the ***[Executing Agency]***, then the Concessionaire shall modify the draft Screening Report to correct any such shortcomings, inaccuracies or deficiencies and/or address, in writing, the ***[Executing Agency]***'s /Bank's comments on the draft Screening Report and submit the revised Screening Report to the ***[Executing Agency]*** for its approval within 10 (ten) days of receipt of comments. The process set out in this Clause 7.2(a)(ii)(D) shall continue until the Screening Report is approved by the ***[Executing Agency]*** in accordance with this Clause 7.2(a)(ii)(D).
      2. Within 30 (thirty) days from the approval of the Basic Engineering Designs, the

Concessionaire shall prepare the balance Phase I Designs and Drawings based on the approved Basic Engineering Designs and submit 4 (four) hard copies and 1 (one) soft copy on a compact disc of the balance Phase I Designs and Drawings to ***[Executing Agency]*** for its review and approval. The process set out in Clause 7.2(a)(i)(C) and Clause 7.2(a)(i)(D) will apply for approval of the balance Phase I Designs and Drawings.

* + 1. *Phase II Designs and Drawings*
       1. At least 2 (two) months prior to the commencement of work for the second Payment Milestone for the Facilities, the Concessionaire shall submit 4 (four) hard copies and 1 (one) soft copy on a compact disc of the Phase II Designs and Drawings for the works corresponding to the second Payment Milestone for the Facilities. The process set out in Clause 7.2(a)(i)(C) and Clause 7.2(a)(i)(D) will apply for approval of the Phase II Designs and Drawings for the works corresponding to the second Payment Milestone.
       2. The process set out in Clause 7.2(a)(iii) above shall apply to the submission and approval of the Phase II Designs and Drawings for the work corresponding to the second Payment Milestone, and thereafter, each subsequent Payment Milestone for the Facilities.
    2. The Concessionaire shall construct the Facilities strictly in accordance with the approved Designs and Drawings. If there are any errors or deficiencies in the Technical Specifications, the Designs and Drawings shall take into account, address or rectify such errors or deficiencies. The Concessionaire shall not deviate from or make any subsequent modification or amendment to the approved Designs and Drawings without the prior written approval of ***[Executing Agency]***. The Concessionaire shall not commence construction of any part of the Facilities prior to approval of the Designs and Drawings in accordance with this Clause 7.2. If the Concessionaire undertakes any construction work for the Facilities prior to the approval of the Designs and Drawings, it shall do so at its own risk and ***[Executing Agency]*** shall have the right to reject any such construction work that does not comply with the approved Designs and Drawings.
    3. Notwithstanding any approval of the Designs and Drawings by ***[Executing Agency]***, the Concessionaire shall bear all risk, responsibility and liability for the suitability, accuracy, adequacy and practicality of the Designs and Drawings. Subject to Clause 3.5 and Clause 7.11(b), the Concessionaire shall not be entitled to any extension of time and/or costs incurred in the preparation of the Designs and Drawings and complying with the requirements of this Clause 7.2.
  1. **Construction Plan**
     1. Within 30 (thirty) days from the Appointed Date, the Concessionaire shall prepare and submit to ***[Executing Agency]*** a detailed Construction Plan. The Construction Plan shall set out:
        1. The detailed plan for completing the construction of the ***[Location]*** Facilities by

the Scheduled Construction Completion Date; specific activities and extent of construction work to be performed by the Concessionaire to achieve each of the 4 (four) ***[Location]*** Facilities Payment Milestones; and

* + - 1. the order in which the Concessionaire proposes to execute the construction of the Facilities.
    1. ***[Executing Agency]*** shall review and provide comments, if any, on the draft Construction Plan to the Concessionaire or notify the Concessionaire of its approval of the draft Construction Plan within 30 (thirty) days from the date of receipt of the draft Construction Plan from the Concessionaire. ***[Executing Agency]*** may require the Concessionaire to amend or modify the draft Construction Plan if ***[Executing Agency]*** identifies any deficiencies or shortcomings in the draft Construction Plan. If the Concessionaire receives any comments, suggestions or instructions to modify the draft Construction Plan from ***[Executing Agency]*,** then the Concessionaire shall incorporate the suggestions made by ***[Executing Agency]*** and modify the draft Construction Plan to address any such comments, shortcomings or deficiencies identified by ***[Executing Agency]***. Thereafter, the Concessionaire shall submit the revised Construction Plan to ***[Executing Agency]*** for its approval. The process set out in this Clause 7.3(b) shall continue until the Construction Plan is approved by ***[Executing Agency]*** in accordance with this Clause 7.3(b).
    2. The Concessionaire shall construct the Facilities strictly in accordance with the approved Construction Plan. The Concessionaire shall not deviate from or make any subsequent modification or amendment to the approved Construction Plan without the prior written approval of ***[Executing Agency]*.** The Concessionaire shall not commence construction of any part of the Facilities prior to approval of the Construction Plan in accordance with this Clause 7.3.
    3. Notwithstanding any approval of the Construction Plan by ***[Executing Agency]***, the Concessionaire shall, subject to Clause 7.11(b), be solely liable for completing the construction of the Facilities by the Scheduled Construction Completion Date.
    4. The Concessionaire shall submit a consolidated Construction Plan for the ***[Location]***

Facilities.

* 1. **ESHS Documents**
     1. Within 45 (forty five) days from the Appointed Date, the Concessionaire shall prepare and submit 4 (four) hard copies and 1 (one) soft copy on a compact disc of the ESHS Documentsto ***[Executing Agency]***.
     2. The ESHS Documents shall set out the Facilities Specific health, safety and environment policies, guidelines and procedures to be followed by the Concessionaire in undertaking the Project, developed in accordance with the ESMF, this Agreement (including, specifically, Schedule 9), Applicable Laws, Applicable Permits, and Good Industry Practices.
     3. The ESHS Documents shall comprise the following:
        1. Safeguard Documents

As part of the Safeguard Documents, the Concessionaire shall be required to:

* + - * 1. submit an update of the environment and social impact assessment report (the ), which has been prepared by ***[Executing Agency]*** and shall be provided to the Concessionaire along with the RFP; and
        2. prepare the environmental management plan (the 

Or

* + - * 1. in case of unavailability of such existing document, create ESIA and prepare the EMP
      1. Safety Documents

As part of the Security Documents, the Concessionaire shall be required to prepare the following:

* + - * 1. environment, social, health and safety management plan (the );
        2. environmental, social, health and safety management strategies and implementation plan (the **-** ) The ESHS-MSIP shall be prepared on the basis of the requirements set out in Schedule 9. The ESHS- MSIP shall include the following, for the purposes of managing the key ESHS risks in relation to the Project:

traffic management plan to ensure safety of local communities from construction traffic;

water resource protection plan to prevent contamination of drinking water;

boundary marking and protection strategy for mobilization and construction to prevent offsite adverse impacts; and

strategy for obtaining Concessionaire Applicable Permits prior to the start of relevant works [such as opening a quarry or borrow pit].

* + - 1. Code of Conduct

The Code of Conduct shall be prepared on the basis of the requirements set out in Schedule 9. The Code of Conduct shall apply to the Concessionaire's employees and subcontractors and shall set out the ESHS obligations of the Concessionaire under the Agreement relating to risks associated with labor influx, spread of communicable diseases, sexual harassment, gender-based violence, illicit behaviour and crime, and maintaining a safe environment etc. The Code of Conduct shall also set out the manner in which the Code of Conduct will be implemented, including how it will be introduced into conditions of employment/engagement, what training will be provided, how it will be monitored and how the Concessionaire proposes to deal with any breaches.

* + - 1. In the ESHS, the Concessionaire shall also be required to provide details of the core team of 3 people for implementation of the Concessionaire's ESHS obligations, comprising: (A) health expert and safety specialist; (B) an environmental specialist; and (C) social specialist, who meet the minimum qualification requirements specified in Schedule 9.
      2. Within 30 (thirty) days from the appointed date, the Concessionaire shall prepare and submit 4 (four) hard copies and 1 (one) soft copy of Labour Influx and Workers Camp Management Plan to ***[Executing Agency]*** that addresses specific activities that will be undertaken to minimize the impact on the local community, including elements such as worker codes of conduct, training programs on
         1. mandatory and repeated training and awareness raising for the workforce about refraining from unacceptable conduct toward local community members, specifically women;
         2. informing workers about national laws that make sexual harassment and gender-based violence a punishable offence which is prosecuted;
         3. introducing a Worker Code of Conduct as part of the employment contract, and including sanctions for non-compliance (e.g., termination), manual scavenging, engagement with local residents, child labor, nondiscrimination, harassment of coworkers including women and those belonging to SC and STs and other minority social groups,
         4. contractors adopting a policy to cooperate with law enforcement agencies in investigating complaints about gender-based violence.
         5. training programs on HIV/AIDS and other communicable diseases, (F)



***[Executing Agency]*** is unable to cater to the demand for affordable housing for this additional workforce in terms of rentals, hostels, apartments etc. ; and

(G) compliant handling Mechanism at the project level

* + 1. ***[Executing Agency]*** shall forward a copy of the draft ESHS Documents to the Project Engineer and ***[Name of the State / National Level Agency, if any]*** for its review and comments.
    2. ***[Executing Agency]*** shall provide comments, if any, on the draft ESHS Documents (including any comments from the Project Engineer and ***[Name of the State / National Level Agency, if any]***)28 to the Concessionaire or notify the Concessionaire of its approval of the draft ESHS Documents within 30 (thirty) days from the date of receipt of the draft ESHS Documents from the Concessionaire. ***[Executing Agency]*** may require the Concessionaire to amend or modify the draft ESHS Documents if

28To be deleted wherever it is not applicable.

***[Executing Agency]*** or the Project Engineer or ***[Name of the State / National Level Agency, if any]*** identifies any deficiencies or shortcomings in the draft ESHS Documents. If the Concessionaire receives any comments, suggestions or instructions to modify the draft ESHS Documents from ***[Executing Agency]***, then the Concessionaire shall modify the draft ESHS Documents to address any such comments, shortcomings or deficiencies identified by ***[Executing Agency]***. Thereafter, the Concessionaire shall submit the revised ESHS Documents to ***[Executing Agency]*** for its approval. The process set out in this Clause 7.4(e) shall continue until the ESHS Documents are approved by ***[Executing Agency]*** in accordance with this Clause 7.4(e).

* + 1. The Concessionaire shall ensure that its Subcontractors comply with and conform in all aspects of the ESHS Documents, approved in accordance with this Clause 7.4, in executing the Project. Any failure of the Concessionaire or the Subcontractors to comply with the ESHS Documents shall constitute a Concessionaire Event of Default. The Concessionaire shall indemnify ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** against all costs, expenses, penalties and liabilities incurred/suffered by ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** due to the Concessionaire's or any Subcontractor's failure to comply with the ESHS Documents in the course of execution of the Project. The Concessionaire shall not deviate from or make any subsequent modification or amendment to the approved ESHS Documents without the prior written approval of ***[Executing Agency]*.**
    2. Neither any approval of the ESHS Documents by ***[Executing Agency]***, nor any failure to review and provide comments on the ESHS Documents shall excuse any failure by the Concessionaire to adopt proper and recognized safety and environment friendly practices during the execution of the Project. The Concessionaire shall bear all risk, responsibility and liability for the accuracy and adequacy of the final ESHS Documents in ensuring compliance with the ESMF, this Agreement (including specifically, Schedule 9), Applicable Laws, Applicable Permits and Good Industry Practices in the execution of the Project. The Concessionaire shall not be entitled to any extension of time and/or costs incurred in preparation of the ESHS Documents and complying with the requirements of this Clause 7.4.
  1. **Subcontracting**
     1. The Concessionaire may enter into Subcontracts to perform any part of its Scope of Work during the Construction Period, with the prior intimation to the ***[Executing Agency]***.
     2. The Concessionaire shall provide a copy of each proposed Subcontract, along with details of the relevant Subcontractor, for the record to the ***[Executing Agency]***, which should set out the precise Scope of Work to be Sub-contracted to such Subcontractor and should be consistent with the terms of this Agreement.
     3. The Concessionaire shall be responsible for the supervision and monitoring of the performance of any work or services by the Subcontractor.
     4. If the Concessionaire proposes to novate or replace a Subcontract after submission of details as required under sub-clause (b) above, then such novation or replacement shall also be intimated to the ***[Executing Agency]***.
     5. The Concessionaire shall be and remain liable under this Agreement for all work and services subcontracted under this Agreement and for all acts, omissions or defaults of any Subcontractor. No default under any Subcontract shall excuse the Concessionaire from its obligations or liabilities under this Agreement. All references in this Agreement to any act, default, omission, breach or negligence of the Concessionaire shall be construed to include any such act, default, omission, breach or negligence of the Subcontractors.
     6. The Project Engineer and Authority have the right to access of information and audit the Subcontractor files with regards to the Concession Agreement.
  2. **Concessionaire's Construction Obligations**

The Concessionaire shall design, finance, construct and complete the Facilities and achieve the COD in accordance with Applicable Laws, Applicable Permits, Good Industry Practice, the Technical Specifications, the ESHS Documents, the Designs and Drawings, the Construction Plan and other provisions of this Agreement.

For this purpose, during the Construction Period, the Concessionaire shall:

* + 1. complete the work corresponding to each Payment Milestone by the Scheduled Payment Milestone Completion Date and complete the construction of the relevant Facilities by the relevant Scheduled Construction Completion Date, in a manner that:
       1. is in compliance with the Technical Specifications, the Designs and Drawings, the Construction Plan, the ESHS Documents, Applicable Laws, Applicable Permits and Good Industry Practices. For the avoidance of doubt, if there arises any ambiguity or conflict between the Technical Specifications and any Applicable Laws, then the one setting out the more stringent requirements or specifications shall prevail;
       2. the Facilities are fabricated, erected, installed and completed in accordance with the final Designs and Drawings;
       3. the Facilities are free from all defects in design, materials, and workmanship;
       4. the Facilities are safe, reliable and fit for purpose;
       5. the ***[Location]*** FSTP(s) shall be capable of treating Faecal Sludge/Septage up to their respective Design Capacity; and
       6. the***[Location]*** STP(s) shall be capable of treating Sewage up to their respective Design Capacity.
    2. maintain and comply with the conditions of all Applicable Permits in undertaking theconstruction of the Facilities;
    3. within 30 (thirty) days of the Effective Date, and in any event, prior to the commencement of any construction of the Facilities, appoint a Person with sufficient skill and expertise to act as the Concessionaire's Representative. The Concessionaire's Representative shall monitor, coordinate and supervise the completion of the Facilities, and liaise with ***[Executing Agency]***'s Representative, ***[Name of the State / National Level Agency, if any]***'s Representative and the Project Engineer during the Construction Period and the O&M Period. At any time during the Term, the Concessionaire may replace the Concessionaire's Representative with prior written notice to ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]***;
    4. provide all necessary assistance to the Project Engineer, ***[Name of the State / National Level Agency, if any]***, and ***[Executing Agency]*** in undertaking inspection of the Facilities, and in performing its other obligations and duties under this Agreement;
    5. ensure that none of its employees, consultants, service providers, suppliers, or sub- contractors, who may be engaged in future, shall be engaged in corrupt, fraudulent, collusive, coercive or obstructive practice, as defined in Clause 23.18;
    6. reasonably consider and act upon the comments/suggestions made by the Project Engineer and ***[Executing Agency]*** during any meetings with the Concessionaire;
    7. rectify any defects and/or deficiencies in the Facilities, including any defects and/or deficiencies identified by the Project Engineer or ***[Executing Agency]***;
    8. take all necessary measures to maintain the safety and security of personnel, material and property at the Site and the Adjoining Properties, in accordance with the approved ESHS Documents and all Applicable Laws;
    9. ensure that all excavated materials, earthworks, waste materials and hazardous substances are stored and/or disposed in accordance with the ESHS Documents, Applicable Laws and Applicable Permits;
    10. submit monthly reports to the Project Engineer (with a copy to ***[Executing Agency]***), no later than 10 (ten) days after the end of each month, which should set out the following:
        1. extent of progress of construction activities performed by the Concessionaire for the Facilities;
        2. comparison of actual progress against the planned progress of construction works, reasons for delay, if any and steps taken by the Concessionaire to mitigate the delay;
        3. details of any accident or hazardous incident at the Site and the steps taken by the Concessionaire to mitigate the consequences of such accident or hazardous

incident; and

* + - 1. status of rectification of defects and/or deficiencies discovered by the Project Engineer or ***[Executing Agency]***;
    1. ensure that an adequate number of suitably skilled and experienced contractors, architects, workmen and other personnel are engaged to undertake the Project. The Concessionaire shall be solely responsible for the work performed by any staff and labour engaged by it to execute the Project and for payment of all applicable labour charges, fees, cess payable under Applicable Laws (including labour welfare legislations) in connection with the skilled and unskilled manpower employed for the

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necessary amenities and welfare facilities for the staff and labour engaged by them at the Site and comply with all applicable labour laws. The Concessionaire shall indemnify and hold harmless ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** from and against all claims, liabilities, expenses, costs and losses suffered or incurred by ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** due to the Concessionaire's or any Subcontractor's failure to comply with any Applicable Laws (including labour welfare legislations);

* + 1. arrange for all equipment, machinery, tools and other resources required to undertake the Project and be solely responsible for such equipment, machinery, tools and resources;
    2. take all reasonable measures to ensure that the transportation of any of the Concessionaire's or the Subcontractors' personnel or equipment, to or from the Site, does not interfere with local traffic in the vicinity of the Site;
    3. maintain accurate and systematic accounts and records of goods and material utilized and other costs and expenses incurred in connection with the construction works for the Facilities, including all invoices, receipts, *challans*, vouchers, quotations and other records and documents with respect to the Facilities in accordance with Applicable Laws;
    4. obtain and maintain adequate insurances as per this Agreement; and
    5. prepare and keep up-to-date, "as-built" records of the execution of the construction work for the Facilities, showing the exact as-built locations, sizes and details of the works executed. The "as-built" records shall be kept on the Site and be made available to the Project Engineer and ***[Executing Agency]*** for review and verification. The Concessionaire shall provide 4 (four) hard copies and 1 (one) soft copy on a compact disc, of the complete set of "as-built" drawings for the Facilities to ***[Executing Agency]*** as a condition precedent to the issuance of the Construction Completion Certificate.
    6. The Concessionaire shall not be ordinarily entitled to additional land beyond the quoted land in the Financial Proposal for the Construction of the Project. However, under unavoidable circumstances and in the interest of the Project, ***[Executing Agency]*** based

on availability, may consider to allocate additional land for the construction of the Project upon the request of the Concessionaire and such allocation shall be subject to the payment of [150% (one hundred and fifty percent)] of the [circle rate] of the land, for each additional acres of land and part thereof. If the additional land requirement changes position of the Selected Bidder vis-à-vis the second preferred bidder, then the Concessionaire shall pay to ***[Executing Agency]***, a sum of equivalent to: (a) 150% (one hundred and fifty percent) of the [circle rate] of the landfor each additional acres of land and part there of; or (b) the difference between Bid Price of second preferred bidder and the revised Bid Price of the Selected Bidder/Concessionaire; whichever is higher.

* 1. **[Power Plant**
     1. The Concessionaire may construct a biogas power plantat the ***[Location]*** Facilities Sites to utilise the biogas generated from the treatment of the Sewage/Faecal Sludge/Septage at the ***[Location]*** STP(s) and the ***[Location]*** FSTP(s) to produce clean energy. The Concessionaire may also construct a rooftop solar power plant or employ any other technology at the ***[Location]*** Facilities to produce clean energy. The Concessionaire shall utilise the energy produced by the power plant to operate the relevant Facilities and sell any excess energy to third party consumers during the Term, in accordance with all Applicable Laws.
     2. [If the Concessionaire chooses to construct a power plant at the Site, the Concessionaire shall undertake such construction of power plant at the Site in accordance with all Applicable Laws and after obtaining all necessary approvals and consents to construct the power plant at the Site.]
     3. The Concessionaire shall not be entitled to any additional land, Construction Payments, or an extension of the Scheduled Construction Completion Date for construction of the power plant.
     4. The Concessionaire shall not be entitled to any additional O&M Payments for operating the power plant.
     5. In case the Concessionaire sets up a power plant***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** shall not be liable to the Concessionaire in any manner whatsoever if the quality or quantity of Sewage, Faecal Sludge/Septage delivered to the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) is not adequate or appropriate to produce sufficient energy to operate the power plant at the ***[Location]*** Facilities Sites.
     6. The ownership, rights and title to the power plant constructed by the Concessionaire shall vest with ***[Executing Agency]*** during the entire Term and thereafter.
     7. It  for purposes of setting up, operating and maintaining the power plant.]
  2. ***[Executing Agency]*'s Rights and Obligations**

During the Construction Period, ***[Executing Agency]*** shall:

* + 1. to the extent applicable, comply with all its obligations under Applicable Laws (including, specifically the ***[Act applicable in the State]*** Act) and ***[Executing Agency]*** Applicable Permits;
    2. make reasonable endeavors to assist the Concessionaire in obtaining the Applicable Permits from the relevant Government Authorities, provided that the Concessionaire has complied with all the requirements as per Applicable Laws for applying for such Applicable Permits;
    3. maintain the Supporting Infrastructure to enable the delivery of Sewage/Faecal Sludge/Septage at the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) and disposal of the Treated Effluent from the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) during the Trial Operations;
    4. within 30 (thirty) days of the Effective Date, and in any event, prior to the commencement of any construction for the Facilities, appoint a Person with sufficient skill and expertise to act as ***[Executing Agency]***'s Representative. ***[Executing Agency]***'s Representative shall liaise with the Concessionaire's Representative, ***[Name of the State***

***/ National Level Agency, if any]***'s Representative and the Project Engineer during the Construction Period and the O&M Period. At any time during the Term, ***[Executing Agency]*** may replace ***[Executing Agency]***'s Representative with prior written notice to the Concessionaire and ***[Name of the State / National Level Agency, if any]***;

* + 1. cause the Project Engineer to carry out timely inspection of the Facilities, and perform its other obligations and duties under this Agreement;
    2. upon progressive completion of construction works for the Facilities in accordance with the Technical Specifications, Designs and Drawings, Construction Plan and other provisions of this Agreement, as certified by the Project Engineer, issue the Milestone Completion Certificates and the Construction Completion Certificate to the Concessionaire; and
    3. ensure that the Concessionaire enjoys peaceful access to the Site and shall not assign, transfer, or otherwise dispose its rights, title, and interest in the Site or create any Encumbrance over any part of the Site, which may adversely impact the exercise of the Concessionaire's rights and duties under this Agreement.
  1. ***[Name of the State / National Level Agency, if any]*'s29 Rights and Obligations**

During the Construction Period, ***[Name of the State / National Level Agency, if any]*** shall:

* + 1. comply with all its obligations under the Applicable Laws;

29If not applicable the rights & obligations mentioned under this Clause has to be merged with the rights and obligations of the Executing Agency under Clause 7.8.

* + 1. make the Construction Payments, on satisfactory completion of the relevant Payment Milestone, in accordance with Clause 9.3;
    2. within 30 (thirty) days of the Effective Date, and in any event, prior to the commencement of any construction for the Facilities, appoint a Person with sufficient skill and expertise to act as the ***[Name of the State / National Level Agency, if any]***'s Representative. ***[Name of the State / National Level Agency, if any]***'s Representative shall liaise with the Concessionaire's Representative, ***[Executing Agency]***'s Representative and the Project Engineer during the Construction Period and the O&M Period. At any time during the Term, ***[Name of the State / National Level Agency, if any]*** may replace the ***[Name of the State / National Level Agency, if any]*** Representative with prior written notice to ***[Executing Agency]*** and the Concessionaire; and
    3. ensure that the Escrow Account is funded with the Minimum Escrow Balance.
  1. **Utilities**
     1. The Concessionaire shall obtain install and maintain at its cost, all utilities necessary for undertaking the construction of the Facilities, including all temporary power and water connections, lighting facilities, telephone connections, internet connections, etc. at the Site. The Concessionaire shall bear the cost of all power, water, and other utilities consumed by it during the Construction Period, and the Concessionaire shall not be entitled to claim any reimbursement from ***[Executing Agency]*** or ***[Name of the State / National Level Agency, if any]*** in this regard.
     2. The Concessionaire shall not be entitled to any extension of time or costs to comply with its obligations in Clause 7.10(a) and Clause 7.10(b) above.
     3. ***[Executing Agency]*** shall provide any reasonable assistance required by the Concessionaire to obtain the utilities for the construction of the Facilities.
  2. **Construction Timelines**
     1. The Concessionaire shall comply with the Construction Plan, the Designs and Drawings and the Technical Specifications and complete the construction of the Facilities on or before the Scheduled Construction Completion Date.
     2. Subject to Clause 7.11(c) below, the Concessionaire shall be entitled to a day-for-day extension of the relevant Scheduled Payment Milestone Completion Date or as the case may be, the Scheduled Construction Completion Date, if the completion of construction of the Facilities is delayed due to any of the following reasons (each such event, a ):
        1. occurrence of a Force Majeure Event, provided that the requirements of Article 14 have been complied with;
        2. a Qualifying Change in Law;
        3. undue delay by the relevant Government Authority in granting or renewing any Applicable Permit, despite the Concessionaire having applied for such grant or renewal expeditiously and having complied with the requirements of Applicable Laws in making such application;
        4. undue delay by the relevant Government Authority in providing any utility connection, despite the Concessionaire having applied for such utility connection expeditiously and having complied with the requirements of Applicable Laws in making such application;
        5. any delay attributable to unforeseen site conditions in accordance with Clause 4.4;
        6. delay by ***[Executing Agency]*** in approval of the Phase II Designs and Drawings in accordance with Clause 7.2;
        7. delay by ***[Executing Agency]*** in approval of the O&M Manual in accordance with Clause 8.2;
        8. delay by ***[Executing Agency]*** in approval of the ESHS document in accordance with Article 7.4;
        9. delay by ***[Executing Agency]*** in issuance of a Milestone Completion Certificate in accordance with Clause 7.13(a);
        10. any variation proposed by ***[Executing Agency]*** in the Technical Specifications or the Designs and Drawings in accordance with Article 20; or
        11. delay caused in complying with any instructions of ***[Executing Agency]*** or the Project Engineer, which instructions are not attributable to any default of the Concessionaire.

The Concessionaire shall promptly provide ***[Executing Agency]*** (with a copy to the Project Engineer and ***[Name of the State / National Level Agency, if any]***) with a notice upon becoming aware of any Delay Event listed at Clause 7.11(b) above. The notice should specify the nature of the Delay Event, the extent of delay suffered or likely to be suffered by the Concessionaire and mitigation measures being taken by the Concessionaire.

The issuance of the notice under this Clause 7.11(b), within 7 days from the date the Concessionaire became aware of the Delay Event, shall be a condition precedent to the Concessionaire's entitlement to an extension under Clause 7.11(b).

* + 1. Without prejudice to the Concessionaire's obligations to notify ***[Executing Agency]*** regarding the occurrence of a Delay Event above, the Concessionaire shall: (i) keep and maintain records as reasonably necessary to substantiate and establish claims for extensions under Clause 7.11(b); and (ii) give ***[Executing Agency]*** and the Project

Engineer access to such records and documents or provide ***[Executing Agency]*** and the Project Engineer with copies, if so requested.

* + 1. If the Concessionaire claims an extension of time in accordance with Clause 7.11(b) and ***[Executing Agency]*** is of the opinion that such delay was caused or materially contributed to by any concurrent or interacting cause or causes of delay not listed in Clause 7.11(b) but solely attributable to the Concessionaire, then the Concessionaire shall not be entitled to any extension of time for the concurrent period of delay.
    2. If two or more of the Delay Events listed in Clause 7.11(b) occur concurrently, then such concurrent period shall not be counted twice in determining an extension under Clause 7.11(b).
    3. Except as provided in Clause 7.11(b), the Concessionaire shall not be entitled to any extension of time for any reason whatsoever, including due to:
       1. delay caused in complying with any instructions of ***[Executing Agency]*** or the Project Engineer which are attributable to any act or omission of the Concessionaire;
       2. failure of any Subcontractor to commence or carry out any work within the prescribed timelines;
       3. unavailability or shortage of equipment, materials, or any other resources;
       4. any delay in approving the drafts of the Designs and Drawings, the Construction Plan, the ESHS Documents or any other document submitted by the Concessionaire due to any deficiencies or shortcomings in such drafts of the Designs and Drawings, the Construction Plan, the ESHS Documents or other documents, as the case may be; or
       5. ***[Location]*** the construction of Power Plant at the Site
    4. Any Dispute between the Parties with respect to the occurrence, length of subsistence or consequence of any of the Delay Event shall be settled in a final and binding manner in accordance with Article 21.
  1. **Delay Liquidated Damages and Bonus**
     1. Subject to Clause 7.11(b), if the Concessionaire fails to complete the work corresponding to any Payment Milestone by the relevant Scheduled Payment Milestone Completion Date or fails to complete the construction of the Facilities by the Scheduled Construction Completion Date, then ***[Executing Agency]*** shall be entitled to liquidated damages for each day of delay beyond the Scheduled Payment Milestone Completion Date, or, as the case may be, the Scheduled Construction Completion Date, at the rate of 0.1% (zero point one per cent) of the ***[Location]*** Facilities Performance Security (in case of a delay in achieving a ***[Location]*** Facilities Payment Milestone or completing the ***[Location]*** Facilities by the Scheduled Construction Completion Date) for each day

of delay up to 6 (six) months from the Scheduled Payment Milestone Completion Date, or the Scheduled Construction Completion Date as the case may be (the  **Liqui **).

The Delay Liquidated Damages will be payable until the work for the relevant Payment Milestone is completed or, as the case may be, the construction of the Facilities is completed, as certified by ***[Executing Agency]*** in accordance with Clause 7.13.

If the Concessionaire completes the construction of the Facilities by the Scheduled Construction Completion Date, the aggregate Delay Liquidated Damages recovered by ***[Executing Agency]*** under this Clause 7.12(a) for a delay in achieving any Payment Milestone shall be refunded by ***[Executing Agency]*** to the Concessionaire, without any interest.

* + 1. ***[Executing Agency]*** shall be entitled to deduct the Delay Liquidated Damages from the amount payable to the Concessionaire for any Payment Milestone, and if such amounts are insufficient, ***[Executing Agency]*** shall have a right to invoke the Performance Securities to the extent of the Delay Liquidated Damages.
    2. The Parties acknowledge that the Delay Liquidated Damages are a genuine pre- estimation of and reasonable compensation for the loss that shall be suffered by ***[Executing Agency]*** as a result of the delay in the completion of the Facilities, and not as penalty.
    3. If, for any reason, the above paragraphs relating to the payment of Delay Liquidated Damages are void, invalid or otherwise inoperative so as to disentitle ***[Executing Agency]*** from claiming any Delay Liquidated Damages, then ***[Executing Agency]*** will be entitled to claim against the Concessionaire for general damages for delay in completing the works for the relevant Payment Milestone by the Scheduled Payment Milestone Completion Date, or for the delay in completing the construction of the Facilities by the Scheduled Construction Completion Date.
    4. If the Concessionaire fails to complete the works for a Payment Milestone within 6 (six) months of the Scheduled Payment Milestone Completion Date or if the Concessionaire fails to complete the construction of the Facilities within 6 (six) months from the Scheduled Construction Completion Date, other than on account of any Delay

), then such failure shall be deemed to be a Concessionaire Event of Default in accordance with Clause 16.1.

* + 1. The payment or deduction of Delay Liquidated Damages shall not relieve the Concessionaire from its obligations to complete the construction of the Facilities, or from any of its other duties, obligations or responsibilities under the Agreement. The Concessionaire shall use and continue to use its best endeavors to avoid or reduce further delay in completing the Facilities.
    2. Bonus on early completion

If the Construction Completion Date for a Facilities occurs prior to the Scheduled

Construction Completion Date, the Concessionaire shall be entitled to a bonus equal to 0.05% (zero point zero five per cent) of the relevant Performance Security for each day by which the Construction Completion Date precedes the Scheduled Construction Completion Date.

* 1. **Completion of Works**
     1. Completion of Payment Milestones
        1. Upon completion of the works corresponding to each Payment Milestone, as specified in the Construction Plan, the Concessionaire shall issue a notice to ***[Executing Agency]***, with a copy to the Project Engineer and ***[Name of the State***

***/ National Level Agency, if any]***, requiring ***[Executing Agency]*** to inspect (or cause the Project Engineer to inspect) the completed works covered by the relevant Payment Milestone. The purpose of such inspection shall be to determine whether the works corresponding to the relevant Payment Milestone have been completed in accordance with the requirements of Clause 7.6.

* + - 1. If ***[Executing Agency]*** is satisfied that the works for the relevant Payment Milestone have been completed in accordance with the requirements of Clause 7.6, then, subject to Clause 7.13(a)(v) below, ***[Executing Agency]*** shall issue a Milestone Completion Certificate to the Concessionaire for such completed Payment Milestone, with a copy to ***[Name of the State / National Level Agency, if any]***, within 7(seven) Business Days from the date of inspection of the works covered by such Payment Milestone.
      2. If ***[Executing Agency]*** is of the view that the works for the relevant Payment Milestone do not satisfy the requirements of Clause 7.6, then ***[Executing Agency]*** shall have the right to provide any comments, suggestions and/or instruct the Concessionaire to carry out necessary modifications, to ensure that the works comply with the requirements of Clause 7.6. Upon receipt of such comments, suggestions or instructions from ***[Executing Agency]***, the Concessionaire shall make necessary modifications to the works to remedy any defects or deficiencies and re-issue a notice to ***[Executing Agency]***. The Concessionaire shall bear all costs of remedying the defects and deficiencies in the works and shall not be entitled to any extension of time for remedying such defects or deficiencies. This process shall be repeated until ***[Executing Agency]*** is satisfied that the works for the relevant Payment Milestone have been completed in accordance with the requirements of Clause 7.6 and issues a Milestone Completion Certificate in accordance with this Clause 7.13(a).
      3. If ***[Executing Agency]*** fails to:
         1. inspect the completed portion of the works covered by the relevant Payment Milestone, within 7 (seven) Business Days from the date of receipt of a notice from the Concessionaire under Clause 7.13(a)(i) above;
         2. provide any comments or suggestions or notify the Concessionaire of any defects or deficiencies in the completed portion of the works covered by the

relevant Payment Milestone, within 7 (seven) Business Days from the date of inspection of such completed portion of the works; or

* + - * 1. issue the Milestone Completion Certificate, within 7 (seven) Business Days from the date of inspection of the completed portion of the works covered by the relevant Payment Milestone,

then, such delay shall be treated as a Delay Event, which will entitle the Concessionaire to a day for day extension in the Scheduled Payment Milestone Completion Date or the Scheduled Construction Completion Date, as the case may be, beyond the 7 (seven) Business Days period.

* + - 1. ***[Executing Agency]*** may exercise its rights to review and certify the completion of works for any Payment Milestone either itself or through the Project Engineer. If ***[Executing Agency]*** instructs the Project Engineer to undertake a review of the works, then the Concessionaire shall cooperate with the Project Engineer to facilitate such review and rectify any defects or deficiencies identified by the Project Engineer in the works. Provided that, in all instances, ***[Executing Agency]*** shall finally approve the works and issue the Milestone Completion Certificates.
    1. Testing and Commissioning of the Facilities
       1. Upon completion of construction of each Facilities, in accordance with the requirements set out in this Agreement, the Concessionaire shall issue a notice to ***[Executing Agency]***, with a copy to ***[Name of the State / National Level Agency, if any]***, requiring it to be present at the Site on the date specified in such notice to undertake a final inspection of the completed Facilities and conduct any tests required to ensure that the Facilities complies with the Technical Specifications, the Designs and Drawings, Applicable Laws and Applicable Permits.
       2. Within 5 days from the date of receipt of a notice under Clause 7.13(b)(i) above, ***[Executing Agency]*** may request the Concessionaire to vary the date of the final inspection and tests and the Concessionaire shall accommodate such request, provided that, such date shall be no later than 7 (seven) days from the date specified in the notice received from the Concessionaire under Clause 7.13(b)(i) above.
       3. The Concessionaire shall, on the date specified in the notice issued under Clause 7.13(b)(i) or on such other date as may be agreed with ***[Executing Agency]***, carry out the tests in accordance with the instructions and under the supervision of ***[Executing Agency]***, to demonstrate that the Facilities complies with the requirements of Clause 7.6.
       4. If ***[Executing Agency]*** is not satisfied with the results of the tests or inspection, then the Concessionaire shall remedy any defects or deficiencies in the Facilities, identified by ***[Executing Agency]*** or revealed through the tests and the Facilities shall be tested again upon rectification of such defects or deficiencies. This

process shall be repeated until such time that ***[Executing Agency]*** is satisfied that the Facilities has been completed in accordance with Clause 7.6 and is safe and fit for purpose. The Concessionaire shall bear all costs of remedying the defects and deficiencies and retesting the Facilities and shall not be entitled to any extension of time for remedying such defects or deficiencies or for retesting the Facilities.

* + - 1. If ***[Executing Agency]*** is satisfied with the results of the tests and inspection of the Facilities, ***[Executing Agency]*** shall issue the Milestone Completion Certificate in respect of the last Payment Milestone to the Concessionaire, with a copy to ***[Name of the State / National Level Agency, if any]***, within 7 (seven) days from the date of inspection and testing of the completed Facilities. The issue of the Milestone Completion Certificate for the last Payment Milestone shall certify that the Facilities has been completed in accordance with this Agreement, the Technical Specifications, the Designs and Drawings, Applicable Laws and Applicable Permits and the Facilities is safe and fit for purpose.
      2. If ***[Executing Agency]*** fails to:
         1. inspect or witness the testing of the Facilities within 14 (fourteen) Business Days from the date of receipt of notice from the Concessionaire issued under Clause 7.13(b)(i) or such other date as may be agreed with the Concessionaire;
         2. notify the Concessionaire of any defects or deficiencies in the Facilities within 7 (seven) Business Days from the date of inspection and testing of the Facilities; or
         3. issue the Milestone Completion Certificate for the last Payment Milestone within 7 (seven) Business Days from the date of inspection and testing of the Facilities,

then, such delay shall be treated as a Delay Event, which will entitle the Concessionaire to a day for day extension in the Scheduled Payment Milestone Completion Date and the Scheduled Construction Completion Date.

* + 1. Issue of Construction Completion Certificate
       1. Within 7 (seven) Business Days from the date of issuance of the Milestone Completion Certificate for the last Payment Milestone, ***[Executing Agency]*** shall issue the Construction Completion Certificate for the Facilities to the Concessionaire, with a copy to ***[Name of the State / National Level Agency, if any]***, subject to the following conditions having been fulfilled by the Concessionaire:
          1. the submission of 4 (four) hard copies and 1 (one) soft copy on a compact

Facilities;



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* + - * 1. the Concessionaire having obtained all Applicable Permits necessary for commencement of the O&M services (including specifically, the consent to operate from the ***[State Pollution Control Board]*** for the operation of the Facilities);
        2. the Concessionaire having obtained adequate insurance for the O&M Period in accordance with Clause 11.2;
        3. the Concessionaire having engaged sufficient number of adequately skilled O&M personnel to perform the services during the O&M Period; and
        4. the O&M Manual having been approved by ***[Executing Agency]***; and
        5. the Concessionaire having cleared the Site and removed all debris, hazardous materials, surplus construction materials, equipment, temporary works, work sheds, labour camps and all other temporary installations on the Site.
      1. If ***[Executing Agency]*** fails to issue the Construction Completion Certificate for the Facilities to the Concessionaire within 7 (seven) Business Days from the date of satisfaction of the conditions set out in Clause 7.13(c)(i)(A) to (F) above and fails to notify the Concessionaire of any reasons for the failure to issue the Construction Completion Certificate for the Facilities, then, the Construction Completion Certificate for the Facilities shall be deemed to have been issued to the Concessionaire upon the expiry of the 7 (seven) Business Days period.
      2. The date of the issuance or deemed issuance of the Construction Completion Certificate shall be the Construction Completion Date for the Facilities.
  1. **Trial Operations**
     1. Subject to Clause 7.14(c) below, within [1 (one)] day of the issuance or deemed issuance of the Construction Completion Certificate for the Facilities to the Concessionaire, the Concessionaire shall commence the Trial Operations of the Facilities in accordance with the Trial Operation Procedures to determine whether the Facilities meets the KPIs on a continuous basis and is fit and ready to be placed into commercial operations for treatment and disposal of Sewage/Faecal Sludge/Septage in accordance with this Agreement.
     2. ***[Executing Agency]*** shall ensure that adequate quantity of Sewage/Faecal Sludge/Septage is delivered to the Facilities during the Trial Operations to enable the Concessionaire to demonstrate that the Facilities meets the Technical Specifications and the KPIs.
     3. If the Concessionaire fails to commence or continue the Trial Operations, due to the inadequate quantity or inferior quality of the Sewage/Faecal Sludge/Septage delivered to the relevant Facilities, then the Concessionaire shall promptly notify ***[Executing Agency]***. If in the opinion of ***[Executing Agency]***, the quantity or quality of

Sewage/Faecal Sludge/Septage is not adequate to undertake Trial Operations, then ***[Executing Agency]*** shall extend the time period for the Trial Operations. In such case, the Scheduled COD will also be extended on a day-for-day basis, provided that the Scheduled COD shall not be extended beyond the date which is 6 (six) months from the Construction Completion Date.

* + 1. During the Trial Operations, ***[Executing Agency]*** shall or shall cause the Project Engineer to monitor the performance of the Facilities on a regular basis and shall have the right to test the compliance of the incoming Sewage/Faecal Sludge/Septage with the Influent Standards and test the compliance of the STP By-Products, FSTP By-Products and the Treated Effluent with the Discharge Standards every 7 (seven) days to ensure that the Facilities meets the Technical Specifications.
    2. If ***[Executing Agency]***, or, as the case may be, the Project Engineer is of the view that:
       1. the Trial Operations are not being conducted in accordance with the Trial Operations Procedure; or (ii) there are any defects or deficiencies in the Facilities, ***[Executing Agency]*** shall instruct the Concessionaire to follow the Trial Operation Procedures and/or rectify the defects and deficiencies to ensure compliance with the KPIs.

It is clarified that no Availability Liquidated Damages or Performance Liquidated Damages are payable by the Concessionaire during the Trial Operations period for a failure to achieve the KPIs. However, for the Trial Operations to be successfully concluded, the Concessionaire must demonstrate that the Facilities consistently and continuously meets the KPIs during the last 20 (twenty) days of the 3 (three) months Trial Operations period, as may be extended in accordance with Clause 7.14(c) above. If the Facilities fails to achieve the KPIs on a continuous basis during the last 20 (twenty) days of the initial 3 (three) months Trial Operations period (as extended in accordance with Clause 7.14(c), then the Trial Operations period shall be extended by another 20 days. Subject to Clause 7.14(e)(i), the Trial Operations shall continue until the Concessionaire can demonstrate that the Facilities consistently achieves the KPIs for 20 (twenty) consecutive days.

* + 1. If the Concessionaire has been able to consistently achieve the KPIs for 20 (twenty) consecutive days (as supported by daily reports), the Concessionaire shall issue a notice to ***[Executing Agency]*** requiring ***[Executing Agency]*** to undertake a final inspection of the Facilities. ***[Executing Agency]*** shall have the right to undertake such final inspection within 5 (five) Business Days of a notice being issued by the Concessionaire.
    2. If, upon final inspection, ***[Executing Agency]*** is satisfied that the Facilities meets the KPIs and the Technical Specifications, and are capable of safe and reliable operations, then, ***[Executing Agency]*** shall issue the Trial Operations Completion Certificate for the Facilities to the Concessionaire within 7 (seven) days of ***[Executing Agency]*** undertaking a final inspection of the Facilities pursuant to Clause 7.14(e) above.
    3. If, upon final inspection, ***[Executing Agency]*** believes that the Facilities does not comply with the KPIs and/or Technical Specifications, other than due to: (i) volume of Sewage/Faecal Sludge/Septage being inadequate to conduct the Trial Operations; or (ii) the quality or characteristics of the Sewage/Faecal Sludge/Septage being beyond the

Influent Standards, then ***[Executing Agency]*** shall reject the Facilities and terminate this Agreement. Upon termination of this Agreement, in accordance with this Clause 7.14(g), the consequences set out in Article 16 shall follow.

* + 1. If ***[Executing Agency]***: (i) does not undertake a final inspection of the Facilities within 5 (five) Business Days of receipt of a notice from the Concessionaire under Clause 7.14(e); or (ii) fails to notify the Concessionaire of any defects in the Facilities within 7 (seven) days of undertaking a final inspection; or (iii) fails to issue a Trial Operations Completion Certificate within 7 (seven) Business Days from the date of the final inspection, then the Trial Operations shall be deemed to have been successfully completed for Facilities and the Trial Operations Completion Certificate will be deemed to have been issued to the Concessionaire upon the expiry of the 5 (five) Business Days period (in case of (i)) and upon the expiry of the 7 (seven) Business Days period (in case of (ii) and (iii)).
    2. If the Trial Operations are not successfully completed and/or the Concessionaire fails to issue a notice to ***[Executing Agency]*** under Clause 7.14(e) above on or prior to the Scheduled COD, as may be extended in accordance with Clause 7.14(c), for any Facilities, then such failure shall be treated as a Concessionaire Event of Default and the consequences set out at Article 16 shall follow.
    3. Notwithstanding anything contained in Clause 7.14(h), if the Concessionaire fails to successfully complete the Trial Operations for the Facilities on or prior to the Scheduled COD, as may be extended in accordance with Clause 7.14(c), due to the: (i) volume of Sewage/Faecal Sludge/Septage being inadequate to conduct the Trial Operations; or (ii) quality or characteristics of the Sewage/Faecal Sludge/Septage being beyond the Influent Standards, for any Facilities, then such failure will be treated as a ***[Executing Agency]*** Event of Default, and the consequences set out at Article 16 shall follow.
    4. The Concessionaire will not be entitled to any O&M Payments or any other payment for conducting the Trial Operations, which shall be carried out solely at the cost and risk of the Concessionaire.
  1. **Commercial Operations Date**
     1. Within 7 (seven) Business Days from the date of issuance or deemed issuance of the Trial Operations Completion Certificates for the ***[Location]*** Facilities, ***[Executing Agency]*** shall issue the COD Certificate, with a copy to ***[Name of the State / National Level Agency, if any]***, subject to the following conditions having been fulfilled by the Concessionaire:
        1. the Concessionaire having received the Construction Completion Certificate
        2. the Concessionaire having submitted to ***[Executing Agency]*** the Scheduled Maintenance Programme for the first-year post COD; and
        3. the O&M Manual having been approved by ***[Executing Agency]***
        4. the Concessionaire having submitted the ***[Location]*** Facilities O&M Security to

***[Executing Agency]***.

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* + 1. If ***[Executing Agency]*** fails to issue the COD Certificate to the Concessionaire within 7 (seven) Business Days from the date of satisfaction of the conditions set out in Clause

7.15 (a) above and fails to notify the Concessionaire of any reasons for the failure to issue the COD Certificate, then, the COD Certificate shall be deemed to have been issued to the Concessionaire upon the expiry of the 7 (seven) Business Days period.

* + 1. The date on which the COD Certificate is issued or deemed to have been issued to the Concessionaire shall be the Commercial Operations Date of the Facilities.



* 1. **Commencement and Duration**

The period for the operation and maintenance of the Facilities shall commence on and from COD and shall continue until the Expiry Date (the ), unless the Agreement is terminated earlier in accordance with Article 16.

* 1. **O&M Manual**
     1. The Concessionaire shall prepare a detailed O&M Manual for the Facilities based on the Proposed Technology and in accordance with the Technical Specifications, the ESHS Documents, Applicable Laws and Applicable Permits. The O&M Manual shall specify the operation procedures (separately for each component of the Facilities) and maintenance procedures. In case of any errors or deficiencies in the Technical Specifications, the O&M Manual shall take in account, address or rectify such errors or deficiencies. The Language of the O&M Manual shall be English.
     2. At least 30 (thirty) days prior to the Scheduled Construction Completion Date, the Concessionaire shall submit 4 (four) hard copies and 1 (one) soft copy on a compact disc of the draft O&M Manual to ***[Executing Agency]*** for its review and approval.
     3. ***[Executing Agency]*** shall review and provide comments, if any, on the draft O&M Manual to the Concessionaire or notify the Concessionaire of its approval of the draft O&M Manual within 20 (twenty) days from the date of receipt of the draft O&M Manual from the Concessionaire. ***[Executing Agency]*** may require the Concessionaire to amend or modify the draft O&M Manual if ***[Executing Agency]*** identifies any deficiencies, inaccuracies or shortcomings in the draft O&M Manual. If the Concessionaire receives any comments, suggestions or instructions to modify the draft O&M Manual from ***[Executing Agency]***, then the Concessionaire shall modify the draft O&M Manual to correct any shortcomings, inaccuracies or deficiencies identified by ***[Executing Agency]*** and/or address, in writing, ***[Executing Agency]***'s comments on the draft O&M Manual and submit the revised O&M Manual to ***[Executing Agency]*** within 10 days of having received ***[Executing Agency]***



process set out in this Clause 8.2(c) shall continue until the O&M Manual is approved by ***[Executing Agency]*** in accordance with this Clause 8.2(c).

* + 1. The Concessionaire shall revise the O&M Manual as and when the Concessionaire thinks it necessary to do so and in such case the provisions of Clause 8.2(c) will apply as is to the approval of the revised manual.
    2. The Concessionaire shall undertake the O&M of the Facilities strictly in accordance with the approved O&M Manual. The Concessionaire shall not deviate from or make any amendment to the approved O&M Manual without the prior written approval of ***[Executing Agency]***. The Concessionaire shall not commence operation of the Facilities prior to approval of the O&M Manual in accordance with this Clause 8.2.
    3. Notwithstanding any approval of the O&M Manual by ***[Executing Agency]*,** the Concessionaire shall bear all risk, responsibility and liability for the suitability, accuracy, adequacy and practicality of the O&M Manual. The Concessionaire shall not be entitled to any extension of time and/or costs incurred in the preparation of or updating the O&M Manual and complying with the requirements of this Clause 8.2.
    4. The Concessionaire shall submit a consolidated O&M Manual for the [Location] Facilities.
  1. **Subcontracting**
     1. The Concessionaire may enter into Subcontracts to perform any part of its scope of work during the O&M Period, with the prior written consent of ***[Executing Agency]*.**
     2. The Concessionaire shall provide a copy of each proposed Subcontract, along with details of the relevant Subcontractor, to ***[Executing Agency]*** for its approval, which should set out the precise scope of work to be subcontracted to such Subcontractor and should be consistent with the terms of this Agreement.
     3. Within 15 (fifteen) days of receipt of a draft Subcontract under Clause 8.3(b) above, ***[Executing Agency]*** shall notify the Concessionaire of its approval or rejection (along with reasons) of the Subcontractor.
     4. The approval of any Subcontractor and the corresponding Subcontract by ***[Executing Agency]*** shall be subject to the following conditions:
        1. the Subcontractor appointed by the Concessionaire possesses the requisite skill, expertise and capability to perform the relevant obligations of the Concessionaire during the O&M Period;
        2. the Subcontract is on terms consistent with this Agreement;
        3. the Subcontract contains provisions that provide, at ***[Executing Agency]***'s option, for the Subcontract to be novated or assigned to ***[Executing Agency]*** or its nominee without any further consent or the approval from the Concessionaire or the Subcontractor or entitle ***[Executing Agency]*** or its nominee to step into such Subcontract, in substitution of the Concessionaire, if this Agreement is terminated due to a Concessionaire Event of Default. However, the step-in rights of ***[Executing Agency]*** shall always be subject to the substitution rights of the Lenders under this Agreement or the Substitution Agreement; and
        4. the Concessionaire shall be responsible for the supervision and monitoring of the performance of any work or services by the Subcontractors.
     5. If ***[Executing Agency]*** does not notify its approval or rejection of any Subcontract to the Concessionaire within 15 (fifteen) days of the receipt of the draft Subcontract, then

such Subcontract will be deemed to be approved by ***[Executing Agency]***.

* + 1. Within 7 (seven) days of the execution of an amendment to any approved Subcontract, the Concessionaire shall submit a copy of such amendment to ***[Executing Agency]*** for its records.
    2. If the Concessionaire proposes to novate an approved Subcontract and/or replace an approved Subcontractor, then such novation or replacement shall be with prior approval of ***[Executing Agency]*** and the process set out in this Clause 8.3 shall apply in such case.
    3. Notwithstanding the approval of any Subcontractor by ***[Executing Agency]*,** the Concessionaire shall be and remain liable under this Agreement for all work and services subcontracted under this Agreement and for all acts, omissions or defaults of any Subcontractor. No default under any Subcontract shall excuse the Concessionaire from its obligations or liabilities under this Agreement. All references in this Agreement to any act, default, omission, breach or negligence of the Concessionaire shall be construed to include any such act, default, omission, breach or negligence of the Subcontractors.
  1. **Concessionaire's rights and obligations**
     1. The Concessionaire shall operate and maintain the Facilities in a manner that:
        1. is in compliance with the Technical Specifications, Applicable Laws, Applicable Permits and Good Industry Practice;
        2. results in the Facilities achieving the KPIs;
        3. ensures that each of the ***[Location]*** STP is capable of treating Sewage up to its Design Capacity on a daily basis
        4. ensures that each of the ***[Location]*** FSTP is capable of treating Faecal Sludge/Septage up to its Design Capacity on a daily basis
        5. ensures efficient treatment of Sewage/Faecal Sludge/Septage ensures that each of the ***[Location]*** STP and ***[Location]*** FSTP is capable of treating Sewage/Faecal Sludge/Septage up to its Design Capacity on a daily basis
        6. and handling and disposal of STP By-Products, FSTP By-Products and the Treated Effluent;
        7. is safe and reliable, subject to normal wear and tear of the Facilities;
        8. is in compliance with the technology license agreement(s) executed by the Concessionaire for the technology, processes, know-how and systems used or incorporated into the Facilities
        9. maintains the safety and security of personnel, material and property at the Site, in accordance with the approved ESHS Documents, Applicable Laws and Applicable Permits; and
        10. ensures that all waste materials and hazardous substances are stored and/or disposed in accordance with the ESHS Documents, Applicable Laws and Applicable Permits
        11. rectify, cure, remedy all defects, deficiencies, defaults, damage etc. with all of the facilities at its own cost and risk.
     2. The Concessionaire shall provide adequate power backup at the Site (including through installation of DG Sets) to ensure continuous supply of power (even during any interruption(s) in the supply of power from the grid) for the uninterrupted operations of the Facilities during the O&M Period.
     3. The Concessionaire shall provide all necessary assistance to the Project Engineer, ***[Name of the State / National Level Agency, if any]***, and ***[Executing Agency]*** in undertaking inspection and monitoring of the operation and maintenance of the Facilities.
     4. The Concessionaire shall reasonably consider and act upon the comments/suggestions made by the Project Engineer and ***[Executing Agency]*** during any meetings of the Concessionaire with its Subcontractors.
     5. The Concessionaire shall provide ***[Executing Agency]*** and the Project Engineer with reasonable access to the Site during office hours to monitor and inspect the Facilities.
     6. The Concessionaire shall arrange for all equipment, machinery, tools and other resources required to undertake the O&M of the Facilities and shall take all reasonable measures to ensure that the transportation of any of the Concessionaire's or the Subcontractors' personnel or equipment, to or from the Site, does not interfere with local traffic in the vicinity of the Site.
     7. The Concessionaire shall develop and implement a safety and surveillance programme for the Facilities and for handling and disposal of the STP By-Products, FSTP By- Products and the Treated Effluent and adopt appropriate measures and safeguards for security of the environment, life, and property at the Site.
     8. The Concessionaire shall ensure that none of its employees, consultants, service providers, suppliers, or Subcontractors, including any O&M contractor appointed by the Concessionaire, shall engage in any corrupt, fraudulent, collusive, coercive or obstructive practice, as defined in Article 23.18.
  2. ***[Executing Agency]*'s rights and obligations**

During the O&M Period, ***[Executing Agency]*** shall:

* + 1. to the extent applicable, comply with all its obligations under Applicable Laws (including, specifically the ***[ACT APPLICABLE IN THE STATE]*** Act) and ***[Executing Agency]*** Applicable Permits;
    2. monitor and review the operations and performance of the Facilities, including disposal of the STP By-Products, FSTP By-Products and the Treated Effluent. This includes the right to access the Facilities, and review the records and reports that the Concessionaire is required to maintain, during normal working hours;
    3. review the Scheduled Maintenance Programme and all other plans and documents

submitted by the Concessionaire in an expeditious manner, in accordance with this Agreement; and

* + 1. ensure that the Concessionaire continues to enjoy peaceful access to the Site and shall not assign, transfer, or otherwise dispose of its rights, title, and interest in the Site or create any Encumbrance over any part of the Site, which may adversely impact the exercise of the Concessionaire's rights and duties under this Agreement.
  1. ***[Name of the State / National Level Agency, if any]*'s30 rights and obligations**

During the O&M Period, ***[Name of the State / National Level Agency, if any]*** shall:

* + 1. comply with all its obligations under the Applicable Laws;
    2. make the O&M Payments in accordance with Clause 9.4; and
    3. ensure that the Escrow Account is funded with the Minimum Escrow Balance.
  1. **Utilities**
     1. The Concessionaire shall apply for and obtain the power connection (at the battery limit of the relevant Site) for the operation of the Facilities, in its name, at least 30 (thirty) days prior to the Scheduled Construction Completion Date. The ***[Executing Agency]***shall provide all necessary assistance to the Concessionaire in procuring the power connection, including by providing all documents and information necessary to complete the application process.
     2. The Concessionaire shall install and maintain at its cost, all utilities necessary for the O&M of the Facilities, including water, telephone connections, internet connections, etc. at the Site. Specifically, to procure water for the O&M of the Facilities, the Concessionaire may dig bore wells at the Site after obtaining all Applicable Permits (including any no-objection certificates from the Central Ground Water Authority or the relevant state authority).
     3. The Concessionaire shall not be entitled to any additional costs to comply with its obligations in this Clause 8.7.
     4. ***[Executing Agency]*** shall provide any reasonable assistance required by the Concessionaire to obtain the utilities for the O&M of the Facilities.
  2. **Monitoring and Reporting**
     1. Online Monitoring and Meters
        1. At ***[Location]*** STP/Pumping Stations, the Concessionaire shall install and

30If not applicable the rights & obligations mentioned under this Clause has to be merged with the rights and obligations of the Executing Agency under Clause 8.5

maintain an online monitoring system, in accordance with the Technical Specifications and Applicable Laws (including specifically, the EPA) to monitor the volume, specifications and characteristics of the incoming Sewage/Faecal Sludge/Septage ensures that each of the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) is capable of treating Sewage/Faecal Sludge/Septage up to its Design Capacity on a daily basis.

* + - 1. The online monitoring devices should be capable of measuring and analyzing:
         1. the flow rate and characteristics of the Sewage/Faecal Sludge/Septage at the Inlet Point and of the Treated Effluent at the Outlet Point.
         2. the sump level of the Pumping Station and the flow rate of the Sewage/Faecal Sludge/Septage at the Outlet Point of the Pumping Station



historical running information, status, faults, and any other parameters required to judge its conditions. Such monitoring shall be conducted in accordance with Applicable Laws and Good Industry Practices.

* + - 1. As part of the online monitoring system, the Concessionaire shall also install flow measurement meters in accordance with Applicable Laws and Technical Specifications, at the rising mains, Inlet Point, the Outlet Point and at any other point set out in the Technical Requirements/ Specifications or required as per Applicable Laws, to measure the flow of Sewage/Faecal Sludge/Septage over the weir and the volume and concentration of Sewage/Faecal Sludge/Septage delivered to the Facilities, and the Treated Effluent discharged from the Facilities.
      2. The Concessionaire shall record and transmit all data collected from the online monitoring systems and the meter reading of the grade, volume and characteristics of the incoming Sewage/Faecal Sludge/Septage and the Treated Effluent. The Concessionaire shall furnish a summary report for ***[Location]*** STP(s) and ***[Location]*** FSTP(s) to ***[Executing Agency]*** (with a copy to the Project Engineer) on a daily basis, which shall indicate: (A) the volume of the Sewage/Faecal Sludge/Septage received at the relevant ***[Location]*** STP(s) and ***[Location]*** FSTP(s) and the volume of the Treated Effluent discharged from the relevant ***[Location]*** STP(s) and ***[Location]*** FSTP(s) during each hour of the relevant day; (B) the periods during which the volume of Sewage/Faecal Sludge/Septage received at the relevant ***[Location]*** STP(s) and ***[Location]*** FSTP(s) exceeded its Design Capacity; (C) the quality of the incoming Sewage/Faecal Sludge/Septage was beyond the Influent Standards; (D) the quality of the Treated Effluent was beyond the Discharge Standards, (E) hourly sump level for each sewage pumping station (SPS); and (F) the hourly volume of Sewage discharged at each SPS.
      3. The Concessionaire shall also be required to upload the periodic reports from the online monitoring on the Central Pollution Control Board's website.
      4. The Concessionaire shall maintain the online monitoring systems and meters at

its own cost and expense for the entire O&M Period.

1. At ***[Location]*** STP(s) and ***[Location]*** FSTP(s), the Concessionaire shall also install meters and gauges at the DG Sets to measure the total number of energy units (in kWh) consumed from the DG Sets in each month of the O&M Period.
2. If the Concessionaire sets up a Power Plant, then the Concessionaire shall install meters at the Power Plant to measure the total number of energy units (in kWh) generated from the Power Plant in each month of the O&M Period.
3. The meters shall be calibrated once every year during the O&M Period in accordance with Good Industry Practices and the meters shall be jointly tested by ***[Executing Agency]*** and the Concessionaire to ensure the accuracy of the meters installed by the Concessionaire.
   * 1. Records and Reporting Requirements
        1. The Concessionaire shall maintain:
           1. records of the volume and characteristics of the Sewage/Faecal Sludge/Septage received at, and the STP By-Products, FSTP By-Products, and the Treated Effluent discharged from the ***[Location]*** STP(s) and ***[Location]*** FSTP(s); and
           2. records of the sump levels and volume of the Sewage/Faecal
           3. books of accounts recording all payments received from ***[Name of the State / National Level Agency, if any]*** and other revenues derived/collected by it from the Facilities or resulting from its use,separately for ***[Location]*** STP(s) and ***[Location]*** FSTP(s).
        2. The Concessionaire shall provide to ***[Executing Agency]***, 2 (two) copies of its audited financial statements along with a report from its statutory auditors, within 90 (ninety) days of the close of each Financial Year.
        3. For***[Location]*** STP(s) and ***[Location]*** FSTP(s), the Concessionaire shall deliver to ***[Executing Agency]***, with a copy to the Project Engineer, the following during the O&M Period within the specified timelines:
           1. reports relating to any activity, problem, incident or circumstance that threatens or may threaten public health, safety, the environment or the safety and security of the Facilities, and any action taken to mitigate the effect of such incident or problem, as soon as reasonably practicable but no later than 12 hours after the occurrence of such event or circumstance;
           2. reports on any critical breakdowns or failures in the Facilities, within 12 hours of such occurrence;
           3. reports on accidents or other incidents in relation to the O&M personnel or

any third party, along with statements on actions taken to minimize recurrence, within 2 (two) days of such occurrence;

* + - * 1. daily reports with the data collected from the monitoring and metering system, the online monitoring system and the tests conducted by the Concessionaire in accordance with Clause 8.10 on the characteristics and volume of Sewage/Faecal Sludge/Septage treated at the Facilities, the STP By-Products, FSTP By-Products and the Treated Effluent discharged from the Facilities, at the end of each day (i.e., on or before 1500 hours every day);
        2. monthly progress reports relating to the performance of O&M services (including on compliance with the KPIs, details of disposal or sale, as the case may be, of the STP By-Products, FSTP By-Products and the Treated Effluent, and details of any Emergency during the relevant month), on or before the 7th(seventh) day of the following month. The monthly progress report must be certified by the Project Engineer before it is submitted to ***[Executing Agency]***;
        3. copies of any reports, notices or responses submitted for compliance/non- compliance with Applicable Laws or Applicable Permits, within 2 (two) days of making such submissions to the relevant Government Authority; and
        4. reports on any material litigation, including any winding-up proceedings or notice to commence winding-up proceedings or material disputes to which the Concessionaire is a party, appointment of a receiver or administrator in relation to the business or assets of the Concessionaire and any adverse orders or judgments passed by any Government Authorities that affects or is likely to affect the performance of the O&M services, as soon as reasonably possible after the occurrence of any such event.
    1. It is clarified that the reports set out in this Clause 8.8 will be separately prepared and furnished for ***[Location]*** STP(s) and ***[Location]*** FSTP(s).
  1. **Design Capacity Utilization**
     1. During each day of the O&M Period, the Concessionaire shall ensure that ***[Location]*** STP(s) and ***[Location]*** FSTP(s) can accept, treat, and process Sewage/Faecal Sludge/Septage up to its Design Capacity.
     2. The Concessionaire shall notify ***[Executing Agency]*** (with a copy to the Project Engineer) as soon as it becomes aware that the volume of Sewage/Faecal Sludge/Septage received at the relevant ***[Location]*** STP(s) and ***[Location]*** FSTP(s) is more than its Design Capacity.
     3. In such circumstances, if the Concessionaire is unable to accept and treat the excess

Sewage/Faecal Sludge/Septage (i.e., over and above the Design Capacity) at the relevant ***[Location]*** STP(s) and ***[Location]*** FSTP(s), then such failure shall be treated as a Forced Unavailability for which the Concessionaire shall not be liable, subject to the Concessionaire having notified ***[Executing Agency]*** in accordance with Clause 8.9(b) above. ***[Executing Agency]*** reserves the right to require the Project Engineer to verify the capacity utilization at any **[Location]** STP(s) and ***[Location]*** FSTP(s), at any time during the O&M Period.

* 1. **Testing**
     1. The Sewage/Faecal Sludge/Septage and the Treated Effluent will be tested at the Inlet Point and the Outlet Point, respectively in accordance with this Clause 8.10 and the Technical Specifications.
     2. The Concessionaire shall test the characteristics of the incoming Sewage/Faecal Sludge/Septage at the Inlet Point to determine if the incoming Sewage/Faecal Sludge/Septage meets the Influent Standards. The Concessionaire will be required to carry out such tests at the Inlet Point at the intervals specified in the Technical Specifications or at such other time interval as may be instructed by ***[Executing Agency]***.
     3. The Concessionaire shall test the characteristic of the Treated Effluent at the Outlet Point to determine if the Treated Effluent meets the Discharge Standards. The Concessionaire will be required to carry out such tests at the Outlet Point at the intervals specified in the Technical Specifications or such other time interval as may be instructed by ***[Executing Agency]***.
     4. The Concessionaire shall test the characteristics of the Digested Sludge after digestion of the raw Sewage/Faecal Sludge/Septage at the ***[Location]*** STP(s) and ***[Location]***FSTP(s) to assess the volatile suspended solids value of the Digested Sludge, in accordance with the Technical Specifications.
     5. The Concessionaire shall maintain proper records of the tests conducted at the Inlet Point, the Outlet Point or at any other point at the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) (for the Digested Sludge) and the test results shall be verified by the Project Engineer. Separately, the Project Engineer shall also have the right to take random samples of the incoming Sewage/Faecal Sludge/Septage, the Digested Sludge and the Treated Effluent at any time during the O&M Period to test compliance with the Influent Standards and the Discharge Standards.
     6. For ***[Location]*** STP(s) and ***[Location]*** FSTP(s), the Concessionaire shall prepare daily reports compiling the test reports for each day, which shall be submitted to ***[Executing Agency]***, after being duly certified by the Project Engineer.
  2. **Maintenance and Repair of the Facilities**
     1. During the O&M Period, the Concessionaire shall, at its own cost, undertake the maintenance of the Facilities and repair any damage to the Facilities either by itself, or through an approved Subcontractor, such that the Facilities shall be:
        1. in good working condition (subject only to wear and tear and Force Majeure) and achieve their full useful economic life in accordance with the Designs and Drawings;
        2. maintained in compliance with the Technical Specifications, O&M (iii) Manual, Scheduled Maintenance Programme, Applicable Laws, Applicable Permits, Good Industry Practice and the recommendations of the technology providers;
        3. capable of meeting the KPIs.
     2. For the first year of the O&M Period, the Concessionaire shall submit its scheduled maintenance programme for the ***[Location]*** STP(s) and ***[Location]*** FSTP(s), specifying the Scheduled Maintenance periods for ***[Location]*** STP(s) and ***[Location]*** FSTP(s) and the impact of such Scheduled Maintenance periods on the Availability of each ***[Location]*** STP(s) and ***[Location]*** FSTP(s) (the **Scheduled Maintenance **) to ***[Executing Agency]*** at least 1 (one) month before the Scheduled COD and for every subsequent year of the O&M Period, the Concessionaire shall submit the Scheduled Maintenance Programme, at least 1 (one) month prior to the beginning of the relevant year. The Scheduled Maintenance Programme for the first year will cover the period from the COD until the end of the calendar year in which the COD occurs. It is clarified that the Concessionaire shall submit a consolidated Scheduled Maintenance Programme for the Facilities.
     3. Within 15 (fifteen) days of receipt of the Scheduled Maintenance Programme,

***[Executing Agency]*** shall notify the Concessionaire of its approval of such schedule.

If ***[Executing Agency]*** does not accept any one or more of the requested Scheduled Maintenance periods or its impact on the Availability of a Facilities, ***[Executing Agency]*** shall advise the Concessionaire within 15 (fifteen) days of the receipt of the Scheduled Maintenance Programme on when any Scheduled Maintenance can be rescheduled or how its impact on the Availability of a Facilities may be minimised. The rescheduled time shall be as close as reasonably practicable to the requested time and shall be of equal duration as the requested period. If ***[Executing Agency]*** fails to object to any Scheduled Maintenance within the specified time period or fails to advise the Concessionaire of a substitute time, the Concessionaire may schedule the Scheduled Maintenance for such duration and at such time as initially requested.

* + 1. Notwithstanding the finalization of the Scheduled Maintenance Programme pursuant to this Clause 8.11, ***[Executing Agency]*** may require the Concessionaire to reschedule a Scheduled Maintenance in the Scheduled Maintenance Programme, provided that:
       1. ***[Executing Agency]*** has given the Concessionaire at least 30 (thirty) days' prior written notice of such re-scheduling;
       2. ***[Executing Agency]*** shall not require such Scheduled Maintenance to be rescheduled for a period of shorter or longer duration;
       3. ***[Executing Agency]*** shall not require that a single Scheduled Maintenance period be split into two or more periods; and
       4. ***[Executing Agency]*** shall not require that a Scheduled Maintenance be brought forward any earlier than 15 (fifteen) days from the date of such notice without the consent of the Concessionaire.
    2. Notwithstanding the finalization of the Scheduled Maintenance Programme pursuant to this Clause 8.11, the Concessionaire may request a rescheduling of any Scheduled Maintenance upon 60 (sixty) days' prior written notice to ***[Executing Agency]***. ***[Executing Agency]*** shall respond to such request within 10 (ten) days and shall not unreasonably withhold its permission for such re-scheduling.
    3. Within 5 (five) days of any re-scheduling of a Scheduled Maintenance in accordance with Clause 8.11(d) or Clause 8.11(e) above, the Concessionaire shall provide to ***[Executing Agency]***, the amended Scheduled Maintenance Programme, which shall then be the "**Scheduled Maintenance Programme**".
    4. During the O&M Period, the Concessionaire shall, at its own cost, replace any component or part of the Facilities that is damaged or worn out or in the Concessionaire's judgment becomes no longer practicable to repair as a result of normal wear and tear.
    5. If at any time during the O&M Period, a Facilities is damaged by a Minor Casualty, the Concessionaire shall, with reasonable diligence, proceed to process the claim with insurance providers and repair, replace, and restore the damaged portion of the Facilities to the same condition that it was in before the occurrence of such Minor Casualty. To the extent available, insurance proceeds shall be applied to such repair, replacement or restoration.
    6. If at any time during the O&M Period, a Facilities is damaged by a Total Casualty, then this Agreement shall be terminable at the option of the Concessionaire. If the Concessionaire elects to terminate the Agreement, then the consequences set out at Clause 14.7 will follow. If, however, the Concessionaire elects not to terminate the Agreement, then the Concessionaire shall repair, replace and restore the damaged Facilities to the same condition that it was in before the occurrence of such Total Casualty. To the extent available, insurance proceeds shall be applied to such repair, replacement or restoration.
  1. **Key Performance Indicators**
     1. Availability
        1. The Concessionaire shall ensure that the Availability of each Facilities and Associated Infrastructure on every day during the O&M Period shall be 100% (one hundred per cent) (the ). Provided that during the period of a Scheduled Maintenance that is undertaken as per the approved Scheduled Maintenance Programme or as notified and approved in accordance

with Clause 8.11 for the Facilities, the Concessionaire shall ensure that the Guaranteed Availability of such Facilities and Associated Infrastructure is at least 95% (ninety five per cent).

The 'Availability' of each Facilitiesand Associated Infrastructure will be determined as a ratio of the number of hours in a day during which such Facilities was available to convey, pump, accept and treat the Sewage/Faecal Sludge/Septage up to its Design Capacity, to the total number of hours in a day, and the term 'Available' shall be construed accordingly.

* + - 1. In computing the Availability of each Facilities and Associated Infrastructure, the Concessionaire agrees that the Facilities will be deemed to be Available at all times, other than during the period of:
         1. an Unscheduled Outage affecting such Facilities and Associated Infrastructure;
         2. a Power Outage affecting such Facilities and Associated Infrastructure;
         3. suspension of the O&M services for such Facilities, for reasons attributable to the Concessionaire (in accordance with Clause 15.1 and 15.2); or an Emergency affecting such Facilities, attributable to the Concessionaire,
         4. during which the Facilities and Associated Infrastructure will be deemed to be not Available.
      2. Notwithstanding anything to the contrary contained in this Agreement, during the period of a Forced Unavailability or a Force Majeure, the Facilitiesand Associated Infrastructure affected by such Forced Unavailability or a Force Majeure will be deemed to be Available.
      3. If the Availability for a Facilities on any given day is less than the Guaranteed Availability, ***[Executing Agency]*** shall issue a notice to the Concessionaire requiring the Concessionaire to cure the default causing the reduction in Availability in [3 (three)] days. Any failure to cure the default and achieve the Guaranteed Availability within [3 (three)] days of receipt of the notice from ***[Executing Agency]*** shall constitute a Concessionaire Event of Default. The ***[Executing Agency]***may claim AvailabilityLiquidated Damages would be available till the default is cured or the Agreement is terminated.
      4. Availability Liquidated Damages

Without prejudice to Clause 8.12(a)(iv), if the Availability of any Facilitiesand Associated Infrastructure on any given day is less than the Guaranteed Availability, then the Concessionaire shall pay the liquidated damages set out in Schedule 7.

The aggregate Availability Liquidated Damages payable by the Concessionaire in any quarter of the O&M Period will be deducted from the O&M Payments due to the Concessionaire for such quarter. If the Availability Liquidated Damages for a quarter exceed the O&M Payments for such quarter, then the excess amounts

shall, at the discretion of ***[Executing Agency]***, either be adjusted against the O&M Payments for the subsequent quarter or recovered from the O&M Securities.

* + 1. Influent Standards and Discharge Standards
       1. The Concessionaire is required to receive, treat, and dispose all Sewage, Faecal Sludge/Septage delivered to the ***[Location]*** STP(s) and ***[Location]*** FSTP(s). If, however the Sewage/Faecal Sludge/Septage is beyond the Influent Standards as set out in Schedule 10, then the Concessionaire shall be required to treat such Sewage/Faecal Sludge/Septage but will not be liable for any Performance Liquidated Damages if the Treated Effluent and/or the Digested Sludge fails to meet the Discharge Standards
       2. Subject to Clause 8.12(b)(i) above, the Concessionaire shall ensure that the Treated Effluent and Digested Sludge comply with the Discharge Standards set out in the Technical Specifications.
       3. Subject to Clause 8.12(b)(iv) below, for each Facilities, if the Treated Effluent or the Digested Sludge does not comply with the Discharge Standards, then the process set out below shall follow:
          1. In the first instance of non-compliance of the Treated Effluent or the Digested Sludge with the Discharge Standards (**First Breach**), ***[Executing Agency]*** shall issue a notice to the Concessionaire on the first day of such non-compliance (**First Breach Notice**) requiring the Concessionaire to cure the First Breach within 20 days from the date of the First Breach Notice. If the First Breach is cured within 2 days of the First Breach Notice, then the Concessionaire shall not be liable to pay any Performance Liquidated Damages. If, however, the First Breach continues beyond 2 days of the First Breach Notice, then, the Concessionaire shall be liable to pay the Performance Liquidated Damages specified in Schedule 7, from the3rd day of the First Breach.
          2. If: (I) the First Breach continues for 20 (twenty) days from the date of the First Breach Notice; or (II) another instance of non-compliance with the Discharge Standards occurs within 6 (six) months of the First Breach, then such breach shall constitute the **Second Breach**. Upon occurrence of the Second Breach, ***[Executing Agency]*** shall issue a notice to the Concessionaire on the first day of the Second Breach (**Second Breach Notice**) requiring the Concessionaire to cure the Second Breach within 20 days from the date of the Second Breach Notice. If the Second Breach continues beyond 2 (two) days of the Second Breach Notice, then, the Concessionaire shall be liable to pay twice the amount of the Performance Liquidated Damages specified in Schedule 7, from the 1st day of the Second Breach. In case of (I) above, it is clarified that the Concessionaire will be liable to pay Performance Liquidated Damages at the rate specified in Schedule 6, for the first 2 days of a continuing breach from the date of the

Second Breach Notice and twice the specified Performance Liquidated Damages from the 3rd day of a continuing Second Breach.

* + - * 1. If: (I) the Second Breach continues for 20 (twenty) days from the date of the Second Breach Notice; or (II) another instance of non-compliance with the Discharge Standards occurs within 6 (six) months of the Second Breach, then such breach shall constitute the **Third Breach**. Upon occurrence of the Third Breach, ***[Executing Agency]*** shall issue a notice to the Concessionaire on the first day of the Third Breach (**Third Breach Notice**) requiring the Concessionaire to cure the Third Breach within 20 days from the date of the Third Breach Notice. If the Third Breach continues beyond 2 (two) days of the Third Breach Notice, then: (X) the Concessionaire shall be liable to pay thrice the amount of the Performance Liquidated Damages specified in Schedule 7, from the 1st(first) day of the Third Breach; and (Y) the Capex Annuity for the relevant quarter(s) will be reduced by an amount equal to the Capex Annuity for the relevant quarter/90 (ninety) days for each day that the Third Breach continues beyond the 1st(first)day of the Third Breach. In case of (I) above, it is clarified that the Concessionaire will be liable to pay twice the Performance Liquidated Damages specified in Schedule 7, for the first 2 (two) days of a continuing breach from the date of the Third Breach Notice and thrice the specified Performance Liquidated Damages from the 3rd(third) day of the Third Breach, in addition to the reduction in the Capex Annuity.
        2. If: (I) the Third Breach is not cured within 20 (twenty) days from the Third Breach Notice; or (II) a failure to comply with the Discharge Standards results in occurrence of a Third Breach more than 3 (three) times in a continuous 12 (twelve) month period, it will be treated as a Concessionaire Event of Default and the consequences set out at Article 16 shall apply.
        3. The Parties acknowledge that the Performance Liquidated Damages (including any escalation contemplated in this Clause 8.12(b)(iii) are a genuine pre-estimation of and reasonable compensation for the environmental damage that may be caused by the Concessionaire's continuing failure to comply with the Discharge Standards, and not as penalty. The payment of Performance Liquidated Damages will not absolve the Concessionaire from any other liability under Applicable Law, for causing any environmental pollution or health hazard due to its failure to comply with the Discharge Standards and/or Applicable Law.
      1. If the Treated Effluent and/or the Digested Sludge does not meet the Discharge Standards on account of: (A) the characteristics of the Sewage/Faecal Sludge/Septage being beyond the permissible Influent Standards; or (B) the volume of the Sewage/Faecal Sludge/Septage being more than the Design Capacity of the relevant ***[Location]*** STP(s) and ***[Location]*** FSTP(s), then, the Concessionaire shall not be liable to pay any Performance Liquidated Damages for a failure to meet the Discharge Standards.

In the event of the actual volume of Sewage/Faecal Sludge/Septage being more than the design capacity, the Concessionaire shall not be bound by the Guaranteed Energy Consumption limits and the payment of power charges shall be as per the actuals.

* + - 1. The Performance Liquidated Damages payable by the Concessionaire in any quarter of the O&M Period will be deducted from the O&M Payments due to the Concessionaire for such quarter. If the Performance Liquidated Damages for a quarter exceed the O&M Payments for such quarter, then the excess amounts shall, at the discretion of ***[Executing Agency]***, either be adjusted against the O&M Payments for the subsequent quarter or recovered from the O&M Security.
      2. Within 7 (seven) days from the end of each month, the Concessionaire shall be required to provide the monthly progress report for each Facilities (prepared in accordance with Clause 8.8(B)(iii)(E)above) on compliance of such Facilities with the KPIs, which should indicate the periods during which such Facilities did not meet the Guaranteed Availability or the Treated Effluent and/or the Digested Sludge did not meet the Discharge Standards and the reasons for such failure. The Project Engineer shall be required to certify each such monthly report before it is provided to ***[Executing Agency]***. Such certified report on compliance with KPIs shall be referred to as the KPI Adherence Report and shall form the basis for O&M Payments being made to the Concessionaire during the O&M Period.
  1. **Disposal of STP By-Products, FSTP By-Products and the Treated Effluent**

The Concessionaire shall be required to store, handle and dispose the STP By-Products, FSTP By-Products and the Treated Effluent in the manner set out in this Clause 8.13 during the O&M Period:

* + 1. Waste Disposal Site
       1. Within 30 (thirty) days from the Effective Date, ***[Executing Agency]*** shall inform the Concessionaire of each Waste Disposal Site at which the Concessionaire shall be required to dispose the STP By-Products, FSTP By-Products resulting from the treatment of the Sewage/Faecal Sludge/Septage at the ***[Location]*** STP(s) and ***[Location]*** FSTP(s), and any other waste materials resulting from the construction of the Facilities during the Construction Period (including silt).
       2. ***[Executing Agency]*** may shift any Waste Disposal Site from time to time during the O&M Period provided that, the Waste Disposal Sites will always be within a radius of 10 km (ten kilometers) from the boundary of the relevant Site and any shifting of a Waste Disposal Site will be with at least 30 (thirty) days' prior written notice to the Concessionaire.
       3. If, at any time during the O&M Period, ***[Executing Agency]*** shifts a Waste Disposal Site to a location beyond a radius of 10 km (ten kilometers) from the boundary of the relevant Site, then, ***[Executing Agency]*** shall compensate the Concessionaire for any additional transportation costs incurred by the

Concessionaire in transporting the STP By-Products, FSTP By-Products to such Waste Disposal Site.

* + - 1. Any approval for disposal of the STP By-Products, , FSTP By-Products at the Waste Disposal Sites will be obtained by ***[Executing Agency]*** at its cost. Further, all costs and charges in connection with the setting up and maintaining the Waste Disposal Sites (including any tipping fee for the disposal of the STP By-Products and FSTP By-Products) will be borne by ***[Executing Agency]***. The Concessionaire shall only be responsible for transporting the STP By-Products, FSTP By-Products to the Waste Disposal Sites and subject to Clause 8.13(a) above, bearing the costs for transportation and unloading of the STP By-Products, FSTP By-Products at the Waste Disposal Sites.
    1. Disposal of Residual Grit and Screenings
       1. The Concessionaire shall, at its cost and expense, be required to transfer the Residual Grit and the Screenings to the relevant Waste Disposal Site and shall make adequate transportation arrangements for this purpose.
       2. The Concessionaire shall ensure that the Residual Grit and the Screenings are neither disposed at any place on or about the Site, other than the Waste Disposal Sites, {nor discharged into the 31}. The disposal of the Residual Grit and

the Screenings at the Waste Disposal Sites must be strictly in accordance with all Applicable Laws. The Concessionaire shall indemnify ***[Executing Agency]*** against any costs or liabilities that may arise due to the Concessionaire's failure to comply with this Clause 8.13(b) and all Applicable Laws in disposal of the Residual Grit and the Screenings.

* + 1. Disposal of Digested Sludge
       1. As part of each Facilities, the Concessionaire shall be required to set up and maintain a sludge handling Facilities at the relevant Site, where the Concessionaire can dry the Digested Sludge during the O&M Period.
       2. The Concessionaire shall, at its cost and expense, provide for a storageFacilities within the ***[Location]*** Site to temporarily store the dried Digested Sludge until such Digested Sludge is sold or disposed in accordance with this Agreement.
       3. The Concessionaire shall, subject to compliance with Applicable Laws and Applicable Permits, be free to sell the Digested Sludge, at such price and to such Persons as it may deem fit or dispose the Digested Sludge at the Waste Disposal Sites. Provided that if the Concessionaire sells the digested sludge to any third party, the Concessionaire shall be required to share 10% of the revenues from such sale with ***[Executing Agency]***.
       4. The Concessionaire shall maintain proper records of sale of any Digested Sludge

31Insert the name of the water body. Delete if not applicable.

generated from the Facilities (including the revenues earned by the Concessionaire from such sale) and make them available to ***[Executing Agency]*** for its review.

* + - 1. The Concessionaire shall ensure that the Digested Sludge is neither disposed at any place on or about the Site, except the Waste Disposal Sites, {nor discharged into the -------}32. The Concessionaire shall indemnify ***[Executing Agency]*** against any costs or liabilities that may arise due to the Concessionaire's failure to comply with this Clause 8.13(c) and all Applicable Laws in disposal of the Digested Sludge.
    1. Disposal of Treated Effluent
       1. The Concessionaire is required to transfer the Treated Effluent through the Supporting Infrastructure to any discharge point(s) indicated by ***[Executing Agency]***.
       2. The Concessionaire is permitted to divert, transfer or sell the Treated Effluent generated from the STP/FSTP to any third party, provided that if the Concessionaire sells the Treated Effluent to any third party, the Concessionaire shall be required to share 10% (ten per cent) of the revenues from such sale with ***[Executing Agency]***.
       3. The Concessionaire shall maintain proper records of sale of any Treated Effluent generated from the Facilities (including the revenues earned by the Concessionaire from such sale) and make them available to ***[Executing Agency]*** for its review.
       4. The Concessionaire shall indemnify ***[Executing Agency]*** against any costs or liabilities that may arise due to the Concessionaire's failure to comply with this Article 8.13(d) and all Applicable Laws in disposal of the Treated Effluent.
    2. Rights and interest in the STP By-Products, FSTP By-Products and the Treated Effluent
       1. Subject to the ***[Executing Agency] ***,all rights and interest in the STP By-Products, FSTP By-Products discharged from the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) shall vest with the Concessionaire at all times during the O&M Period, unless transferred by the Concessionaire to a third party buyer/off-taker in accordance with this Agreement.
       2. All rights and interest in the Treated Effluent discharged from the ***[Location]*** STP(s) and ***[Location]*** FSTP(s) shall vest with the Concessionaire at all times during the O&M Period, unless transferred by the Concessionaire to ***[Executing Agency]*** in accordance with this Agreement.

32Delete if not applicable.

* 1. **Remedial Measures**

If after the COD, the Concessionaire ceases to operate Facilities for a period of 48 consecutive hours other than due to a Forced Unavailability, Scheduled Maintenance, or a suspension pursuant to Clause 15.1 or Clause 15.2, which is not attributable to the Concessionaire, or a Force Majeure Event, without the prior written consent of ***[Executing Agency]***, then ***[Executing Agency]*** shall be entitled to step-in and undertake O&M of such Facilities until the Concessionaire demonstrates to the satisfaction of ***[Executing Agency]*** that it can and will resume normal operation and maintenance of the Facilities. The exercise of ***[Executing Agency]***'s rights under this Clause 8.14 shall be at the cost, risk and expense of the Concessionaire. The Concessionaire shall not be entitled to receive any O&M Charges for the duration that ***[Executing Agency]*** steps-in to operate and maintain the Facilities.

* 1. **O&M Personnel**
     1. The Concessionaire shall engage (either directly or through an approved Subcontractor) adequate number of suitably skilled and qualified personnel to undertake the O&M of the Facilities in accordance with the requirements set out in this Article 8.
     2. The Concessionaire shall be solely responsible for discharging all obligations in connection with the employment of the O&M personnel, including the payment of wages, salaries, Taxes, and retrenchment compensation and providing all amenities and benefits required under applicable laws.
     3. Subject to compliance with the Applicable Laws, the Concessionaire shall have full freedom to determine its internal human resources (HR) policies, including, the wages, benefits and salary structure of its employees, the conditions of service, the shifts of work, its hire and fire policy (whether for misconduct or other cause), and payment of severance or retrenchment compensation.
     4. ***[Executing Agency]*** is not and shall not be treated as the "principal employer" of or be deemed to have any contractual or other relationship with the O&M personnel. The Concessionaire shall hold harmless and indemnify ***[Executing Agency]*** against all losses, claims, costs and damages that ***[Executing Agency]*** may suffer due to the Concessionaire's or any of its Subcontractor's failure to comply with applicable laws.

**ARTICLE 9 PAYMENT AND INVOICING**

* 1. In consideration of the works and services required to be performed by the Concessionaire for designing, financing, constructing, operating and maintaining the Facilities in accordance with this Agreement, the Concessionaire shall be entitled to receive the Construction Payments and the O&M Payments from ***[Executing Agency]***and/or ***[Name of the State / National Level Agency, if any]***33 in accordance with this Article 9.
  2. The Concessionaire shall be deemed to have satisfied itself regarding the adequacy, accuracy and sufficiency of the Construction Payments and the O&M Payments. Except for any adjustment in accordance with Clause 8.13(a) and Clause 13.2, or any permitted Variation, the Construction Payments and the O&M Payments are the total consideration payable to the Concessionaire for undertaking the Project.
  3. **Construction Payments**
     1. ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]*** shall deposit an amount equivalent to the first 2 (two) ***[Location]*** Facilities Payment Milestones in the Escrow Account in accordance with Clause 9.5 and the Escrow Agreement, prior to the Effective Date. From the Effective Date and during the Construction Period, ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]*** shall ensure that the Escrow Account is funded with an amount equivalent to the next 2 ***[Location]*** Facilities Payment Milestones for the ***[Location]*** Facilities.
     2. 10% of the Bid Project Cost for the Facilities shall be given to the Concessionaire as a Mobilization Advance in accordance with Clause 9.3(d), which will be adjusted against the Construction Payments to be paid by ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***34 to the Concessionaire in 4 instalments, in accordance with Clause 9.3(e). The Construction Payments will be paid to the Concessionaire upon completion of the work corresponding to the Payment Milestones and certification of completion of such Payment Milestones by ***[Executing Agency]*** in accordance with Clause 7.13.
     3. Adjustment in Construction Payments
        1. The Construction Payments shall be adjusted during the Construction Period to reflect the variation in the Construction Price Index occurring after the Reference Index Date immediately preceding the Bid Due Date.
        2. All Invoices to be submitted by the Concessionaire to ***[Executing Agency]*** for any installment of the Construction Payments shall be the product of the relevant percentage of the Bid Project Cost and the Price Index Multiple applicable on the date of the Invoice.

33 Delete whichever is not applicable

34Delete whichever is not applicable.

* + 1. Mobilization Advance
       1. 10% of the ***[Location]*** Facilities Bid Project Cost shall be payable to the Concessionaire as the Mobilization Advance, within 30 (thirty) days from the Effective Date, subject to the Concessionaire having submitted a Mobilization Advance Guarantee in accordance with Clause 5.21.
       2. Subject to Article 9.3(d)(iv) below, ***[Location]*** Facilities Mobilization Advance shall be an interest free advance for mobilization and towards execution of the construction works for the ***[Location]*** Facilities.
       3. The Mobilization Advance shall be deducted in equal instalments from the 4 instalments of the Construction Payments to be made to the Concessionaire upon progressive completion of the Payment Milestones.
       4. However, the Concessionaire is liable to pay a simple interest at the rate of 8% on the Mobilization Advance, if the Payment Milestones are not achieved by the Concessionaire in accordance with the agreed Construction Plan and for the reasons attributed to the Concessionaire. The interest shall be payable for the period between the actual Payment Milestone and agreed Payment Milestone. The interest amount shall be deducted along with the Mobilization Advance from the Construction Payments.
    2. Milestone Construction Payments
       1. Subject to this Clause 9.3(e), for each Facilities, the Construction Payments will be paid by ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***35 to the Concessionaire in the following 4 (four) equal installments (**Payment Milestones**) (after adjusting the Mobilization Advance (and the interest payable if any as per Clause 9.3(d)(iii)):
          1. 1st (first) installment equal to [10% (ten per cent)]of the Bid Project Cost, as adjusted for the Price Index Multiple applicable on the date of the relevant Invoice, on achievement of 25% (twenty five per cent)physical progress, upon the issuance of the first Milestone Completion Certificate;
          2. 2nd (second) installment equal to [10% (ten per cent)]of the Bid Project Cost, as adjusted for the Price Index Multiple applicable on the date of the relevant Invoice, on achievement of 50% (fifty per cent)physical progress, upon the issuance of the second Milestone Completion Certificate;
          3. 3rd (third) installment equal to [10% (ten per cent)] of the Bid Project Cost, as adjusted for the Price Index Multiple applicable on the date of the relevant Invoice, on achievement of 75% (seventy five per cent)physical progress, upon the issuance of the third Milestone Completion Certificate; and

35Delete whichever is not applicable.

* + - * 1. 4th (fourth) installment equal to [10% (ten per cent)] of the Bid Project Cost, as adjusted for the Price Index Multiple applicable on the date of the relevant Invoice, on achievement of 100% (hundred per cent) physical progress, upon the issuance of the Construction Completion Certificate.
      1. For the Facilities, within 7 (seven) days of issuance of the Milestone Completion Certificate for a Payment Milestone, the Concessionaire shall submit an Invoice to ***[Executing Agency]*** for the amount of the Construction Payment linked to such Payment Milestone along with the KPI Adherence Report. Any Invoice raised by the Concessionaire for the Construction Payments shall be accompanied by a copy of the relevant Milestone Completion Certificate issued by ***[Executing Agency]***.
      2. Within 10 (ten) days of receipt of an Invoice from the Concessionaire pursuant to Clause 9.3(e)(ii) above, ***[Executing Agency]*** shall verify and certify the amounts due and payable to the Concessionaire, and either:
         1. approve the Invoice and issue a certificate to the Escrow Bank (with a copy to ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]*** and the Concessionaire), conveying its approval for the release of the amount specified in the Invoice, less any necessary deductions or adjustments in accordance with this Agreement and/or Applicable Laws (including for payments to be made by the Concessionaire under applicable labour laws); or
         2. issue a notice to the Concessionaire disputing the Invoice and directing the Concessionaire to issue a revised Invoice, after rectifying the errors or discrepancies identified by ***[Executing Agency]***.

The Concessionaire shall submit a revised Invoice to ***[Executing Agency]*** after rectifying the errors or discrepancies identified by ***[Executing Agency]*** and this process will be repeated until ***[Executing Agency]*** approves the Invoice and issues a certificate to the Escrow Bank {with a copy to ***[Name of the State / National Level Agency, if any]***}36 and the Concessionaire), conveying its approval for release of the amount specified in the Invoice.

* + - 1. Any dispute between the Parties in relation to a disputed Invoice will be settled in accordance with Article 21 (*Dispute Resolution*).
      2. A certificate issued by ***[Executing Agency]*** in accordance with Clause 9.3(e)(iii) shall be referred to as a **Payment Certificate.**
      3. If, within 10 (ten) days from the date of receipt of an Invoice, ***[Executing Agency]*** does not dispute an Invoice, then the Invoice shall be deemed to have been accepted by ***[Executing Agency]*,** and the Concessionaire may issue instructions to the Escrow Bank{ (with a copy to ***[Executing Agency]*** and ***[Name***

36To be deleted if not applicable.

***of the State / National Level Agency, if any]***)}37 to release the amounts specified in the Invoice, upon the expiry of the 10-day period.

* + - 1. Immediately upon receipt of a Payment Certificate from ***[Executing Agency]*** in accordance with Clause 9.3(e)(iii) or upon receipt of instructions from the Concessionaire in accordance with Clause 9.3(e)(vi), the Escrow Bank shall release the amount specified in the Payment Certificate or if no Payment Certificate has been issued, then the amount specified in the relevant Invoice, in accordance with the Escrow Agreement.
      2. Notwithstanding anything to the contrary in this Agreement, ***[Executing Agency]***

shall have no obligation to issue a Payment Certificate unless:

* + - * 1. the Performance Securities remain valid and in effect;
        2. the insurances to be obtained by the Concessionaire in accordance with Clause 11.2 are valid and in effect;
        3. the Concessionaire Applicable Permits for construction of the Facilities are in full force and effect, unless the withdrawal or cancellation of any Applicable Permit is not attributable to the Concessionaire's failure to comply with Applicable Laws;
        4. the Concessionaire has complied with the ESHS Documents in undertaking the construction of the Facilities; and
        5. there is no subsisting Concessionaire Event of Default.
        6. the Concessionaire shall be paid the Construction Payments in Rupees. [However, if, in the Financial Proposal, the Selected Bidder specified any percentage of the Bid Project Cost which it would want to receive in a foreign currency during the Construction Period, then the Construction Payments corresponding to such percentage of the Bid Project Cost shall be paid to the Concessionaire in the relevant foreign currency. For the purpose of payment in a foreign currency, the exchange rate shall be [ ]. It is clarified that the aggregate Construction Payments due to the Concessionaire shall not exceed 40% of the Bid Project Cost, as quoted by the Selected Bidder in Rupees and adjusted for inflation as per Clause 9.3(c), on account of a percentage of the Bid Project Cost being paid to the Concessionaire in foreign currencies]38.
  1. **O&M Payments**
     1. During the O&M Period, ***[Name of the State / National Level Agency, if***

37To be deleted if not applicable.

38Applicable for Bank funded and other international proposals

***any]***/***[Executing Agency]***39shall be required to make the O&M Payments in Rupees to the Concessionaire for each Facilities comprising the Capex Annuity, the interest on the reducing balance of 60% of the Completion Cost, the O&M Charges and the Power Charges, in accordance with this Clause 9.4.

* + 1. Calculation of Completion Cost
       1. The ***[Location]*** Completion Cost for the ***[Location]*** Facilities will be the aggregate of (A) (D) below, for the Facilities:
          1. 25% of the Bid Project Cost for the relevant Facilities adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of the Invoice for the first Payment Milestone;
          2. 25% of the Bid Project Cost for the relevant Facilities adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of the Invoice for the second Payment Milestone;
          3. 25% of the Bid Project Cost for the relevant Facilities adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of the Invoice for the third Payment Milestone; and
          4. 25% of the Bid Project Cost for the relevant Facilities adjusted for the Price Index Multiple as applicable on the Reference Index Date preceding the date of the Invoice for the fourth Payment Milestone.

60% of the ***[Location]*** Completion Cost will be paid in quarterly instalments during the O&M Period as Capex Annuity.

* + 1. On and from the COD and during the O&M Period, ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***40 shall deposit the O&M Payments for each Facilities in the Escrow Account such that the Escrow Account is funded at all times with the Capex Annuity (along with interest), the O&M Charges and the estimated Power Charges for the next 2 years for the Facilities.
    2. Adjustment in O&M Charges
       1. The O&M Charges shall be adjusted during the O&M Period to reflect the variation in the O&M Price Index occurring after the Reference Index Date immediately preceding the Bid Due Date.
       2. All Invoices to be submitted by the Concessionaire to ***[Executing Agency]*** for the quarterly O&M Charges shall be the product of the applicable O&M Charges for the relevant quarter and the Price Index Multiple applicable on the date of the Invoice.

39Delete whichever not applicable.

40Delete whichever not applicable.

* + 1. Capex Annuity
       1. The Capex Annuity shall be payable in 60 equal quarterly installments during the O&M Period.
       2. Interest shall be payable on the reducing balance of 60% of the Completion Cost for the Facilities, at the rate of the SBI MCLR plus 3% per annum. Such interest shall be due and payable quarterly along with each instalment of the Capex Annuity. The Parties agree that such interest shall be calculated on the basis of the number of days for which the relevant rate of the SBI MCLR was applicable during the period of calculation.

By way of illustration, assuming that the balance Completion Cost to be paid to the Concessionaire on the date of payment of the 1st Capex Annuity installment is INR 50,00,00,000 (Rupees fifty crores), the applicable SBI MCLR for the first 50 (fifty) days is 8% and thereafter it is revised to 7.5% and remains unchanged till the date of payment of the 2nd Capex Annuity, the interest would be calculated as ((50\*11%\*50)/365)+((50\*10.5%\*40)/365). For the avoidance of doubt, the interest shall be calculated on simple interest basis and the interest shall not be compounded for the purpose of payment.

* + 1. O&M Charges
       1. The Authority shall pay to the Concessionaire, every [month/quarter] the amount required by the Concessionaire to operate and maintain the Facilities, excluding the Power Charges, during the O&M Period (the ).
       2. The O&M Charges shall be made for every MLD of Sewage treated and /Faecal Sludge collected and treated in the Project Area by the Concessionaire during the Post-COD period. It shall also include cost of infrastructure for door-to-door collection of Faecal Sludge.
       3. The O&M Charges for the first [month/quarter] after COD will be calculated on the basis of the O&M Charges quoted by the Selected Bidder in the Financial Proposal for the first month from the COD, which amount shall be adjusted for the Price Index Multiple applicable on the Reference Index Date preceding the date of the first Invoice for the O&M Payments.
       4. For each subsequent quarter of the O&M Period, the O&M Charges will be adjusted for the Price Index Multiple applicable on the Reference Index Date preceding the date of the relevant Invoice for the O&M Payments.
    2. Power Charges
       1. The Power Charges for the Facilities shall initially be borne by the Concessionaire, which shall be reimbursed by ***[Name of the State / National***

***Level Agency, if any][Executing Agency]***41 to the Concessionaire, subject to a cap of: (A) the Power Charges based on the ***[Location]*** Facilities Guaranteed Energy Consumption.

* + - 1. The Power Charges for any given quarter of the O&M Period will be calculated as follows:
         1. For the units of energy consumed from the grid (as evidenced by a copy of the bill issued by the distribution licensee), the Power Charges will be calculated by multiplying the number of units consumed in such quarter (subject to the Guaranteed Energy Consumption for the energy consumed by the relevant Facilities) with the Power Unit Rate.

If the Concessionaire procures power from outside ***[State of Location]***, then, the Power Unit Rate will be the prevalent power unit rate in ***[State of Location]*** or the tariff at which the Concessionaire procures power from outside ***[State of Location]***, whichever is lower.

* + - * 1. If there is any interruption in the supply of power from the grid, and the Concessionaire uses backup power supply from the DG Sets, then,

the Concessionaire's Representative and ***[Executing Agency]*** shall jointly take readings from the meters installed at the DG Sets to determine the number of units of energy consumed from the DG Sets for O&M of the Facilities;

the number of units of energy consumed from the DG Sets (determined as per (I) above) shall be adjusted such that the aggregate of the total number of units consumed from the grid and the total number of units consumed from the DG Sets shall not exceed the Guaranteed Energy Consumption for the Facilities (**Adjusted DG Set Units**);

the quantity of diesel consumed to generate the Adjusted DG Set Units in the relevant quarter shall be calculated by ***[Executing Agency]*** based on the rated specific fuel consumption of the DG Sets specified by the manufacturers of the DG Sets; and

the Power Charges for the Adjusted DG Set Units will be calculated by multiplying the quantity of diesel consumed (determined as per

(III) above) with the Fuel Price.

* + - * 1. For each Facilities, the Concessionaire shall be liable to pay liquidated damages to ***[Executing Agency]*** for any units of energy consumed beyond the Guaranteed Energy Consumption (whether from the grid or from the DG Sets) for such Facilities (**Power Consumption Liquidated Damages**),

41Delete whichever not applicable.

which will be calculated as follows:

For excess power consumption up to 5% (five per cent) of the Guaranteed Energy Consumption of the Facilities:

Power Consumption Liquidated Damages: (Number of power units consumed in the relevant quarter Guaranteed Energy Consumption for such quarter) \* [Power Unit Rate] \* 0.25

For excess power consumption between 5% (five per cent) and 10% (ten per cent) of the Guaranteed Energy Consumption of the Facilities:

Power Consumption Liquidated Damages: (Number of power units consumed in the relevant quarter Guaranteed Energy Consumption for such quarter) \* [Power Unit Rate] \* 0.5

For excess power consumption above 10% (five per cent) of the Guaranteed Energy Consumption of the Facilities:

Power Consumption Liquidated Damages: (Number of power units consumed in the relevant quarter Guaranteed Energy Consumption for such quarter) \* [Power Unit Rate]

* + - * 1. The Power Consumption Liquidated Damages payable by the Concessionaire in any quarter of the O&M Period will be deducted from the O&M Charges for the Facilities payable to the Concessionaire for such quarter. If the Power Consumption Liquidated Damages for a quarter exceed the O&M Charges for the Facilities for such quarter, then the excess amounts shall, at the discretion of ***[Executing Agency]***, either be adjusted against the O&M Charges for the Facilities for the subsequent quarter or recovered from the O&M Security.
    1. The O&M Payments shall be paid by ***[Name of the State / National Level Agency, if any]*** / ***[Executing Agency]***42 to the Concessionaire on a quarterly basis. For each Facilities, the Concessionaire shall submit an Invoice to ***[Executing Agency]*** for each quarter on or before the 7th(seventh) day of the first month of the following quarter, which should set out: (i) the Capex Annuity due to the Concessionaire in such quarter, along with interest in accordance with Clause 9.4(d)(ii) above; (ii) the O&M Charges due to the Concessionaire in such quarter; and (iii) the Power Charges incurred by the Concessionaire during such quarter for power drawn from the grid or the DG Sets, subject to the cap of the Power Charges based on the Guaranteed Energy Consumption for the Facilities. Any Invoice raised by the Concessionaire for O&M Payments shall be accompanied with a copy of the: (A) KPI Adherence Report for each month of the relevant quarter, duly certified by the Project Engineer; and (B) copy of the bill(s) issued by the state distribution utility for the Power Charges, and if relevant, copy of the joint meter reading for consumption of power from the DG Sets.

42Delete whichever not applicable.

If the Invoice is not accompanied with the supporting documents specified at (A) and

(B) above, ***[Executing Agency]*** shall not be required to process such Invoice.

* + 1. Within 10 (ten) days of receipt of an Invoice from the Concessionaire pursuant to Clause 9.4(h) above, ***[Executing Agency]*** shall verify and certify the amounts due and payable to the Concessionaire, and either:
       1. Approve the invoice and issue a certificate to the Escrow Bank {(with a copy to ***[Name of the State / National Level Agency, if any]***}43and the Concessionaire), conveying its approval for the release of the amount specified in the Invoice, less any necessary deductions or adjustments in accordance with this Agreement and/or Applicable Laws (including any statutory dues); or
       2. issue a notice to the Concessionaire disputing the Invoice and directing the Concessionaire to issue a revised Invoice, after rectifying the errors or discrepancies identified by ***[Executing Agency]***.

The Concessionaire shall submit a revised Invoice to ***[Executing Agency]*** after rectifying the errors or discrepancies identified by ***[Executing Agency]*** and this process will be repeated until ***[Executing Agency]*** approves the Invoice and issues a certificate to the Escrow Bank {(with a copy to ***[Name of the State / National Level Agency, if any]***}44 and the Concessionaire), conveying its approval for release of the amount specified in the Invoice.

* + 1. Any dispute between the Parties in relation to a disputed Invoice will be settled in accordance with Article 21.
    2. A certificate issued by ***[Executing Agency]*** in accordance with Clause 9.4(i) shall be referred to as a Payment Certificate.
    3. If, within 10 (ten) days from the date of receipt of an Invoice, ***[Executing Agency]*** does not dispute an Invoice, then the Invoice shall be deemed to have been accepted by ***[Executing Agency]***, and the Concessionaire may issue instructions to the Escrow Bank

{(with a copy to ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]***)}45 to release the amounts specified in the Invoice, upon the expiry of the 10 (ten) day period.

* + 1. Immediately upon receipt of a Payment Certificate in accordance with Clause 9.4(i)(A) [or upon receipt of instructions from the Concessionaire in accordance with Clause 9.4(l)], the Escrow Bank shall release the amount specified in the Payment Certificate or if no Payment Certificate has been issued, then the amount specified in the relevant Invoice, in accordance with the Escrow Agreement.
    2. Notwithstanding anything to the contrary in this Agreement, ***[Executing Agency]*** shall have no obligation to issue a Payment Certificate unless:

43To be deleted if not applicable. 44 To be deleted if not applicable. 45To be deleted if not applicable.

* + - 1. the O&M Securities remain valid and in effect;
      2. the insurances to be obtained by the Concessionaire in accordance with Clause

11.2 are valid and in effect;

* + - 1. the Concessionaire Applicable Permits for O&M of the Facilities are in full force and effect, unless the withdrawal or cancellation of any Applicable Permit is not attributable to the Concessionaire's failure to comply with Applicable Laws;
      2. the Concessionaire has complied with the ESHS Documents in undertaking the O&M of the Facilities; and
      3. there is no subsisting Concessionaire Event of Default.
  1. **Escrow Account**
     1. Prior to the Effective Date, the Concessionaire, ***[Name of the State / National Level Agency, if any]***,46***[Executing Agency]*** and the Escrow Bank shall enter into the Escrow Agreement and ***[Name of the State / National Level Agency, if any]*** shall open the Escrow Account with the Escrow Bank in accordance with the Escrow Agreement, which shall be operational until the expiry of the Term. The Escrow Agreement shall set out the terms of appointment of the Escrow Bank, ***[Name of the State / National Level Agency, if any]***'s obligation to deposit the Construction Payments and the O&M Payments in accordance with this agreement with the Escrow Bank and terms of withdrawal of amounts from the Escrow Account.
     2. Minimum Escrow Balance

At all times, to maintain the minimum balance in the Escrow Account (the

):

* + - 1. ***[Name of the State / National Level Agency, if any]*** shall deposit an amount equivalent to the first 2 ***[Location]*** Facilities Payment Milestones prior to the Effective Date. From the Effective Date and during the Construction Period, ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***47 shall ensure that the Escrow Account is funded with an amount equivalent to the next 2 ***[Location]*** Facilities Payment Milestones for the ***[Location]*** Facilities; and
      2. on and from the COD until Expiry Date, ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***48 shall deposit the O&M Payments in the Escrow Account such that the Escrow Account is funded at all times with the Capex Annuity (along with interest), the O&M Charges and the estimated Power Charges for the next 2 years for both the ***[Location]*** Facilities,

46To be deleted if not applicable. 47Delete whichever not applicable. 48Delete whciever not applicable.

If at any time during the Construction Period or the O&M Period, the balance in the Escrow Account falls below the Minimum Escrow Balance, ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***49 shall promptly, and in any event, no later than 90 (ninety) days, fund the Escrow Account such that the Minimum Escrow Balance is maintained. A failure to maintain the Minimum Escrow Balance for 90 (ninety) days would be treated as a ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***50 Event of Default and the consequences set out in Article 16 would follow.

It is clarified that any interest earned on the amounts deposited by ***[Name of the State***

***/ National Level Agency, if any]***/ ***[Executing Agency]***51 in the Escrow Account will be counted towards the Minimum Escrow Balance.

* + 1. The Concessionaire may withdraw amounts from the Escrow Account in accordance with the provisions of this Agreement and the Escrow Agreement.
  1. **Taxes and Royalties**
     1. The Construction Payments and the O&M Payments are inclusive of all Taxes.
     2. ***[Executing Agency]*** may deduct from the Construction Payments, the O&M Payments and any other amounts due to the Concessionaire, any income tax or withholding tax that is required to be deducted at source.
     3. The Concessionaire shall be responsible for payment of all applicable Taxes, including all procedural compliances related to the payment of Taxes pursuant to this Agreement, and shall be solely responsible for any proceedings initiated by any Government Authority, in respect of any non-payment or short-payment of Taxes.
     4. The Concessionaire shall be responsible for payment of all applicable royalties on any fine and coarse aggregate, core sand, fine sand, grit and any other minerals extracted and/or used by the Concessionaire or any Subcontractor during the Construction Period and furnish proof of payment of such royalties to ***[Executing Agency]*** along with the Invoices for the Construction Payments.
     5. Upon a request from the Concessionaire, ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]*** will provide all relevant certificates and information to enable the Concessionaire to obtain any Tax exemptions available in relation to the Project. It **is** clarified that ***[Executing Agency]*** shall not be responsible in any manner for ensuring that any applicable Tax exemptions are available to the Concessionaire.
     6. The Concessionaire shall indemnify ***[Name of the State / National Level Agency, if any]***52 and ***[Executing Agency]*** from and against any cost or liability that may arise due to the Concessionaire's failure to pay all applicable Taxes, in connection with the

49Delete whichever not applicable 50Delete whichever not applicable. 51Delete whichever not applicable. 52To be deleted if not applicable.

Project.

* + 1. Any Taxes payable in relation to the ***[Location]***Facilities Sites shall be borne by

***[Executing Agency]***.

* 1. **Default Interest**

Upon any Party's failure to make a payment due and payable by it on the due date for such payment, the defaulting Party shall be liable to pay default interest on all such outstanding amounts at the prevailing SBI MCLR + 3% per annum or part thereof. This is without prejudice to any Party's right to terminate this Agreement in accordance with Article 16 or any other right or remedy available to it under this Agreement or Applicable Laws.

* 1. **Right of Set-Off**

The Concessionaire shall not be entitled to retain or set off any amount due to {***[Name of the State / National Level Agency, if any]*** or}53***[Executing Agency]*** by it, but {***[Name of the State / National Level Agency, if any]*** or}54***[Executing Agency]*** may retain or set off any amount owed to it by the Concessionaire under this Agreement, which has fallen due and payable against any amount due to the Concessionaire under this Agreement. ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***55 shall notify the Concessionaire at the time it exercises its right to set-off and shall provide the Concessionaire its reasons for exercising such right to set-off.

* 1. **Revenue Share**

The Concessionaire agrees to pay to the Authority, for every [year] of the Concession Period, based on the audited financial report issued by an independent Auditor commencing from the [second quarter Post-COD], [10% (ten per cent)] of the Revenue from Disposal and sale of STP By-Products, FSTP By-Products, Treated Effluent, Digested Sludge, Residual Grit and Screenings, etc., **Revenue Share**

as escalated in accordance with this Article 9.

* 1. **Payment of Revenue Share**
     1. The Revenue Share payable under this Agreement shall be due and payable as follows:
        1. Revenue Share to be paid by the Concessionaire shall be due and payable within [15 (fifteen)] days of the commencement of the Financial Year. Provided that the Revenue Share for the first Financial Year shall be paid within [15 (fifteen)] days of the occurrence of the COD; and
        2. The Revenue Share shall be payable in [monthly] installments. Within [7 (seven)] days of the end of each month, the Concessionaire shall pay to the Authority against the Revenue Share, a provisional amount calculated on the basis of

53Delete if not applicable.

54Delete if not applicable.

55Delete whichever not applicable.

Revenue from Disposal of STP By-Products, FSTP By-Products, Treated Effluent, Digested Sludge, Residual Grit and Screenings, etc., of the immediately preceding month and final settlement thereof, based on audited accounts of the Concessionaire, shall be made within [120 (one hundred and twenty)] days of completion of the respective Financial Year.

The Concessionaire shall, with each payment of the Revenue Share submit: (a) a certificate that the amounts paid are correct and in accordance with the provisions of the Agreements; [(b) detailed calculations of the Revenue Share based on the Revenue from Disposal of STP By-Products, FSTP By-Products, Treated Effluent, Digested Sludge, Residual Grit and Screenings, etc.] ; (c) details in respect of Taxes/duties payable/reimbursable in accordance with the provisions of this Agreement; (d) details in respect of other Damages payable in accordance with the provisions of this Agreement; and (e) net amount payable under the provisions of this Agreement.

**ARTICLE 10**

**FINANCING ARRANGEMENTS AND SECURITY**

* 1. **Financing and Bankability Support**
     1. The Parties acknowledge that for the purposes of implementing the Project, the Concessionaire may require Financial Assistance from the Lenders. To this end, ***[Executing Agency]*** shall co-operate with the Concessionaire to achieve Financial Close, including providing such consents and waivers as may be reasonably required by the Lenders.
     2. In case of a Concessionaire Event of Default, ***[Executing Agency]*** and ***[Name of the State / National Level Agency, if any]*** acknowledge that the Lenders will have a right to substitute the Concessionaire in accordance with Clause 16.2 and the Substitution Agreement. ***[Executing Agency]*** will suspend its right to step-in or terminate this Agreement until the expiry of the period available to the Lenders to exercise their substitution rights under Clause 16.2.
     3. The Concessionaire shall maintain books of accounts recording all its receipts (including fees and other revenues derived/collected by it from or on account of any of the Facilities and/or its use), income, expenditure, payments (including payments from the Escrow Account), assets and liabilities, in accordance with this Agreement, Good Industry Practice, Applicable Laws and Applicable Permits.
     4. The Concessionaire shall not make any addition, replacement or amendments to any of the Financing Documents without the prior written consent of the ***[Executing Agency]*** if such addition, replacement or amendment has, or may have, the effect of imposing or increasing any financial liability or obligation on the ***[Executing Agency]***, and in the event that any replacement or amendment is made without such consent, the Concessionaire shall not enforce such replacement or amendment nor permit enforcement thereof against the ***[Executing Agency]***. For avoidance of doubt, the ***[Executing Agency]*** acknowledges and agrees that it shall not unreasonably withhold its consent for restructuring or rescheduling of the debt of the Concessionaire.
  2. **Security Creation**
     1. The Concessionaire shall be entitled to create assignment by way of Security over all of its rights, title and interests in and to the Concession Agreement and the Escrow Agreement in favour of the Lenders for the purpose of obtaining Financial Assistance for the Project, provided that the creation of such Security will not result in any financial liability to ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***}56.
     2. The Concessionaire shall be entitled to include the Lenders as co-insured and/or additional loss payees in any of the insurances taken by the Concessionaire in accordance with Clause 11.2 and/or grant Security over the proceeds of such insurance.

56Delete if not applicable.

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* + 1. Except for any Security created by operation of law and any Security created pursuant to this Clause 10.2, the Concessionaire shall not be entitled to create any other Security over the Concession Agreement, the Escrow Agreement or insurance policies taken by it in favour of any third Persons, without the prior written consent of ***[Executing Agency]***, which consent ***[Executing Agency]*** may deny in its sole discretion.
    2. The Concessionaire shall not be entitled to create any Security over the Site or any part thereof, or any of the Facilities or the Power Plant, if any, whether in favour of the Lenders or any third Persons.

**ARTICLE 11 INSURANCE AND INDEMNITIES**

* 1. **Indemnity and Limitation of Liability**
     1. Subject to Clause 11.1(b) below, the Concessionaire shall be responsible for release, hold harmless and indemnify ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]***, and ***[Executing Agency]*** Related Parties {and the ***[Name of the State / National Level Agency, if any]***}57 Related Parties on demand from and against, all suits, actions, claims, demands, losses, damages, fines, penalties, costs or expenses (including costs of legal fees) or liability for:
        1. death or personal injury of any person;
        2. loss of or damage to property;
        3. non-compliance with Applicable Laws or Applicable Permits (including specifically, environmental laws and environmental consents);
        4. any damage caused to the environment by the Concessionaire (including specifically, due to the Concessionaire's failure to meet the Discharge Standards); and
        5. any third-party losses or claims;

which may arise out of, or in consequence of the performance or non-performance of the Concessionaire's obligations under this Agreement.

* + 1. The Concessionaire shall not be responsible or be obliged to indemnify ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} for any injury, loss, damage, cost and expense caused by the negligence or Wilful Misconduct of ***[Executing Agency]*,** {***[Name of the State / National Level Agency, if any]***}58, ***[Executing Agency]*** Related Parties {or the ***[Name of the State / National Level Agency, if any]*** Related Parties or} by a breach by ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} of their respective obligations under this Agreement, provided the Concessionaire was/is not partly/ wholly or directly/ indirectly responsible for such injury, loss, damage, cost and expense.
    2. ***[Executing Agency]*** {and ***[Name of the State / National Level Agency, if any]***} shall have the right, but not the obligation, to contest, defend, and litigate any claim, action, suit or proceeding by any third party alleged or asserted against them in respect of, resulting from, related to or arising out of any matter for which they are entitled to be indemnified under this Agreement, and the reasonable costs and expenses (including legal fees) thereof, shall be subject to the indemnification obligations of the Concessionaire.

57Delete if not applicable.

58Contents in the curly parenthesis may be deleted if not applicable.

If, however, the Concessionaire acknowledges in writing its obligations to indemnify ***[Executing Agency]*** {and/or ***[Name of the State / National Level Agency, if any]***} in respect of loss to the full extent provided by this Agreement, the Concessionaire shall be entitled, at its option, to assume and control the defense of such claim, action, suit or proceeding at its expense and through a counsel of its choice if it gives prompt notice of its intention to do so to ***[Executing Agency]*** {and ***[Name of the State / National Level Agency, if any]***}59 and reimburses ***[Executing Agency]*** {and/or ***[Name of the State / National Level Agency, if any]***} for the costs and expenses incurred by ***[Executing Agency]*** {and/or ***[Name of the State / National Level Agency, if any]***} prior to the assumption by the Concessionaire of such defense. A Party shall not settle or compromise any such claim, action, suit or proceeding without the prior written consent of the other Parties, which consent shall not be unreasonably withheld or delayed. Notwithstanding the foregoing, ***[Executing Agency]*** {and/or ***[Name of the State / National Level Agency, if any]***} shall have the right to employ its own counsel and such counsel may participate in such action, but the fees and expenses of such counsel, as and when incurred, shall be at the expense of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***}, as the case may be.

* + 1. ***[Executing Agency]*** shall be responsible for, release, hold harmless and indemnify the Concessionaire and the Concessionaire Related Parties on demand from and against, all suits, actions, claims, demands, losses, damages, fines, penalties, costs or any other liability incurred or suffered by the Concessionaire under Applicable Laws, or pursuant to the law of torts, principles of absolute liability or strict liability or polluter pays principle, as a result of any environmental pollution or health hazard caused by the quality of raw Sewage/Faecal Sludge/Septage which is delivered at the Facilities not pertaining to the Influent Standards, for which the Concessionaire was/is not partly/ wholly or directly/ indirectly responsible.
    2. Limitation of liability
       1. Notwithstanding anything to the contrary contained in this Contract, the maximum overall liability of any Party under this Agreement shall not exceed ***[Amount of Liability]60***
       2. Provided that the limitation of liability set out in Clause 11.1(e) above shall not apply to the following:
          1. breach of Applicable Law and Applicable Permits;
          2. breach of any third-party Intellectual Property Rights;
          3. fraud and Wilful Misconduct;

59Contents in the curly parenthesis may be deleted if not applicable.

60Total agreed capital cost.

* + - * 1. gross negligence;
        2. damages to or loss of third-party property;
        3. damage caused to the environment;
        4. misrepresentation by the Concessionaire; and
        5. health hazard, bodily injury or loss of life.
      1. The Parties agree and acknowledge that the provisions of this Clause 11.1(e) in respect of limitation and exclusion of liabilities is an agreed allocation of risk between the Parties, the sufficiency of which the Parties hereby agree and acknowledge.
    1. The provisions of this Clause 11.1 shall survive the termination of this Agreement.
  1. **Insurance**
     1. The Concessionaire shall, obtain and maintain the policies of insurance set out below in the minimum coverage amounts and during the specified periods. In addition, the Concessionaire shall obtain any additional coverage required by Applicable Laws and/or deemed necessary by the Concessionaire, the Lenders or ***[Executing Agency]*** in accordance with this Clause 11.2.

Insurances during the Construction Period

During the Construction Period, the Concessionaire shall obtain and maintain such insurances for such maximum sums as may be required under the Financing Documents and Applicable Laws, and such insurances as may be necessary or prudent in accordance with Good Industry Practices.

Insurances during the O&M Period

During the O&M Period, the Concessionaire shall obtain and maintain insurance policies including but not limited to the following:

* + - 1. loss, damage or destruction of the Facilities, at replacement value;
      2. comprehensive third-party liability insurance including injury to or death of personnel of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***}61 or others caused by the Project;
      3. the Concessionaire's general liability arising out of the Project;
      4. liability to third parties for goods or property damage;
      5. workmen's compensation insurance; and
      6. any other insurance that may be necessary to protect the Facilities, the Concessionaire and its employees, including for all Force Majeure Events that are insurable at commercially reasonable premiums and not otherwise covered in items (i) to (v) above.
    1. The level of insurance to be maintained by the Concessionaire after repayment of the Lenders' dues in full shall be determined on the same principles as applicable for determining the level of insurance prior to such repayment of the Lenders' dues, in accordance with the Financing Documents.
    2. The Concessionaire shall, within 30 (thirty) days of the Effective Date, provide a notice to ***[Executing Agency]***, setting out information in respect of the insurances that it proposes to effect and maintain. Within 15 (fifteen) days of receipt of such notice, ***[Executing Agency]*** may require the Concessionaire to effect and maintain such other insurances as it may deem necessary, and in the event of any difference or disagreement relating to any such insurance, the provisions of Article 21 (*Dispute Resolution*) shall apply.
    3. The Concessionaire shall purchase insurance from reputable Indian and/or international companies licensed to operate in India, at competitive terms, and shall maintain the insurances on terms consistent with Good Industry Practices. Within 15 (fifteen) days of obtaining any insurance cover, the Concessionaire shall furnish to ***[Executing Agency]***, notarised true copies of the certificate(s) of insurance, copies of insurance policies and premium payment receipts in respect of such insurance.
    4. Each insurance policy shall contain the following endorsements:
       1. ***[Executing Agency]*** shall be additional insured under all policies maintained by the Concessionaire in relation to the Site and the Project, against loss or damage;
       2. the insurers shall waive all rights of subrogation against ***[Executing Agency]***

{and ***[Name of the State / National Level Agency, if any]***}62;

* + - 1. the insurance policy may not be cancelled or materially changed by the insurer without giving 45 (forty five) days' prior written notice, except in the case of non- payment, in which case it will be 10 (ten) days' prior written notice, to ***[Executing Agency]***; and
      2. ***[Executing Agency]*** shall not be responsible for payment of any insurance premium.
    1. Any changes in the insurances which impact the Site, or the Project will need the prior written consent of ***[Executing Agency]***, which consent shall not be unreasonably withheld.

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* + 1. The Concessionaire shall apply proceeds from all insurance claims, except life and injury, for any necessary repair, reconstruction, reinstatement, replacement, improvement, delivery or installation of the Facilities, and the balance remaining, if any, shall be applied in accordance with the provisions contained in this behalf in the Financing Documents.
    2. If the Concessionaire fails to procure or maintain any insurance required pursuant to this Clause 11.2 which is required to be obtained for the Site or the Project, ***[Executing Agency]*** shall have the right to procure and maintain such insurance in accordance with the requirements of this Clause 11.2 and charge the full cost thereof to the Concessionaire.

**ARTICLE 12 CHANGE IN OWNERSHIP**

* 1. **Ownership Information**

The Selected Bidder shall inform ***[Executing Agency]*** that it has caused the Concessionaire to be incorporated as a special purpose company to implement the Project and undertake other obligations of the Concessionaire under and in accordance with this Agreement. The shareholding pattern of the ***[Selected Bidder/Members]63*** in the Concessionaire is as follows:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Name of the shareholder** | **No. of**  **shares held** | **Nature of the**  **shares [Equity/ Preference]** | **Value of the shares held [INR]** | **Shareholdi ng [in %]** |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

The Concessionaire represents and warrants to ***[Executing Agency]*** {and ***[Name of the State / National Level Agency, if any]***}64 that no arrangements are in place that have resulted or may result in a breach of the change in ownership restrictions set out in Clause 12.2 below.

* 1. **Change in Ownership Restrictions**
     1. The Concessionaire shall ensure that the Selected Bidder holds at least 51% (fifty one per cent) of the total Capital and voting rights of the Concessionaire until the COD, and at least [26% (twenty six per cent)] of the total Capital and voting rights of the Concessionaire until [1 (one)] year after the COD.

After the expiry of [1 (one)] year from the COD, with the prior consent of the ***[Executing Agency]***, the Selected Bidder can exit the Concessionaire, subject to: (i) the entity acquiring the shareholding of the Selected Bidder in the Concessionaire meeting the O&M qualification criteria set out in the RFP; or (ii) the Concessionaire appointing an O&M contractor who complies with the technical qualification criteria set out in the RFP.]65

* + 1. The Concessionaire shall ensure that the change in ownership restrictions set out in Clause 12.2(a) are incorporated in the articles of association of the Concessionaire.
    2. If, any Associate, whose credentials were taken into consideration for determining Technical Capacity, ceases or will cease to be an Associate of the ***[Selected Bidder/Member]66,*** then, the Concessionaire shall seek the approval of ***[Executing Agency]*** for such occurrence along with all relevant details. While ***[Executing Agency]*** shall not unreasonably withhold or delay such approval, the decision of ***[Executing***

63 Delete Member if the Selected Bidder is a single entity.

64Delete if not applicable.

65 This paragraph may be deleted if the Selected Bidder is a Consortium.

***Agency]*** will be final in this regard. If ***[Executing Agency]*** is of the view that such occurrence is likely to affect the Technical Capacity of the Concessionaire to undertake the Project, then ***[Executing Agency]*** may treat such occurrence as a Concessionaire Event of Default, in which case the consequences set out in Article 16 shall follow.

* + 1. If, at any time after the expiry of [1 (one)] year from the COD, the ***[Selected Bidder/any Member]67***is proposed to be replaced by an entity that meets the O&M qualification criteria set out in the RFP or the Concessionaire proposes to appoint an O&M contractor to meet the change in ownership condition set out in Clause 12.2(a), then the Concessionaire shall submit a proposal to ***[Executing Agency]*** with details of the proposed shareholder/O&M contractor, for its approval. The proposal should demonstrate to the satisfaction of ***[Executing Agency]*** that the Concessionaire or the proposed O&M contractor meets the O&M qualification criteria specified in the RFP.

Within 15 (fifteen) days of receipt of a proposal from the Concessionaire, ***[Executing Agency]*** shall notify the Concessionaire of its approval or rejection (along with reasons) of the proposed shareholder/O&M contractor.

The approval of the proposed shareholder/O&M contractor by ***[Executing Agency]***

shall be at ***[Executing Agency]***'s sole discretion.

If ***[Executing Agency]*** does not notify its approval or rejection of the proposed shareholder/O&M contractor within 60 (sixty) days of the receipt of the proposal from the Concessionaire, then such proposed shareholder/O&M contractor will be deemed to be approved by ***[Executing Agency]*.**

**ARTICLE 13 CHANGE IN LAW**

* 1. **Change in Law**

The Concessionaire may claim the benefit of and/or relief for a Change in Law event subject to and in accordance with this Article 13.

* 1. **Consequences of Change in Law**
     1. The Concessionaire shall not be allowed any relief and/or compensation for any Change in Law which is not a: (i) Qualifying Change in Law; or (ii) Fundamental Change in Law.
     2. If a Qualifying Change in Law occurs, then the Concessionaire shall notify ***[Executing Agency]*** {and ***[Name of the State / National Level Agency, if any]***}68 of such Qualifying Change in Law along with details of:
        1. any necessary change in the Construction Plan, the O&M Manual or the Technical Specifications on the basis of which construction works and O&M services are required to be undertaken for the Facilities;
        2. any changes that are required to the terms of this Agreement to deal with such Qualifying Change in Law;
        3. any extension of the Scheduled Payment Milestone Completion Date or the Scheduled Construction Completion Date, to account for the delay, if any, resulting from the Qualifying Change in Law; and/or
        4. any increase in Costs that will result from the Qualifying Change in Law.
     3. As soon as practicable and in any event, within 30 days from the receipt of any notice from the Concessionaire under Clause 13.2(b) above, the Parties shall agree on the consequences of the Qualifying Change in Law, as specified in the notice, and any way in which the Concessionaire can mitigate the effect of the Qualifying Change in Law, including:
        1. providing evidence that the Concessionaire has used reasonable endeavors (including, where practicable, the use of competitive quotes) to minimise any increase in Costs or oblige the Subcontractors to minimise any increase in Costs;
        2. providing evidence as to how the Qualifying Change in Law has affected prices of materials used for construction or O&M of STP which are similar to the Facilities; and
        3. demonstrating to ***[Executing Agency]*** {and ***[Name of the State / National Level***

68Contenets in curly parenthesis may be deleted if not applicable..

***Agency, if any]***} that the Qualifying Change in Law is the direct cause of the increase in Costs or delay and the estimated increase in Costs, or extension of time could not reasonably be expected to be mitigated or recovered by the Concessionaire.

* + 1. If the Parties fail to agree on the consequences of the Qualifying Change in Law within 30 days from the receipt of any notice from the Concessionaire under Clause 13.2(b) above, the dispute will be finally settled in accordance with the dispute resolution procedure set out in Article 21 (Dispute Resolution).
    2. If the Concessionaire has complied with Clause 13.2 (c) above and the Parties mutually agree or it is determined in accordance with Clause 13.2 (d) above, that the Concessionaire is required to incur additional Costs due to a Qualifying Change in Law, then:
       1. the Concessionaire shall be required to bear all Costs resulting from any one or more Qualifying Change in Law events, up to an aggregate amount equivalent to 0.5% of the total Bid Project Cost (Threshold Limit); and
       2. for any additional Costs resulting from the Qualifying Change in Law, which is in excess of the Threshold Limit, the Concessionaire shall be entitled to be compensated for such additional Costs, in excess of the Threshold Limit, by way of,
          1. a lump-sum payment of an amount equivalent to the additional Costs incurred by the Concessionaire, over and above the Threshold Limit; or
          2. an appropriate adjustment in the O&M Charges.
    3. If the Concessionaire has complied with Clause 13.2(c) above and the Parties mutually agree or it is determined in accordance with Article 21 that the Concessionaire will suffer any delay as a result of the occurrence of a Qualifying Change in Law, then the Concessionaire shall be entitled to an extension of time in accordance with Clause 7.11(b).
    4. In case of a dispute with respect to the quantum of relief (whether extension of time or compensation) that the Concessionaire shall be entitled to under this Clause 13.2 shall be as agreed by the Parties or as determined in accordance with Article 21, provided always that:
       1. the Concessionaire shall bear any increased Cost to the extent of the Threshold Limit; and
       2. the Concessionaire shall only be entitled to relief that is reasonable for such Qualifying Change in Law.
    5. Notwithstanding anything to the contrary in this Agreement, the Concessionaire shall not be entitled to any schedule relief and/or compensation or adjustment in the Bid

Project Cost or the O&M Charges due to a Qualifying Change in Law, if such Qualifying Change in Law becomes applicable as a result of a delay in the execution of the Project, which is not attributable to a Delay Event.

* + 1. If a Fundamental Change in Law occurs, then,
       1. the affected Party may notify the other Parties of the effects of such Fundamental Change in Law on the validity and enforceability of this Concession Agreement or on the rights of the Concessionaire under this Agreement; and
       2. any Party may propose amendments to the Concession Agreement, which would make the Concession Agreement compliant with Applicable Laws, while enabling the Parties to achieve their commercial objectives.

If the Parties are unable to agree on necessary amendments to the terms of this Agreement within 30 days of receipt of a notice from the affected Party or the Fundamental Change in Law event is such that it cannot be mitigated with amendments to the terms of this Agreement, the Fundamental Change in Law event shall be treated as a Direct Political Force Majeure Event in accordance with Article 14.

**ARTICLE 14 FORCE MAJEURE**

* 1. **Force Majeure Events**
     1. A **Force Majeure Event** means any act, event or circumstance or a combination of acts, events or circumstances or the consequence(s) thereof occurring after the date of this Agreement, which is/are:
        1. beyond the reasonable control of the Affected Party;
        2. such that the Affected Party is unable to overcome or prevent despite exercise of due care and diligence;
        3. which does/do not result from the negligence of such Affected Party or the failure of such Affected Party to perform its obligations hereunder; and
        4. such that it/they has/have a Material Adverse Effect.
     2. A Force Majeure Event means the following events and circumstances to the extent that they satisfy the conditions set out in Clause 14.1(a):
        1. Non-Political Force Majeure Events
           1. acts of God including storm, tempest, cyclone, hurricane, tsunami, flood, whirlwind, lightning, earthquake, washout, landslide, soil erosion, volcanic eruption, or extreme adverse weather or environmental conditions or actions of the elements;
           2. fire or explosion caused by reasons not attributable to the Concessionaire or any Concessionaire Related Parties;
           3. chemical or radioactive contamination or ionising radiation;
           4. epidemic, plague or quarantine;
           5. the discovery of geological conditions, toxic contamination or archaeological remains on the Site that could not reasonably have been expected to be discovered through a site inspection; and
           6. accidents of navigation, air crash, shipwreck, train wreck or other similar failures of transportation of equipment and/or material necessary for construction or O&M of the Facilities.

Non-Political Force Majeure Event shall not include the following conditions, except to the extent resulting from a Non-Political Force Majeure Event:

1. heavy rainfall;
2. quantum of the Sewage/Faecal Sludge/Septage being more than the Design Capacity;
3. characteristics of the Sewage/Faecal Sludge/Septage being beyond the Influent Standards;
4. unavailability, late delivery or changes in cost of plant, machinery, equipment, materials or spare parts required for undertaking the Project;
5. a delay in the performance of any Subcontractor;
6. non-performance resulting from normal wear and tear; or
7. non-performance caused by the non-performing Party's (I) negligent or intentional acts, errors or omissions, (II) failure to comply with the Applicable Laws or Applicable Permits, or (III) breach of, or default under, this Agreement, as the case may be.
   * + 1. Indirect Political Force Majeure Events
          1. hostilities (whether declared as war or not), riot, civil disturbance, revolution, rebellion, insurrection, act of terrorism, in each case involving the GoI or the Go***[XX]69*** or occurring in ***[State of Location]***;
          2.     

embargo, revolution, insurgency, nuclear blast/explosion, politically motivated sabotage, religious strife or civil commotion, in each case involving the GoI or the Go***[XX]*** or occurring in ***[State of Location]***;

* + - * 1. strikes or boycotts (including non-political strikes other than those involving the Concessionaire, Sub-Contractors or their respective employees/representatives, or attributable to any act or omission of any of them and the indirectpolitical strikes such as industry-wide or state-wide strikes), lockout, or other industrial disputes which are not directly attributable to the actions of the Affected Party;
        2. any orders issued by the relevant Government Authority, which require the Concessionaire to suspend the construction or O&M of the Facilities provided that, such orders are not attributable to the Concessionaire's breach or violation of any Applicable Laws or Applicable Permits; and
        3. delay or failure by relevant Government Authorities in renewing or granting any Applicable Permit, despite the Concessionaire having applied for such Applicable Permit expeditiously and complied with the requirements of Applicable Laws in making such application or the unlawful revocation of any Applicable Permit.
      1. Direct Political Force Majeure Events

69Name of the State Government.

* + - * 1. occurrence of a Fundamental Change in Law in accordance with Clause 13.2(i);
        2. compulsory acquisition in national interest or expropriation of the Site; and
        3. any order, notification or judgement issued or passed by any Government Authority/ Court of Law/ Tribunal which restricts the Concessionaire from constructing or operating the Facilities as contemplated in this Agreement on the Site, unless such restriction is, in any manner, attributable to the Concessionaire.
    1. Without prejudice to the provisions of Clauses 14.1(a) or 14.1(b) above,
       1. any act, event or circumstance which primarily affects any of the Concessionaire Related Parties associated with the Project shall constitute a Force Majeure Event if and to the extent that it is of a kind or character that, if it had directly affected the Concessionaire, it would have come within the definition of Force Majeure Event under this Clause 14.1; and
       2. any act, event or circumstance which primarily affects any of ***[Executing Agency]*** Related Parties {or the ***[Name of the State / National Level Agency, if any]*** Related Parties}70 shall constitute a Force Majeure Event if and to the extent that it is of a kind or character that, if it had directly affected ***[Executing Agency]*** or {***[Name of the State / National Level Agency, if any]***}, it would have come within the definition of Force Majeure Event under this Clause 14.1.
    2. If the Parties are unable to agree in good faith on the occurrence or existence of a Force Majeure Event, such dispute shall be finally settled in accordance with the dispute resolution procedure set out in Article 21, provided however that the burden of proof as to the occurrence or existence of such Force Majeure Event shall be upon the Affected Party.
  1. **Notice of Force Majeure Events**
     1. The Affected Party shall give notice to the other Party in writing of the occurrence of any Force Majeure Event (the **FM Notice**), as soon as the same arises or as soon as reasonably practicable and in any event within 3 days after the Affected Party knew of its occurrence, the adverse effect it has or is likely to have on the performance of its obligations under this Agreement, the actions being taken and an estimate of the time period required to overcome the Force Majeure Event and/or its nature and effects (if it is possible to estimate the same).
     2. If, following the issue of the FM Notice, the Affected Party receives or becomes aware of any further information relating to the Force Majeure Event, it shall submit such further information to the other Party as soon as reasonably practicable.
     3. Any party claiming to have been affected by a Force Majeure Event shall not be entitled

70Contents in curly parenthesis may be deleted if found not applicable.

to any relief unless it has complied with all the provisions of this Clause 14.2.

* 1. **Excuse of Performance**

If the Affected Party is rendered wholly or partially unable to perform its obligations under this Agreement because of a Force Majeure Event, it shall be excused from performance of such of its obligations to the extent it is unable to perform on account of such Force Majeure Event; provided that:

* + 1. the suspension of performance shall be of no greater scope and of no longer duration than is reasonably required by the Force Majeure Event;
    2. the Affected Party shall make all reasonable efforts to mitigate or limit damage to the other Party arising out of or as a result of the existence or occurrence of such Force Majeure Event and to cure the same with due diligence; and
    3. when the Affected Party is able to resume performance of its obligations under this Agreement, it shall give to the other Party notice to that effect and shall promptly resume performance of its obligations hereunder.

If a Force Majeure Event affects only one Facilities, and not the other Facilities, then the Affected Party shall only be excused from the performance of its obligations in relation to the affected Facilities.

* 1. **No Liability for Other Losses**

Save and except as expressly provided in this Agreement, no Party shall be liable in any manner whatsoever to the other Parties in respect of any loss relating to or arising out of the occurrence or existence of any Force Majeure Event or the exercise by it of any right pursuant to this Article 14.

* 1. **Resumption of Performance**

The Affected Party shall in consultation with the other Parties, make all reasonable efforts to limit or mitigate the effects of a Force Majeure Event on the performance of its obligations under this Agreement. The Affected Party shall also make efforts to resume performance of its obligations under this Agreement as soon as possible and upon resumption, shall notify the other Parties of the same in writing. The other Parties shall afford all reasonable assistance to the Affected Party in this regard.

* 1. **Allocation of costs during a Force Majeure Event**
     1. Upon occurrence of a Force Majeure Event prior to the COD, the Parties shall bear their respective Costs and no Party shall be required to pay any Costs to the other Parties.
     2. Upon occurrence of a Force Majeure Event after the COD, the costs incurred and

attributable to such event and directly relating to the Facilities (the **Force Majeure Costs** ) shall be allocated and paid as follows:

* + - 1. upon occurrence of a Non-Political Event, the Parties shall bear their respective Force Majeure Costs and neither Party shall be required to pay to the other Party any costs thereof;
      2. upon occurrence of an Indirect Political Event, all Force Majeure Costs attributable to such Indirect Political Event, and not exceeding the Insurance Cover for such Indirect Political Event, shall be borne by the Concessionaire, and to the extent Force Majeure Costs exceed such Insurance Cover, one half of such excess amount shall be reimbursed by the Authority to the Concessionaire; and
      3. upon occurrence of a Political Event, all Force Majeure Costs attributable to such Political Event shall be reimbursed by the Authority to the Concessionaire.

Provided that upon occurrence of a Force Majeure Event post the COD, the Concessionaire shall be entitled to continue receiving the Capex Annuity (along with interest) and the O&M Charges during the subsistence of the Force Majeure Event.

* + 1. For avoidance of doubt, Force Majeure Costs may include interest payments on debt, O&M Charges, any increase in the cost of development, construction and operation and maintenance of the Facilities on account of inflation and all other costs directly attributable to the Force Majeure Event, but shall not include loss of Revenue, or debt repayment obligations, and for determining such costs, information contained in the Financial Package may be relied upon to the extent that such information is relevant.
    2. Save and except as expressly provided in this Article, neither Party shall be liable in any manner whatsoever to the other Party in respect of any loss, damage, cost, expense, claims, demands and proceedings relating to or arising out of occurrence or existence of any Force Majeure Event or exercise of any right pursuant hereto.
  1. **Termination due to Force Majeure Event**
     1. **Termination due to a Non-Political Force Majeure Event**

If within a continuous period of [365 (three hundred and sixty five)] days, a Non- Political Force Majeure Event continues for a period of [180 (one hundred and eighty)] days or more, after the notification of a Non-Political Force Majeure Event or any extended period agreed in pursuance of Clause 14.3, any Party shall, after the expiry of the period of [180 (one hundred and eighty)] days or any other mutually extended period, be entitled to forthwith terminate this Agreement in its sole discretion by issuing a notice to that effect to the other Parties.

Notwithstanding anything contained in this Clause 14.7:

* + - 1. if the ***[Location]*** Facilities are affected by a Total Casualty, then the Concessionaire may terminate this Agreement without having to wait for the expiry of the period of [180 (one hundred and eighty)] days stipulated for a Non- Political Force Majeure Event;
      2. if the ***[Location]*** Facilities are affected by a Minor Casualty, then the Concessionaire shall be required to repair and restore the ***[Location]*** Facilities to the same condition as previously existed and the Concessionaire shall not be entitled to terminate this Agreement on the grounds of a continuing Non-Political Force Majeure Event.
    1. **Termination due to an Indirect Political Force Majeure Event**

If within a continuous period of [365 (three hundred and sixty five)] days, an Indirect Political Force Majeure Event continues for a period of [180 (one hundred and eighty)] days or more, after the notification of an Indirect Political Force Majeure Event or any extended period agreed in pursuance of Clause 14.3, any Party shall, after the expiry of the period of [180 (one hundred and eighty)] days or any other mutually extended period, be entitled to forthwith terminate this Agreement in its sole discretion by issuing a notice to that effect to the other Parties.

* + 1. **Termination due to a Direct Political Force Majeure Event**

If within a continuous period of [365 (three hundred and sixty five)] days, an Direct Political Force Majeure Event continues for a period of [180 (one hundred and eighty)] days or more, after the notification of a Direct Political Force Majeure Event or any extended period agreed in pursuance of Clause 14.3, any Party shall, after the expiry of the period of [180 (one hundred and eighty)] days or any other mutually extended period, be entitled to forthwith terminate this Agreement in its sole discretion by issuing a notice to that effect to the other Parties.

All the other consequences of termination that are set out at Article 17 shall apply in case of termination of this Agreement due to a Force Majeure Event.

**ARTICLE 15 SUSPENSION**

* 1. **[Suspension by the Concessionaire**
     1. Suspension of construction or O&M of the Facilities
        1. At any time during the Term, the Concessionaire may suspend, whether partially or wholly, the construction or O&M of any Facilities, in case of an Emergency.
        2. The Concessionaire acknowledges that suspension of the construction of any Facilities during the Construction Period pursuant to Clause 15.1(a)(i) shall not entitle the Concessionaire to an extension of time, if such event is attributable to the Concessionaire.
        3. In case of suspension of the performance of the O&M services of any Facilities pursuant to Clause 15.1(a)(i) for reasons attributable to the Concessionaire, the Concessionaire shall be entitled to continue to receive the Capex Annuity along with interest, but not the O&M Charges, for the period during which it suspends the performance of the O&M services pursuant to Clause 15.1(a)(i).
        4. In case of suspension of the performance of the O&M services pursuant to Clause 15.1(a)(i) for reasons not attributable to the Concessionaire, the Concessionaire shall be entitled to continue to receive the Capex Annuity along with interest, and the O&M Charges, for the period during which it suspends the performance of the O&M services pursuant to Clause 15.1(a)(i).
        5. Upon the occurrence of an Emergency, the Concessionaire shall as soon as reasonably possible, and in no event later than 3 (three) days after such occurrence, notify ***[Executing Agency]*** of such occurrence.
        6. If, upon notification, ***[Executing Agency]*** does not concur with the Concessionaire on the nature of such occurrence, then the Concessionaire shall be required to immediately re-commence the construction or O&M of the Facilities, as the case may be. Upon re-commencement of the construction or O&M services, the Concessionaire may initiate a Dispute regarding its claim for the occurrence of such an event or circumstance, and such Dispute shall be finally settled in accordance with the dispute resolution procedure set out in Article 21, provided however that the burden of proof as to the occurrence or existence of such an event shall be upon the Concessionaire.]
     2. Mitigation, Resumption and Termination
        1. The Concessionaire shall make best endeavors to:
           1. mitigate the effects (including incremental costs and delays) of the events or circumstances resulting in suspension pursuant to Clause 15.1(a)(i) above. Notwithstanding anything to the contrary contained in this

Agreement, if ***[Executing Agency]*,** in its sole assessment, is not satisfied with the steps being taken by the Concessionaire to mitigate the effects of the Emergency, ***[Executing Agency]*** shall have the right to step-in to this Agreement and undertake necessary measures to mitigate the effect of the Emergency at the cost and risk of the Concessionaire; and

* + - * 1. resume the construction or O&M services of the Facilities within 24 hours of the ceasing of any of the events or circumstances resulting in suspension pursuant to Clause 15.1(a)(i) or such longer period as may be approved by ***[Executing Agency]*** and notify ***[Executing Agency]*** of the resumption of the works or services.
      1. Without prejudice to Clause 15.1(b)(i):
         1. if suspension of the construction or O&M of a Facilities pursuant to Clause 15.1(a)(i) continues for a period of 60 days, and such event is attributable to the Concessionaire, then such suspension shall amount to a Concessionaire Event of Default in accordance with Clause 16.1; and
         2. if suspension of the construction or O&M of a Facilities pursuant to Clause 15.1(a)(i) continues for a period of 60 days, and such event is not attributable to the Concessionaire, then such event will be treated as a Force Majeure Event and the consequences set out in Article 14 shall apply.
  1. **Suspension by *[Executing Agency]***
     1. Suspension of construction and/or O&M of the Facilities
        1. At any time during the Term, ***[Executing Agency]*** may suspend, whether partially or wholly, the construction or O&M of a Facilities, in any of the following events or circumstances:
           1. upon the occurrence of an Emergency; or
           2. if the Concessionaire fails to comply with Applicable Laws, Applicable Permits, the ESHS Documents, the O&M Manual or otherwise fails to perform its obligations in accordance with this Agreement (including the Technical Specifications).
        2. The Concessionaire acknowledges that suspension of the construction of the Facilities during the Construction Period pursuant to Clause 15.2(a)(i) shall not entitle the Concessionaire to an extension of time if such event is attributable to the Concessionaire.
        3. In case of suspension of the performance of the O&M services pursuant to Clause 15.2(a)(i) for reasons attributable to the Concessionaire, the Concessionaire shall be entitled to continue to receive the Capex Annuity along with interest, less the

Liquidated Damages payable by the Concessionaire for failure to operate the Facilities pursuant to Clause 15.2(a)(i). The Concessionaire shall not be entitled to the O&M Charges for the period during which it suspends the performance of the O&M services pursuant to Clause 15.2(a)(i).

* + - 1. In case of suspension of the performance of the O&M services pursuant to Clause 15.2(a)(i) for reasons not attributable to the Concessionaire, the Concessionaire shall be entitled to continue to receive the Capex Annuity along with interest, and the O&M Charges, for the period during which it suspends the performance of the O&M services pursuant to Clause 15.2(a)(i).
    1. Mitigation, Resumption and Termination
       1. The Concessionaire shall make best endeavors to:
          1. mitigate the effects (including incremental costs and delays) of the events or circumstances resulting in suspension pursuant to Clause 15.2(a) above. Notwithstanding anything to the contrary contained in this Agreement, if ***[Executing Agency]***, in its sole assessment, is not satisfied with the steps being taken by the Concessionaire to mitigate the effects of the Emergency, ***[Executing Agency]*** shall have the right to step-in to this Agreement and undertake necessary measures to mitigate the effect of the Emergency at the cost (as determined by the Project Engineer) and risk of the Concessionaire; and
          2. resume the construction or O&M services of the relevant Facilities within 24 hours of the ceasing of any of the events or circumstances resulting in suspension pursuant to Clause 15.2(a) or such longer period as may be agreed between the Parties, and notify ***[Executing Agency]*** of the resumption of the works or services.
       2. Without prejudice to Clause 15.2(b)(i):
          1. if suspension of the construction or O&M of the relevant Facilities pursuant to Clause 15.2(a)(i)(A) and the Emergency is attributable to the Concessionaire, or a suspension pursuant to Clause 15.2(a)(i)(B), continues for a period of 60 days, and such suspension is attributable to the Concessionaire then such suspension shall amount to a Concessionaire Event of Default in accordance with Clause 16.1; and
          2. if suspension of the construction or O&M of the relevant Facilities pursuant to Clause 15.2(a)(i)(A) continues for a period of 60 days, and such suspension is not attributable to the Concessionaire, then such suspension will be treated as a Force Majeure Event and the consequences set out in Article 14 shall apply.

**ARTICLE 16 EVENTS OF DEFAULT**

* 1. **Concessionaire Events of Default**

A **Concessionaire Event of Default** means any of the following events arising out of any acts or omissions of the Concessionaire and which have not occurred solely as a consequence of a ***[Executing Agency]*** Event of Default,{an ***[Name of the State / National Level Agency, if any]*** Event of Default}, a Qualifying Change in Law, a Fundamental Change in Law or any other Force Majeure Event, and where the Concessionaire has failed to remedy the defects within any specified time period (to the extent any time period is provided):

* + 1. failure of the Concessionaire to complete the construction of a Facilities by the expiry of the Grace Period;
    2. failure of the Concessionaire to pay the Delay Liquidated Damages within the timelines specified in this Agreement;
    3. failure of the Concessionaire to achieve successful completion of Trial Operations of a Facilities in accordance with Clause 7.14;
    4. failure of the Concessionaire to remedy any reduction in Availability within 3 days of receipt of a notice from ***[Executing Agency]*** in accordance with Clause 8.12(a)(v);
    5. for any Facilities, failure of the Concessionaire to cure a Third Breach within 20 days from the Third Breach Notice or a failure to comply with the Discharge Standards results in occurrence of a Third Breach more than 3 times in a continuous 12 (twelve) month period, in accordance with Clause 8.12(b)(iii)(D);
    6. for any Facilities, failure of the Concessionaire to achieve the KPIs for 2 (two) consecutive days, 32 (thirty two) times in a continuous 12 (twelve) month period;
    7. for any Facilities, failure of the Concessionaire to achieve the KPIs for one day, 64 (sixty four) times in a continuous 12 (twelve) month period;
    8. suspension of the construction or O&M of a Facilities pursuant to Clause 15.1(a)(i) (to the extent such Emergency is attributable to the Concessionaire) for a continuous period of 60 (sixty) days;
    9. suspension of construction or O&M of a Facilities pursuant to Clause 15.2(a)(i)(A) (to the extent the Emergency is attributable to the Concessionaire) or a suspension pursuant to Clause 15.2(a)(i)(B), for a continuous period of 60 (sixty) days;
    10. a breach by the Concessionaire of its obligations under this Agreement which has a Material Adverse Effect on the ability of the Concessionaire to construct and/or operate and maintain the Facilities and such breach, if capable of being remedied, is not remedied within 30 (thirty) days of issuance of written notice from ***[Executing Agency]*** specifying such breach and requiring the Concessionaire to remedy the same;
    11. any representation made or warranties given by the Concessionaire under this Agreement being found to be false or misleading in any material respect;
    12. failure of the Concessionaire to submit and maintain a valid Performance Security in accordance with Clause 5.1 or a valid O&M Security in accordance with Clause 5.4;
    13. failure of the Concessionaire to maintain a valid Mobilization Advance Guarantee in accordance with Clause 5.21;
    14. breach by the Concessionaire of its obligations under Article 4, 10.2 or 23.12;
    15. breach of the Concessionaire's obligations under Article 12;
    16. failure of the Concessionaire to obtain, renew and maintain any Concessionaire Applicable Permit;
    17. failure of the Concessionaire to comply with any Applicable Law (including specifically the EPA);
    18. failure of the Concessionaire to obtain and maintain insurance cover in accordance with Clause 11.2;
    19. failure of the Concessionaire or the Subcontractors to comply with the ESHS Documents in accordance with Clause 7.4;
    20. (i) a resolution for insolvency of the Concessionaire is passed, or any petition for insolvency of the Concessionaire is initiated before a court (including tribunal) of competent jurisdiction in accordance with the provisions of Insolvency and Bankruptcy Code, 2016 and such application has not been withdrawn within 14 (fourteen) days of the date thereof;

1. if a trustee or receiver is appointed for the Concessionaire or for the whole or material part of its assets that has a material bearing on the Project;
2. a resolution for winding up of the Concessionaire is passed, or any petition for winding up of the Concessionaire is admitted by a court(including tribunal) of competent jurisdiction in accordance with the provisions of Insolvency and Bankruptcy Code, 2016 or Companies Act, 1956/Companies Act, 2013 and a liquidator or receiver is appointed and such order has not been set aside within 90(ninety) days of the date thereof or the Concessionaire is ordered to be wound up by Court except for the purpose of amalgamation or reconstruction; provided that, as part of such amalgamation or reconstruction, the entire property, assets and undertaking of the Concessionaire are transferred to the amalgamated or reconstructed entity and that the amalgamated or reconstructed entity has unconditionally assumed the obligations of the Concessionaire under this Agreement and the agreements in relation thereto; and provided that:
   1. the amalgamated or reconstructed entity has the capability and operating experience necessary for the performance of its obligations under this Agreement and the agreements in relation thereto; and
   2. the amalgamated or reconstructed entity has the financial standing to perform its obligations under this Agreement and the agreements in relation thereto and has a credit worthiness at least as good as that of the Concessionaire as at the Effective Date; or
      1. the breach of the Concessionaire's obligations under or the occurrence of an 'event of default' or analogous event under the Financing Documents or the Escrow Agreement, or termination of the Financing Documents, or the Escrow Agreement (for reasons attributable to the Concessionaire).
      2. [failure of the Concessionaire to meet the obligations in Clause 3.2(d) and 3.2(e) of the RFP document.]71
      3. [failure of the Concessionaire to meet the obligations in Clause 2.4(c) of this Concession Agreement.]72
   3. **Notice of Intent to Terminate upon occurrence of a Concessionaire Event of Default**
      1. Without prejudice to the other provisions of this Agreement, upon the occurrence of a Concessionaire Event of Default, ***[Executing Agency]*** may initiate termination by delivering a Notice of Intent to Terminate to the Concessionaire,{ with a copy to ***[Name of the State / National Level Agency, if any]***}73. The Notice of Intent to Terminate shall specify with reasonable detail the grounds on which termination is sought.
      2. If, within 60 days from the date of the Notice of Intent to Terminate, the Concessionaire rectifies or remedies the Event of Default to the satisfaction of ***[Executing Agency]*** or ***[Executing Agency]*** is satisfied with the steps taken or proposed to be taken by the Concessionaire or the Event of Default has ceased to exist, ***[Executing Agency]*** shall withdraw the Notice of Intent to Terminate, in writing.
      3. If, within 60 days from the date of the Notice of Intent to Terminate, the Concessionaire does not rectify or remedy the Event of Default to the satisfaction of ***[Executing Agency]*** or ***[Executing Agency]*** is not satisfied with the steps taken or proposed to be taken by the Concessionaire to remedy the Event of Default, ***[Executing Agency]*** shall issue a notice to the Lenders to exercise their substitution rights.
      4. If, within 60 days from the date of receipt of the Notice of Intent to Terminate pursuant to Clause 16.2(c) or such longer period as may be mutually agreed between ***[Executing Agency]*** and the Lenders, the Lenders have notified their intent to substitute the defaulting Concessionaire, then:

71To be deleted if not applicable 72To be deleted if not applicable 73To be deleted if not applicable.

* + - 1. ***[Executing Agency]*** shall withdraw the Notice of Intent to Terminate, in writing, with a copy to the Lenders; and
      2. the process set out in the Substitution Agreement for nomination and approval of a substitute concessionaire will apply.
    1. If, within 60 days from the date of receipt of the Notice of Intent to Terminate pursuant to Clause 16.2(c) or such longer period as may be mutually agreed between ***[Executing Agency]*** and the Lenders, the Lenders have not notified their intent to substitute the defaulting Concessionaire, then, ***[Executing Agency]*** shall terminate the Agreement and the consequences set out in Article 17 shall apply.
    2. Notwithstanding anything contained in this Clause 16.2, during the subsistence of a Concessionaire Event of Default, the Parties shall continue to perform such of their respective obligations under this Agreement, which are capable of being performed in accordance with this Agreement.
  1. ***[Executing Agency]*'s Events of Default**

***[Executing Agency]* Event of Default** means any of the following events, unless such an event has occurred as a consequence of a Concessionaire Event of Default, or a Force Majeure Event and where ***[Executing Agency]*** has failed to remedy the defects within any specified time period (to the extent any time period is provided):

* + 1. a breach by ***[Executing Agency]*** of Clause 23.12 (b);
    2. a breach by ***[Executing Agency]*** of its obligations under this Agreement which has a Material Adverse Effect on the ability of the Concessionaire to construct or operate and maintain a Facilities and such breach, if capable of being remedied, is not remedied within 30 (thirty) days of a notice being given by the Concessionaire;
    3. failure to achieve successful completion of Trial Operations due to the inadequate quantity or inferior quality of the Sewage/Faecal Sludge/Septage delivered to the relevant Facilities;
    4. a breach by ***[Executing Agency]*** of its obligations under Clause 7.8(g) or Clause 8.5(d), in relation to its rights, title and interest in the Site; or
    5. any representation made or warranties given by ***[Executing Agency]*** under this Agreement being found to be false or misleading in any material respect.
  1. ***[Name of the State / National Level Agency, if any]*'s74 Events of Default**

An ***[Name of the State / National Level Agency, if any]* Event of Default** means any of the following events, unless such an event has occurred as a consequence of a Concessionaire

74If not applicable the provisions under this Clause shall be added to the Executing Agency event default in Clause 16.3.

Event of Default, or a Force Majeure Event and where ***[Name of the State / National Level Agency, if any]*** has failed to remedy the defects within any specified time period (to the extent any time period is provided):

* + 1. a failure by ***[Name of the State / National Level Agency, if any]*** to pay any undisputed amounts due and payable for 90 consecutive days, notwithstanding service of a formal written demand by the Concessionaire;
    2. a failure by ***[Executing Agency]***/***[Name of the State / National Level Agency, if any]***

to maintain the Minimum Escrow Balance for a period of 90 (ninety) days;

* + 1. a breach by ***[Name of the State / National Level Agency, if any]*** of Clause 23.12 (b); or
    2. any representation made or warranties given by ***[Name of the State / National Level Agency, if any]*** under this Agreement being found to be false or misleading in any material respect.
  1. **Notice of Intent to Terminate upon occurrence of a *[Executing Agency]* Event of Default**

**{or an *[Name of the State / National Level Agency, if any]* Event of Default}**

* + 1. Without prejudice to the other provisions of this Agreement, upon the occurrence of a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default}75, the Concessionaire may initiate termination of this Agreement by delivering a Notice of Intent to Terminate, which shall specify with reasonable detail the grounds on which termination is sought.
    2. If, within 60 days from the date of the Notice of Intent to Terminate, ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***, }as the case may be, rectifies or remedies ***[Executing Agency]*** Event of Default {or the ***[Name of the State / National Level Agency, if any]*** Event of Default,}76 to the satisfaction of the Concessionaire or the Concessionaire is satisfied with steps taken or proposed to be taken by***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} or ***[Executing Agency]*** Event of Default {or the ***[Name of the State / National Level Agency, if any]*** Event of Default}, as the case may be, has ceased to exist, the Concessionaire shall withdraw the Notice of Intent to Terminate.
    3. If, within 60 days from the date of the Notice of Intent to Terminate, ***[Executing Agency]*** Event of Default {or the ***[Name of the State / National Level Agency, if any]*** Event of Default} has not been remedied or ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***, as the case may be}, has not taken steps or proposed to take steps to remedy ***[Executing Agency]*** Event of Default {or the ***[Name of the State / National Level Agency, if any]*** Event of Default} to the satisfaction of the Concessionaire, then the Concessionaire shall terminate the Agreement and the consequences set out in Article 17 shall follow.

75Contents in curly parenthesis may be deleted if not applicable.

76Contents in curly parenthesis may be deleted if not applicable.

* + 1. During the subsistence of a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default}, the Parties shall continue to perform such of their respective obligations under this Agreement, which are capable of being performed in accordance with this Agreement.

**ARTICLE 17 CONSEQUENCES OF TERMINATION**

* 1. **Upon termination of this Agreement**
     1. the Concessionaire shall cease all work in relation to construction of the Facilities and the Power Plant (if any);
     2. the Concessionaire shall cease all work in relation to O&M of the Facilities and the Power Plant (if any);
     3. the Concessionaire shall take all necessary steps to safeguard and protect the Facilities and the Power Plant (if any) (at whatever stage of completion or operation) and all other equipment, materials and goods on the Site;
     4. the Concessionaire shall hand over the Site, the Facilities and the Power Plant, if any, to ***[Executing Agency]*** or its nominee in accordance with the Hand-back Requirements set out in Clause 19.3, to the extent applicable; and
     5. in case of termination of this Agreement due to a ***[Executing Agency]*** Event of Default

{or an ***[Name of the State / National Level Agency, if any]*** Event of Default,} ***[Executing Agency]*** shall return the Performance Security(ies), the O&M Security(ies) and the Mobilization Advance Guarantee(s), if not already returned to the Concessionaire, after adjusting any outstanding amounts owed by the Concessionaire, within 30 (thirty) days from the date of the Transfer Date.

* 1. **Consequences of termination due to a Force Majeure Event**

In case of termination of the Agreement due to a Force Majeure Event, the following consequences shall apply:

* + 1. the Concessionaire shall hand over the Site, the Facilities and the Power Plant, if any, to ***[Executing Agency]*** on an "as is where is" basis and to the extent relevant, in accordance with the Hand-back Requirements set out in Clause 19.3;
    2. ***[Executing Agency]*** shall be required to return the Mobilization Advance Guarantees, Performance Securities or the O&M Securities, as the case may be, after adjusting any outstanding amounts owed by the Concessionaire, within 30 (thirty) days from the date of the Transfer Date; and
    3. in case of termination due to an Indirect Political Force Majeure Event or a Direct Political Force Majeure Event, ***[Executing Agency]*** shall (or shall require the Project Engineer) to assess the Cost of the construction work undertaken by the Concessionaire in relation to the Facilities as on the date of the notice of termination under Clause 14.7 and based on such assessment, pay the Termination Compensation in accordance with Clause 18.4.
  1. **Accrued Rights and Liabilities**
     1. Notwithstanding anything to the contrary contained in this Agreement, any termination of this Agreement shall be without prejudice to the accrued rights of a Party, including its right to claim and recover damages and other rights and remedies which it may have in law or contract. All accrued rights and obligations of a Party under this Agreement, including without limitation, all rights and obligations with respect to Termination Compensation, shall survive the termination of this Agreement, to the extent such survival is necessary for giving effect to such rights and obligations.
     2. Nothing in Article 16 or this Article 17 shall prevent or restrict a Party to seek injunctive relief or a decree of specific performance or other discretionary remedies of the court.

**ARTICLE 18 TERMINATION COMPENSATION**

* 1. **Termination Compensation for Termination post the Effective Date but prior to the Construction Completion Date**
     1. For a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default}

If the Agreement is terminated prior to the Construction Completion Date for a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default,}77***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***78 shall be liable to pay to the Concessionaire the aggregate of:

* + - 1. Construction Payments due to the Concessionaire for Payment Milestones completed and certified by ***[Executing Agency]*** as on the date of the Notice of Intent to Terminate;
      2. Debt Due;
      3. Equity infused in the Concessionaire as on the date of Notice of Intent to Terminate along with interest on the Equity at the rate of the prevailing SBI MCLR + 3%;

**LESS**

* + - 1. any unadjusted Mobilization Advance (and interest if any);
      2. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages).
    1. For a Concessionaire Event of Default

If the Agreement is terminated prior to the Construction Completion Date for a Concessionaire Event of Default, ***[Name of the State / National Level Agency, if any]*** / ***[Executing Agency]***79 shall pay to the Concessionaire, the aggregate of:

* + - 1. Construction Payments due to the Concessionaire for Payment Milestones completed and certified by ***[Executing Agency]*** as on the date of the Notice of Intent to Terminate;
      2. 85% of Debt Due;

**LESS**

77Contents in curly parenthesis may be deleted if not applicable.

78Delete whichever not applicable

79Delete whichever not applicable.

* + - 1. any unadjusted Mobilization Advance (and interest if any);
      2. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages).
  1. **Termination Compensation for Termination post the Construction Completion Date but prior to the COD**
     1. For a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default}80

If the Agreement is terminated post the Construction Completion Date but prior to the COD for a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default,} ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***81 shall be liable to pay to the Concessionaire the aggregate of:

* + - 1. Construction Payments, if not already paid as on the date of the Notice of Intent to Terminate;
      2. Debt Due or the percentage of the Bid Project Cost linked with each of the payment milestones, whichever is lower;82
      3. Equity infused in the Concessionaire as on the date of Notice of Intent to Terminate along with interest on the Equity at the rate of the prevailing SBI MCLR + 3% (three percent);

**LESS**

* + - 1. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages).
    1. For a Concessionaire Event of Default

If the Agreement is terminated post the Construction Completion Date but prior to the COD for a Concessionaire Event of Default, ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***83 shall pay to the Concessionaire, the aggregate of:

* + - 1. Construction Payments, if not already paid as on the date of the Notice of Intent to Terminate;
      2. 85% of Debt Due;

80Contents in curly parenthesis may be deleted if not applicable.

81Delete whichever is not applicable.

82For clarity Among the aggregate, Debt Due or [x] milestones shall be added; with [x]% being different for each payment milestone.

83Delete whichever is not applicable.

**LESS**

* + - 1. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages).
  1. **Termination Compensation for Termination post the COD**
     1. For a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default}84

If the Agreement is terminated post the COD for a ***[Executing Agency]*** Event of Default {or an ***[Name of the State / National Level Agency, if any]*** Event of Default,} ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***85 shall be liable to pay to the Concessionaire the aggregate of:

* + - 1. Construction Payments that remain outstanding on the date of the Notice of Intent to Terminate;
      2. O&M Payments due to the Concessionaire as on the date of the Notice of Intent to Terminate;
      3. Capex Annuity for the unexpired portion of the O&M Period;

**LESS**

* + - 1. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages).
    1. For a Concessionaire Event of Default

If the Agreement is terminated post the COD for a Concessionaire Event of Default, ***[Name of the State / National Level Agency, if any]*** shall pay to the Concessionaire, the aggregate of:

* + - 1. Construction Payments that remain outstanding on the date of the Notice of Intent to Terminate;
      2. O&M Payments due to the Concessionaire as on the date of the Notice of Intent to Terminate;
      3. Such percentage of Capex Annuity payments for post COD facilities for the unexpired portion of the O&M period as specified in Schedule 13;

**LESS**

84Contents in curly parenthesis may be deleted if not applicable.

85Delete whichever not applicable.

* + - 1. any amounts due and payable by the Concessionaire under this Agreement (including Availability Liquidated Damages).
  1. **Termination Compensation for Termination due to a Force Majeure Event**
     1. Non-Political Force Majeure Event and Indirect Political Force Majeure
        1. If the Agreement is terminated due to an Indirect Political Force Majeure Event or Non-Political Force Majeure Event, prior to the COD:
           1. Construction Payments due to the Concessionaire for Payment Milestones completed and certified by ***[Executing Agency]*** as on the date of the notice of termination under Article 14.7;
           2. Debt Due;

**LESS**

* + - * 1. any insurance proceeds received and retained by the Concessionaire
      1. If the Agreement is terminated due to an Indirect Political Force Majeure Event or Non-Political Force Majeure Event, post the COD, ***[Name of the State / National Level Agency, if any]***/ ***[Executing Agency]***86 shall be liable to pay to the Concessionaire:
         1. Construction Payments that remain outstanding on the date of the notice of termination in case of facilities under Article 14.7;
         2. O&M Payments due to the Concessionaire as on the date of the notice of termination under Article 14.7;
         3. Debt Due;

**LESS**

* + - * 1. any insurance proceeds received and retained by the Concessionaire.
    1. Direct Political Force Majeure
       1. If the Agreement is terminated due to a Direct Political Force Majeure Event, prior to the COD, ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***87 shall be liable to pay to the Concessionaire:
          1. Construction Payments due to the Concessionaire for Payment Milestones completed and certified by ***[Executing Agency]*** as on the date of the notice

86Delete whichever not applicable

87Delete whichever not applicable.

of termination under Clause 14.7;

* + - * 1. Debt Due;
        2. Equity infused in the Concessionaire as on the date of the notice of termination under Clause 14.7 along with interest on the Equity at the rate of the prevailing SBI MCLR + 3%;

**LESS**

* + - * 1. any unadjusted Mobilization Advance (and interest if any);
        2. any insurance proceeds received and retained by the Concessionaire; and
        3. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages and any amount payable under Clause 19.2).
      1. If the Agreement is terminated due to a Direct Political Force Majeure Event post the COD, ***[Name of the State / National Level Agency, if any]***/***[Executing Agency]***88 shall be liable to pay to the Concessionaire:
         1. Construction Payments that remain outstanding on the date of the notice of termination under Clause 14.7;
         2. O&M Payments due to the Concessionaire as on the date of the notice of termination under Clause 14.7;
         3. Capex Annuity for the unexpired portion of the O&M Period;

**LESS**

* + - * 1. any insurance proceeds received and retained by the Concessionaire; and
        2. any amounts due and payable by the Concessionaire under this Agreement (including Liquidated Damages and any amount payable under Clause 19.2).
  1. All Termination Compensation required to be paid by ***[Name of the State / National Level Agency, if any]*** to the Concessionaire shall be paid within 60 (sixty) days of handover of the Site, the Facilities and the Power Plant, if any, to ***[Executing Agency]*** in accordance with Article 19.
  2. **Limitations on Termination Compensation**
     1. Termination Compensation, due and payable under this Agreement shall be limited to the Debt Due and Adjusted Equity, as the case may be, which form part of the Bid Project Cost, in accordance with the provisions of this Agreement. For avoidance of

88Delete whichever not applicable.

doubt, it is agreed that within a period of [60 (sixty)] days from COD, the Concessionaire shall notify to the ***[Executing Agency]***, the Bid Project Cost and its disaggregation between Debt Due and Equity, and only the amounts so conveyed shall form the basis of computing Termination Compensation, and it is further agreed that in the event such disaggregation is not notified to the Authority, the Equity and Debt Due shall be arrived at by adopting the proportion between debt and equity as specified in the Financing Documents. The Parties also agree that, notwithstanding anything contained in this Agreement, for the purposes of computing Termination Compensation, the Debt Due shall at no time exceed [50% (fifty percent)] of the Bid Project Cost.

* + 1. The amount payable in respect of any Debt Due expressed in foreign currency shall be computed at the Reference Exchange Rate for conversion into the relevant foreign currency as on the date of Termination Compensation. Provided, however, that the provisions of this Article 18.6 (b) shall not apply if the Concessionaire does not notify the particulars of any foreign currency loans within [60 (sixty)] days of the date of conversion of such foreign currency loans into Indian currency. Provided further that all borrowings in foreign currency shall be restricted to the financing of the Bid Project Cost ad any borrowings in excess thereof shall not qualify for computation of Termination Compensation.
  1. **Full and Final Settlement**

Notwithstanding anything to the contrary elsewhere in this Agreement, any Termination Compensation determined pursuant to this Article 18 shall, once paid, be in full and final settlement of any claim, demand and/or proceedings of the Concessionaire against{ ***[Name of the State / National Level Agency, if any]*** and}89***[Executing Agency]***, in relation to termination of this Agreement and the Concessionaire shall be excluded from all other rights and remedies in respect of such termination.

* 1. The provisions of this Article 18 shall survive the termination of this Agreement.

89Delete if not applicable.

**ARTICLE 19**

**TRANSFER UPON THE EXPIRY OR ON TERMINATION**

* 1. **Transfer of the Site and the Facilities**

Upon the expiry or early termination of this Agreement, the Concessionaire shall hand over the Site, the Facilities, and the Power Plant, if any, to ***[Executing Agency]*** or any other entity nominated by ***[Executing Agency]*** in accordance with this Article 19 on a date mutually decided by the ***[Executing Agency]***).

* 1. **Inspection of the Site and the Facilities**
     1. No later than 30 days from the end of the 14th(fourteenth) year of the O&M Period or 30 (thirty) days from the date of termination of the Agreement, as the case may be, ***[Executing Agency]*** shall or shall cause the Project Engineer to carry out a survey of the Site, the Facilities and the Power Plant, if any, to assess whether they have been maintained by the Concessionaire in accordance with its obligations under this Agreement, and are in working condition in line with the design life stipulated in the Technical Specifications.
     2. ***[Executing Agency]*** shall notify the Concessionaire at least 7 (seven) days prior to the date on which it wishes to carry out the survey of the Site, the Facilities and the Power Plant, if any.
     3. If the survey carried out by ***[Executing Agency]*** or the Project Engineer shows that the Concessionaire has not or is not complying with its obligations under this Agreement, then ***[Executing Agency]*** shall notify the Concessionaire of the rectification and/or maintenance work which is required to ensure that the condition of the Site, the Facilities and the Power Plant, if any, is restored to the Hand-back Conditions.
     4. The Concessionaire shall carry out such rectification and/or maintenance work to achieve the Hand-back Conditions within 30 (thirty) days from the receipt of a notice from ***[Executing Agency]*** in accordance with Clause 19.2(c) above, at its own cost and risk. Upon completion of the rectification and/or maintenance work, the Concessionaire shall request ***[Executing Agency]*** to carry out a final survey and inspection of the Site, the Facilities, and the Power Plant, if any. ***[Executing Agency]*** shall carry out the final survey within 7 (seven) days of receipt of a notice from the Concessionaire pursuant to this Clause 19.2(d).

If ***[Executing Agency]*** is satisfied with the results of the final survey, then ***[Executing Agency]*** shall notify the Concessionaire within 7 days of carrying out the final survey that the Site, the Facilities and the Power Plant, if any, comply with the Hand-back Conditions. If ***[Executing Agency]*** is not satisfied with the results of the final survey, then ***[Executing Agency]*** shall or shall cause the Project Engineer to estimate the cost of restoring the Site, the Facilities and/or the Power Plant, if any, to the Hand-back Conditions and recover such cost from the Concessionaire.

* 1. **Hand-back Requirements**

On the expiry or early termination of this Agreement, the Concessionaire shall, at its own cost:

* + 1. hand over to ***[Executing Agency]*** or any entity nominated by ***[Executing Agency]***, the Site, the Facilities and the Power Plant, if any;
    2. to the extent that such rights and interests are not already vested in ***[Executing Agency]***, transfer all its rights and interest in the assets comprising in the Facilities and the Power Plant, if any and execute such deeds and documents as may be necessary for this purpose and complete all related legal or other formalities;
    3. hand over all records and documents relating to the Site, the Facilities and the Power Plant, if any, including as-built records, Designs and Drawings, online monitoring and metering data, operating logs, manuals, reports, plans and records;
    4. transfer to ***[Executing Agency]*** or its nominee (free of cost) the license to use the Proposed Technology and other know-how relating to the Facilities and the Power Plant, if any;
    5. transfer or cause to be transferred to ***[Executing Agency]*** or its nominee any Subcontract that ***[Executing Agency]*** or its nominee has chosen to take over and terminate all other Subcontracts;
    6. transfer to ***[Executing Agency]*** or its nominee all Concessionaire Applicable Permits which ***[Executing Agency]*** or its nominee may require, and which can be legally transferred;
    7. remove from the Site all employees and workmen, and assets, equipment and materials that are not required to be taken over by ***[Executing Agency]*** or its nominee; and
    8. cooperate with and assist the ***[Executing Agency]***with theProject post the handing over.
  1. The provisions of this Article 19 shall survive the termination of this Agreement.

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**ARTICLE 20 VARIATION**

* 1. Both ***[Executing Agency]*** and the Concessionaire may, at any time during the Term, propose a Variation to the Scope of Work, Technical Specifications, and/or the Designs and Drawings.
  2. ***[Executing Agency]* Proposed Variation**
     1. ***[Executing Agency]*** may propose a Variation in the Scope of Work, Technical Specifications or the approved Designs and Drawings. Provided that, ***[Executing Agency]*** shall not propose a Variation, which: (i) is not technically feasible; or (ii) is not in compliance with any Applicable Law or Applicable Permit.
     2. Within 15 (fifteen) days of receipt of a request for Variation from ***[Executing Agency]*,** the Concessionaire shall submit a proposal to ***[Executing Agency]***(with a copy to the Project Engineer) setting out in sufficient detail the implications of the proposed Variation, including any implications on the Construction Plan, the Scheduled Milestone Completion Date, the Scheduled Construction Completion Date and Scope of Work and additional Costs incurred in undertaking the Variation or any reduction in Costs resulting from the Variation. It is clarified that the additional Costs incurred in undertaking the Variation or any reduction in Costs resulting from the Variation will be determined on the basis of ***[Executing Agency]***'s schedule of rates for similar worksapplicable at the time of undertaking such works.
     3. Notwithstanding anything to the contrary in this Clause 20.2, the Concessionaire shall have the right to reject a Variation proposed by ***[Executing Agency]*** if, in the Concessionaire's view, the proposed variation will result in: (i) the Concessionaire incurring additional Costs, of more than 25% of the Bid Project Cost of the Facilities;

(ii) reduction in the Bid Project Cost of the Facilities by more than 25%; or (iii) a delay of more than 120 days in a Scheduled Milestone Completion Date or the Scheduled Construction Completion Date.

* + 1. Based on its review of the proposal submitted by the Concessionaire, ***[Executing Agency]*** may, at its sole discretion: (i) accept the proposal and the corresponding adjustment to the Construction Plan and/or the additional Costs or reduction in the Bid Project Cost for undertaking the Variation; (ii) provide its comments on the proposal seeking amendments and/or justification for the implications put forth by the Concessionaire; or (iii) reject the proposal submitted by the Concessionaire and withdraw the proposed Variation, within 15 (fifteen) days from the date of receipt of the Concessionaire's proposal under Clause 20.2(b) above.90
    2. To the extent ***[Executing Agency]*** seeks amendments and/or justification in the proposal submitted by the Concessionaire, the Concessionaire shall incorporate or address, in writing, ***[Executing Agency]***'s comments and submit a revised proposal.

90The Executing Agency may include athreshold amount for undertakingvariations upto which the costswould be borne by theConcessionaire, beyond which thecosts would be reimbursed by theExecuting Agency.

* + 1. On approval of the proposal or the revised proposal, as the case may be, ***[Executing Agency]*** shall issue a Variation Order and Concessionaire shall proceed with the Variation in accordance with the Variation Order.
    2. If the Parties are unable to agree on the implications of a Variation proposed by ***[Executing Agency]***, which in ***[Executing Agency]***'s view is necessary or desirable for the Project, ***[Executing Agency]*** shall have the right to require the Concessionaire to carry out the proposed variation at the cost determined in accordance with ***[Executing Agency]***'s schedule of rates for similar works. Where ***[Executing Agency]***'s schedule of rates do not provide schedule of rates for similar works, then the cost of the works covered by the proposed Variation will be determined by ***[Executing Agency]***, in consultation with the Project Engineer. Any dispute on the terms of the Variation will be resolved in accordance with Article 21.
    3. On implementation of a Variation Order, the Concessionaire shall be entitled to the agreed adjustment to the Construction Plan, Scheduled Milestone Completion Date, Scheduled Construction Completion Date and/or payment of additional amounts, if any, set out in the Variation Order.
  1. **Concessionaire Proposed Variation**
     1. The Concessionaire may propose a Variation if it considers such Variation necessary or desirable to improve the efficiency, quality, reliability, durability, maintainability or safety of the Facilities.
     2. To propose a Variation, the Concessionaire shall submit a proposal to ***[Executing Agency]*** (with a copy to the Project Engineer), with a statement setting out:
        1. the need for a Variation;
        2. the additional work required; and
        3. adjustment to the Effective Date, Construction Plan, Scheduled Milestone Completion Date and Scheduled Construction Completion Date;
     3. Based on its review of the proposal submitted by the Concessionaire, if ***[Executing Agency]*** is of the view that the proposed Variation is justified, then it will determine the cost of the proposed Variation using ***[Executing Agency]***'s schedule of rates for similar works and where ***[Executing Agency]***'s schedule of rates do not provide schedule of rates for similar works, then the cost of the works covered by the proposed Variation will be determined by ***[Executing Agency]***, in consultation with the Project Engineer. Thereafter, ***[Executing Agency]*** shall notify the Concessionaire of the additional cost determined by ***[Executing Agency]*** for the proposed Variation and any other comments that ***[Executing Agency]*** may have on the implications of the proposed Variation. To the extent ***[Executing Agency]*** seeks amendments and/or justification in the proposal submitted by the Concessionaire, the Concessionaire shall incorporate or address, in writing, ***[Executing Agency]***'s comments.
     4. On the Concessionaire's acceptance of the costs determined by ***[Executing Agency]*** for the proposed Variation and any other amendments sought by ***[Executing Agency]*** to the Concessionaire's proposal, ***[Executing Agency]*** shall issue a Variation Order and Concessionaire shall proceed with the Variation in accordance with the Variation Order.
     5. On implementation of a Variation Order, the Concessionaire shall be entitled to the agreed adjustment in the Construction Plan and/or additional costs, as set out in the Variation Order.
  2. To the extent of Variation in Scope of Work and Technical Specifications and Standards, the Concessionaire shall be obliged to implement the Project in accordance with the provisions set forth, *inter-alia*, in Articles 7 and 8 shall be applicable.
  3. Pursuant to a Variation Order, if the Concessionairedoes not undertake additional works, the ***[Executing Agency]*** shall hold theright to undertake such additional works (by itself or through a contractor), at the cost of the Concessionaire.
  4. Notwithstanding anything to the contrary in this Article 20, the Concessionaire shall be bound to implement any Variation that is necessitated by a Change in Law and any consequent adjustment in the Construction Plan and additional Costs shall be determined in accordance with Article 13.
  5. Notwithstanding the above, a Variation made necessary due to any act, omission or default of the Concessionaire or any Subcontractor in the performance of the Concessionaire's obligations under this Agreement shall not entitle the Concessionaire to any adjustment in the Construction Plan or any other compensation or relief.
  6. No Variation shall invalidate this Agreement.

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**ARTICLE 21 DISPUTE RESOLUTION**

* 1. **Amicable Resolution**
     1. Save where expressly stated to the contrary in this Agreement, any dispute, difference or controversy of whatever nature between the Parties, howsoever arising under, out of or in relation to this Agreement, including those arising with regard to acts, decision or opinion of the ***[Executing Agency]*** (the "**Dispute**") and so notified in writing by either Party, shall in the first instance be attempted to be resolved amicably by the representatives of the Parties in accordance with the procedure set forth in Article 21.1(b) below.
     2. In the event of a Dispute, either Party may require such Dispute to be referred to the Competent ***[Executing Agency]***, the ***[Executing Agency]*** (or the Person holding charge) and the Chief Executive Officer of the Concessionaire for the time being, for amicable settlement. Upon such reference, the representatives of the Parties shall within 15 (fifteen) days of service of a written notice from one Party to the other Party(ies) (the  hold a meeting (the ) in an effort to resolve the Dispute in good faith. In the absence of any agreement to the contrary, the Dispute Meeting shall be held at the office of the ***[Executing Agency]*** in [Location] and the Dispute may be mutually settled between the parties.
     3. The Parties agree to use their best efforts for resolving all Disputes arising under or in respect of this Agreement promptly, equitably and in good faith, and further agree to provide each other with reasonable access during normal business hours to all non-privileged records, information and data pertaining to any Dispute.
     4. If the Dispute is not amicably settled within 15 (fifteen) days of the Dispute Meeting, either Party may refer the Dispute to conciliation or arbitration in accordance with the provisions of Articles 21.2 and 21.3below.
  2. **Conciliation**

In the event of any Dispute between the Parties, either Party may call upon the Project Engineer, as the case may be, to mediate and assist the Parties in arriving at an amicable settlement thereof. Failing mediation by the Project Engineer or without the intervention of the Project Engineer, as the case may be, either Party may require such Dispute to be referred to Principal Secretary to the ***[Executing Agency]*** and the Chairman of the Board of Directors of the Concessionaire for amicable settlement, and upon such reference, the said persons shall meet no later than [7 (seven)] days from the date of reference to discuss and attempt to amicably resolve the Dispute. If such meeting does not take place within the [7 (seven)] day period or the Dispute is not amicably settled within [15 (fifteen)] days of the meeting or the Dispute is not resolved as evidenced by the signing of written terms of settlement within [30 (thirty)] days of the notice in writing referred to in Article 21.1(a) or such longer period as may be mutually agreed by the Parties, either Party may refer the Dispute to arbitration in accordance with the provisions of Article 21.3.

* 1. **Arbitration**
     1. Procedure

Subject to the provisions of Articles 21.1 and 21.2, any Dispute which is not resolved amicably shall be finally settled by reference to arbitration. Such arbitration shall be held in accordance with the Rules of Arbitration of the International Centre for Alternative Dispute Resolution, New Delhi, or such other rules as may be mutually agreed by the parties, and shall be subject to the provisions of the Arbitration and Conciliation Act, 1996. The expenses of arbitration shall be borne equally by both the Parties.

* + 1. Arbitration Panel

There shall be a panel of three arbitrators, of whom each Party shall appoint one, and the third arbitrator shall be appointed by the two arbitrators so selected, and in the event of disagreement between the two arbitrators, the appointment shall be made in accordance with the Rules of Arbitration of the International Centre for Alternative Dispute Resolution, New Delhi.

* + 1. Place of Arbitration

The place of arbitration shall ordinarily be [Location] but by agreement of the Parties, the arbitration hearings, if required, may be held elsewhere.

* + 1. Language

The request for arbitration, the answer to the request, the terms of reference, any written submissions, any orders and awards shall be in English and, if oral hearings take place, English shall be the language to be used in the hearings. Any party using other than English as language shall supply the other party an authorized transcript of true translation of its submissions into English at its costs and expenses.

* + 1. Enforcement of Award

(i) **Award** ). Any Award made

in any arbitration held pursuant to this Article 39 shall be final and binding on the Parties as from the date it is made, and the Concessionaire and the ***[Executing Agency]*** agree and undertake to carry out such Award without delay subject to the rights of the aggrieved parties to secure relief from any higher forum.

1. The Concessionaire and the ***[Executing Agency]*** agree that an Award may be enforced against the Concessionaire and/or the ***[Executing Agency]***, as the case may be, and their respective assets wherever situated.
2. This Agreement and the rights and obligations of the Parties shall remain in full force and effect, pending the Award in any arbitration proceedings hereunder.
   1. **Performance during Dispute**

Pending the submission of and/or decision on a Dispute and until the arbitral Award is published, the Parties shall continue to perform their respective obligations under this

Agreement without prejudice to a final adjustment in accordance with such Award.

* 1. **Adjudication by Regulatory *[Executing Agency]* or Commission**

In the event of constitution of a statutory regulatory authority or commission with powers to adjudicate upon Disputes between the Concessionaire and the ***[Executing Agency]***, all Disputes arising after such constitution shall, instead of reference to arbitration under Article 21.3, be adjudicated upon by such regulatory authority or commission in accordance with the Applicable Law and all references to Dispute Resolution Procedure shall be construed accordingly. For the avoidance of doubt, the Parties hereto agree that the adjudication hereunder shall not be final and binding until an appeal against such adjudication has been decided by an appellate tribunal or High Court, as the case may be, or no such appeal has been preferred within the time specified in the Applicable Law.

**ARTICLE 22 REPRESENTATIONS AND WARRANTIES**

* 1. **Mutual Representations and Warranties**

Each Party represents and warrants to the other Parties that:

* + 1. it has full power and authority to execute, deliver and perform its obligations under this Agreement, the Substitution Agreement, the Escrow Agreement and any other agreements required in relation to the Project;
    2. it has taken all necessary action to authorise the execution, delivery and performance of this Agreement, the Substitution Agreement and the Escrow Agreement; and
    3. there are no actions, suits or proceedings pending or to its best knowledge, threatened against or affecting it before any court, administrative body or arbitral tribunal which might materially and adversely affect its ability to meet or perform any of its obligations under this Agreement, the Substitution Agreement or the Escrow Agreement.
  1. **Concessionaire's Representations and Warranties**

The Concessionaire represents and warrants to ***[Executing Agency]*** {and ***[Name of the State / National Level Agency, if any]***}91 that:

* + 1. it is duly organized, validly existing and of good standing under the laws of India;
    2. it has the financial standing and capacity to design, finance, construct, complete, operate and maintain the Facilities in accordance with this Agreement;
    3. this Agreement constitutes its legal, valid and binding obligation, enforceable against it in accordance with its terms, and its obligations under this Agreement will be legally valid, binding and enforceable obligations against it in accordance with the terms hereof;
    4. it is subject to the laws of India, and hereby expressly and irrevocably waives any immunity in any jurisdiction in respect of this Agreement or matters arising thereunder including any obligation, liability or responsibility hereunder;
    5. the information furnished in the Bid of the Selected Bidder, and as updated on or before the date of this Agreement is true and accurate in all respects as on the Appointed Date as applicable;
    6. all undertakings and obligations of the Concessionaire arising from the {RFP/RFQ} or otherwise shall be binding on the Concessionaire as if they form part of this Agreement;

91Delete if not applicable.

* + 1. the execution, delivery and performance of this Agreement will not conflict with, result in the breach of, constitute a default under any of the terms of its memorandum and articles of association/charter documents or any Applicable Laws or Applicable Permits or any covenant, contract, agreement, arrangement, understanding, decree or order to which it is a party or by which it or any of its properties or assets is bound or affected;
    2. it has no knowledge of any violation or default with respect to any order, writ, injunction or decree of any court or any legally binding order of the GoI or the Go***[XX92] [State of Location]*** which may result in any Material Adverse Effect on its ability to perform its obligations under this Agreement and no fact or circumstance exists which may give rise to such proceedings that would adversely affect the performance of its obligations under this Agreement;
    3. it has complied with all Applicable Laws and Applicable Permits in all material respects and has not been subject to any fines, penalties, injunctive relief or any other civil or criminal liabilities, which in the aggregate have or may have a Material Adverse Effect on its ability to perform its obligations under this Agreement;
    4. none of its employees, consultants, service providers, suppliers, or Subcontractors, including any O&M contractor, as of this day, have been engaged in any corrupt, fraudulent, collusive, coercive or obstructive practice, as defined in Clause 23.18; and
    5. no representation or warranty by it contained in this Agreement or in any other document furnished by it to ***[Executing Agency]***, ***[Name of the State / National Level Agency, if any]***, the GoI or the Go***[XX]93 [State of Location]*** in relation to Applicable Permits contains any untrue or misleading statement of material fact or omits to state a material fact necessary to make such representation or warranty.
  1. ***[Executing Agency]*'s Representations and Warranties**

***[Executing Agency]*** represents and warrants to the Concessionaire and ***[Name of the State / National Level Agency, if any]*** that:

* + 1. it is duly organized, validly existing and in good standing under the laws of India;
    2. it has the financial standing and legal capacity to execute this Agreement and perform its obligations under this Agreement;
    3. it has taken all necessary approvals to execute this Agreement (including any approval required under the ***[ACT APPLICABLE IN THE State of Location]*** Act) and perform its obligations under this Agreement;
    4. this Agreement constitutes legal, valid and binding obligations enforceable against it in accordance with the terms hereof;

92Name of the State Government.

93Name of the State Government.

* + 1. it has no knowledge of any violation or default with respect to any order, writ, injunction or any decree of any court or any legally binding order of the GoI or the Go***[XX94] [State of Location]***, which may result in any Material Adverse Effect on its ability to perform its obligations under this Agreement; and
    2. it has complied with all Applicable Laws and Applicable Permits in all material respects.
  1. ***[Name of the State / National Level Agency, if any]*'s95 Representations and Warranties**

***[Name of the State / National Level Agency, if any]*** represents and warrants to the Concessionaire and ***[Executing Agency]*** that:

* + 1. it is duly organized, validly existing and in good standing under the laws of India;
    2. it has the financial standing and legal capacity to execute this Agreement and perform its obligations under this Agreement;
    3. it has taken all necessary approvals to execute this Agreement and perform its obligations under this Agreement;
    4. this Agreement constitutes legal, valid and binding obligations enforceable against it in accordance with the terms hereof;
    5. it has no knowledge of any violation or default with respect to any order, writ, injunction or any decree of any court or any legally binding order of the GoI or the Go***[XX] [State of Location]***, which may result in any Material Adverse Effect on its ability to perform its obligations under this Agreement; and
    6. it has complied with all Applicable Laws and Applicable Permits in all material respects.

94Name of the State Government.

9595If not applicable the representations and warranties shall be merged with that of the Executing Agency in Clause 22.3 and the Clause 22.4 may be deleted.

**ARTICLE 23 MISCELLANEOUS**

* 1. **Survival**
     1. Any cause or action which may have occurred in favour of any Party or any right which is vested in any Party under this Agreement as a result of any act, omission, deed, matter or thing done or omitted to be done by any Party before the expiry of the Term by efflux of time or otherwise in accordance with this Agreement, shall survive the expiry of the Agreement.
     2. The provisions of this Agreement, to the fullest extent necessary to give effect thereto, survive the Term or the termination of this Agreement and the obligations of Parties to be performed or discharged following the termination of this Agreement, shall accordingly be performed or discharged by the Parties.
  2. **Entire Agreement**

The Parties hereto acknowledge, confirm and undertake that this Agreement and the RFP constitutes the entire understanding between the Parties regarding the development of the Project and supersedes all previous written or oral representations and/or arrangements regarding the Project.

* 1. **Non-exhaustive Remedies**
     1. Save and except as provided in this Agreement, the remedies available to the Concessionaire under this Agreement are not exhaustive and the Concessionaire and third parties shall be entitled to all other rights and remedies and to take all actions in law and in equity in addition to the remedies provided for herein.
     2. Save and except as provided in this Agreement, the exercise of any rights by any Party under this Agreement shall not preclude such Party from availing of any other rights or remedies that may be available to it under this Agreement or any other agreement in relation to the Project. All remedies available to the Parties shall be cumulative and the exercise or failure thereof of one or more remedies by any Party shall not limit or preclude the exercise of or constitute a waiver of any other remedies by such Party.
  2. **Notices**
     1. Any notice or request in reference to this Agreement shall be written in English language and shall be sent by email, registered post, courier or facsimile and shall be directed to the other Parties at the address mentioned below:

***[Executing Agency]*:**

Attention:

Address:

Tel: [ \_]

Fax: [ \_]

Email: [ \_]

***[Name of the State / National Level Agency, if any]*96:**

Attention: Address: Tel:

Fax:

Email:

**Concessionaire:**

Attention:[ ] Address: [ ] Tel: [ ]

Fax: [ ]

Email: [ ]

* + 1. Any notice or demand served by registered post or courier shall be deemed to be duly served 48 hours after posting and a notice or demand sent by facsimile shall be deemed to have been served at the time of its transmission and in proving service of the same it will be sufficient to prove, in the case of a letter, that such letter was sent by registered post or courier, addressed and placed in the post and in the case of a facsimile transmission, that such facsimile was duly transmitted to a current facsimile number of the addressee at the address referred above.
    2. Each Party may change the above address by prior written notice to the other Parties.
  1. **Governing Law and Jurisdiction**

This Agreement shall be governed by the laws of India and shall be subject to the jurisdiction of the courts at ***[COURTS AS DECIDED BY THE EXECUTING AGENCY]***.

* 1. **Counterparts**

This Agreement may be executed in three counterparts, each of which, when executed and delivered, will be an original, and all three counterparts together shall constitute one and the same instrument.

* 1. **Language**
     1. The formal text of this Agreement and other agreements in relation to the Project shall be in the English language.
     2. All notices and communications between the Parties under this Agreement shall be in English and all arbitration proceedings undertaken pursuant to this Agreement shall be conducted in English.
  2. **Confidentiality**
     1. No recipient Party shall, without the prior written consent of the disclosing Party, at any time divulge or disclose or suffer or permit its representatives to divulge or disclose to any person or use for any purpose unconnected with the Project any Confidential Information during the Term and for a period of 5 years after the expiry or termination of this Agreement, except to its representatives officers, directors, advisors, employers, agents and Associates (including ***[Executing Agency]*** Related Parties, {the ***[Name of the State / National Level Agency, if any]*** Related Parties}97 and the Concessionaire Related Parties) who have a legitimate need to know the Confidential Information in order to perform their duties relating to the Agreement.
     2. This Clause 23.8 shall not apply to Confidential Information, which:
        1. at the time of disclosure or thereafter has become part of public knowledge or literature without a breach of this Agreement;
        2. is already in the possession of the Party receiving such Confidential Information before it was received from any other Party and which was not obtained under any obligation of confidentiality from the Party which disclosed such information;
        3. was obtained from a third party (other than one disclosing it on behalf of a Party) who was free to divulge the same and who was not under any obligation of confidentiality in relation to such Confidential Information to the Party, which disclosed the information;
        4. is disclosed by the Concessionaire to the Lenders, any actual or *bona fide* potential shareholders, investors or bankers (and their professional advisers) of the Concessionaire;
        5. is required to be disclosed pursuant to any legal and mandatory requirement of any court, legislative or administrative body or any Government Authority, or the rules of any applicable stock exchange;
        6. is disclosed by the Concessionaire to its Associates or the permitted assignees and transferees;
        7. is disclosed by the Concessionaire to any Subcontractor of the Concessionaire;
        8. is disclosed to actual or prospective insurers, re-insurers and insurance brokers;
        9. is disclosed to any professional advisors or consultants of any persons to whom a Party is entitled to disclose Confidential Information under this Clause 23.8(b);
        10. is disclosed to any Person in connection with the dispute resolution provisions

under this Agreement;

* + - 1. is independently developed by the receiving Party without reliance on the Confidential Information disclosed by the disclosing Party; or
      2. is disclosed to any Government Authority or any other body in any relevant jurisdiction in connection with the obtaining or renewal of any Applicable Permit required for the Project.

Provided that the Party making a disclosure of Confidential Information pursuant to (iv) and (vi) to (ix) (inclusive) above shall ensure that any Person to whom it makes such disclosure undertakes to hold such Confidential Information subject to the same confidentiality obligations as those set out in Clause 23.8(a) above.

* + 1. A Party making a disclosure of Confidential Information pursuant to Clause 23.8(a) shall,
       1. at the time of making such disclosure, inform its representatives and Associates of their obligation of confidentiality pursuant to this Agreement and ensure their compliance; and
       2. be liable for any breach of such obligations by such representatives and Associates.
    2. In the event that a Party is required or requested to make a disclosure of Confidential Information referred to in Clause 23.8(b)(v) above, such Party shall prior to such disclosure (to the extent permissible by Applicable Law) use its best efforts to promptly notify the disclosing Party or its Associate so that appropriate protection order and/or other action can be taken if possible. In the absence of such a protection order restricting disclosure, the Party required to make such disclosure may disclose only that portion of the Confidential Information which it is legally required to disclose and shall use reasonable efforts to obtain assurances that confidential treatment will be accorded to the Confidential Information.
    3. The recipient party agrees that it, its Associates and representatives shall, upon request by the disclosing Party promptly:
       1. return, and use all reasonable endeavors to procure that any third party to whom the recipient party has disclosed the Confidential Information pursuant to this Agreement shall return, all the Confidential Information that is in tangible form (including, without limitation, Confidential Information contained on compact discs or other electronic storage media or devices) furnished, together with any copies or extracts; and
       2. destroy, and use all reasonable endeavors to procure that any third party to whom the recipient party has disclosed the Confidential Information pursuant to this Agreement shall destroy, all analysis, compilations, studies or other documents which have been prepared and which reflect or refer to any Confidential

Information,

provided that the recipient party shall be entitled to retain such Confidential Information which forms part of the permanent records of the recipient party or its Associates and which was prepared for the purposes of the review or decision-making process of the recipient party or such Affiliate and/or which the recipient party or its Associates is required to retain by Applicable Law if it continues to keep such Confidential Information confidential in accordance with this Agreement.

* 1. **Amendments**
     1. Any provision of this Agreement may be amended, supplemented or modified only by an agreement in writing signed by all the Parties.
     2. A Party may at any time request the other to enter into discussions to review the operation of any part of this Agreement and, but without commitment by the other Parties, to determine whether it should be amended by mutual agreement provided that, unless there is such mutual agreement, the provisions of this Agreement (as then most recently, if at all, amended) shall continue to apply whatever the outcome of any such discussions or review and whether or not any such discussions or review take place.
  2. **Waivers and Consents**
     1. Unless otherwise specified, any provision or breach of any provision of this Agreement may be waived before or after it occurs only if evidenced by an agreement in writing signed by the Parties.
     2. Any consent under or pursuant to any provision of this Agreement must also be in writing and given prior to the event, action or omission for which it is sought.
     3. Any such waiver or consent may be given subject to any conditions thought fit by the Party giving it and shall be effective only in the instance and for the purpose for which it is given.
  3. **Severability**
     1. If any provision of this Agreement is or becomes illegal, invalid or unenforceable in any respect under any Applicable Law, the legality, validity or enforceability of the remaining provisions will not, in any way, be affected or impaired.
     2. The Parties shall negotiate in good faith with a view to agreeing one or more provisions which may be substituted for any such invalid, illegal or unenforceable provision and which produce as nearly as is practicable in all the circumstances the appropriate balance of the commercial interests of the Parties.
  4. **Assignment**
     1. Except as expressly permitted in this Agreement, the Concessionaire shall not be

entitled to divest, transfer, assign or novate all or substantially all of its rights, interests, benefits and obligations under this Agreement, without the prior written consent of ***[Executing Agency]*** {and ***[Name of the State / National Level Agency, if any]***}98.

* + 1. The rights and obligations of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} under this Agreement shall not be assigned, novated or otherwise transferred (whether by virtue of any Applicable Law or otherwise) to any Person other than a public body or a government company or a statutory corporation that:
       1. is a single entity;
       2. acquires the whole of the Agreement;
       3. has the legal capacity, power and authority to become a party to and to perform the obligations of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} under this Agreement, as the case may be; and
       4. has sufficient financial standing or financial resources to perform the obligations of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} under this Agreement, as the case may be.
  1. **No Agency or Partnership**

Nothing contained or implied in this Agreement shall constitute or be deemed to constitute a partnership or agency between the Parties and none of the Parties shall have any authority to bind, commit or make any representations on behalf of the other Parties.

* 1. **Costs and Expenses**
     1. Each Party shall be responsible for paying its own costs and expenses incurred in connection with the negotiation, preparation and execution of this Agreement, the Substitution Agreement and the Escrow Agreement.
     2. The Concessionaire shall bear the applicable stamp duty and registration fee (if applicable) in respect of this Agreement, the Substitution Agreement and the Escrow Agreement.
  2. **Reservation of Rights**

No forbearance, indulgence, relaxation or inaction by the Concessionaire at any time to require performance of any of the provisions of this Agreement shall in any way affect, diminish or prejudice the right of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***}99 to require performance of that provision, and no delay in exercising or omitting to exercise any right, power or remedy accruing to ***[Executing Agency]*** {or

98Contents in curly parenthesis may be deleted if not applicable.

99Contents in the curly parenthesis may be deleted if not applicable.

***[Name of the State / National Level Agency, if any]***} upon any default or otherwise under this Agreement shall impair any such right, power or remedy or shall be construed to be a waiver thereof or any acquiescence in such default, nor shall the action or inaction of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} in respect of any default or any acquiescence by it in any default, affect or impair any right, power or remedy of ***[Executing Agency]*** {or ***[Name of the State / National Level Agency, if any]***} in respect of any other default.

* 1. **Third Parties**

This Agreement and all rights hereunder are intended for the sole benefit of the Parties and, to the extent expressly provided, for the benefit of ***[Executing Agency]*** Related Parties, {***[Name of the State / National Level Agency, if any]*** Related Parties}, the Concessionaire Related Parties and the Lenders, and shall not imply or create any rights on the part of, or obligations to, any other Person.

* 1. **Inspection and Audit**

The Concessionaire shall permit and shall cause its Subcontractors and sub consultants to permit, {the ***[Name of the State / National Level Agency, if any]***}100 / ***[Executing Agency]*** to inspect the Site and/or the accounts and records relating to the performance of the Contract and the submission of the Bid, and to have such accounts and records audited by auditors appointed by {***[Name of the State / National Level Agency, if any]***} / ***[Executing Agency]*** if requested by {***[Name of the State / National Level Agency, if any]*** /} ***[Executing Agency]***.

wn to Clause 23.18 which provides, inter alia, that acts intended to materially impede the exercise of the ***[Name of the State / National Level Agency, if any]***101 / ***[Executing Agency]*** and audit rights provided for under Sub-Clause 23.18.1 constitute a prohibited practice subject to contract termination.

100Contents in curly parenthesis may be deleted if not applicable.

101Delete if not applicable.

In witness whereof the Parties102 hereto have signed this Agreement on this \_ \_day of

2020.

The Executing Agency ***[Name of the EXECUTING AGENCY]***

By:

Name:

Title:

(***[Name of the State / National Level Agency, if any]***)103

By:

Name:

Title:

[***Insert name of the Concessionaire***] (CONCESSIONAIRE) By:

Name: Title:

102 For the purpose of this sub-

103 Delete if not applicable.



# Schedules

**SCHEDULE 1: SCOPE OF WORK**

1. **Scope of work of activities to be undertaken at every site**

In general, the scope includes as a minimum but not limited to design, supply, construction, installation, testing & commissioning and operation, & maintenance of project infrastructure, as necessary.

Designing, part-financing, supplying, constructing, erecting, installing, testing, commissioning and completing the following project infrastructure works and facilities by the scheduled construction completion date and operating and maintaining the facilities and the associated infrastructure for [15 (fifteen)] years from the date of COD, in compliance to Applicable Laws, Applicable Permits, Technical Specifications, Designs and Drawings, the Construction Plan, the ESHS plan, the resource plan, mobilization plan of manpower, material & machinery, QA/QC plan and good industry practices to ensure compliance with the KPIs.

The works should be completed in a manner as desired by Executing Agency and their authorized representatives, as per standard engineering practices, Applicable Laws, Applicable Permits and governing BIS codes or other relevant codes. The Concessionaire shall verify and satisfy themselves with their own reassessment of the engineering requirements as per actual site requirements to ensure smooth operation and maintenance of the entire infrastructure during the Concession Period and handing over all the assets in good operating condition at the end of Concession Period. The details provided below are only for guidance purpose.

Necessary permits, approvals required during construction and operation stage need to be obtained by the Concessionaire. Necessary field investigations such as topography survey, soil investigation and any other testing required to be carried out by the Concessionaire to validate the design basis and assumptions.

The sewage and treated sewage testing need to be carried out by the Concessionaire on a monthly basis at NABL accredited laboratory to validate the testing to be carried out on daily basis at the site level and the online parameters.

All the designs, drawings, specification need to be submitted to ***[Executing Agency]*** for approval. All the works shall be carried out only with the approval of the ***[Executing Agency]***.

List of suggested vendors for equipments, materials, and machineries should be submitted by the Concessionaire to ***[Executing Agency]*** for approval and the procurement/placement of order should be carried out after approval of the ***[Executing Agency]***.

Appointment of subcontractors, agents, advisors and consultants and entering sub-contracts to undertake the project with the prior approval of the ***[Executing Agency]***. The Concessionaire shall operate and maintain the facilities and the associated infrastructure and treat the sewage in a manner such that the KPIs are achieved, and the treated effluent and digested sludge comply with the discharge standards.

The STP by-products and FSTP by-products will be trifurcated into screenings, digested sludge, and residual grit. The Concessionaire will be required to dispose the STP by-products FSTP by-products as follows:

The residual grit and the screenings will be disposed at the waste disposal site to be identified by the ***[Executing Agency]*** within a radius of 10 (ten) kms from the Project site, in accordance with technical specifications.

The Concessionaire shall dry the digested sludge at a sludge handling facility to be provided by the Concessionaire at the site and have the option to sell the digested sludge to farmers/other third- party buyers or dispose the digested sludge at the waste disposal site.

The Concessionaire shall transfer the treated sewage/faecal sludge/septage through the treated effluent disposal pipeline/channel to the discharge point for discharge into the -------(Name of the water body, if applicable), sell to third parties or utilize for irrigation purposes free of cost.

**Indicative engineering assessment of work *[Location]***

|  |  |  |
| --- | --- | --- |
| **S.**  **No.** | **Description** | **Quantity** |
| 1. | Design, supply, installation, testing, and commissioning of [Capacity in MLD] capacity **Sewage Treatment Plant(s)** at ***[Location(s)]***, and [Capacity in MLD] capacity **Faecal Sludge Treatment Plant(s)** at ***[Location(s)]***, complete including all civil works & electro-mechanical works by making necessary preparatory works to treat the sewage as per applicable disposal norms. The power generation using the by-product/biogas is mandatory. |  |
|  | Civil works shall include site grading, dressing, excavation, filling, RCC foundations, plastering, painting, grill and gates, masonry compound wall, internal water supply, drainage, internal road of minimum ***[xx]*** m width and approach road of minimum ***[xx]*** m width, street light, security guard room, footpath, landscaping and gardening, peripheral drain etc., |  |
|  | Electro-mechanical works shall include design, supply, installation, testing, and commissioning of all electro-mechanical components of STP(s)/FSTP(s) including pumps, drive and drive controls - MCCs with local push button stations, tanks, pipelines, pipe fittings, valves and supports, all measuring instruments along with their power supply and instrument / signal cabling, power cabling, cable containments, earthing, firefighting system etc., and carry out the operation and maintenance of STP(s)/FSTP(s) for the Concession Period. | ***[As decided by the Executing Agency]*** |
|  | Provision of Diesel Generator set and electric substation, internal and external electrification as per CPWD/applicable guidelines/codes. |  |
|  | Design, supply and laying of RCC NP-3 treated effluent conduit from STP(s)/FSTP(s) to ***[Outlet Name]*** and discharge point must be designed considering the HFL. The HFL of ***[Outlet]*** is ***[xx]***m. |  |
|  | Co-treatment of ***[xx]*** cum /day sewage/faecal sludge/septage at ***[Capacity of STP/FSTP plant in MLD]*** MLD STP/FSTP. And carry out operation and  maintenance for the Concession Period. |  |



|  |  |  |
| --- | --- | --- |
| **S.no** | **Type of Quarter** | **No. of Quarters** |
| 1 | A | [As per standards  set by Executing Agency/MoHUA] |
| 2 | B |
| 3 | C |
| 4 | D |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Description** | | | | | | | **Quantity** |
|  | Design and construct all necessary buildings for administrative, laboratory (supply of all necessary testing apparatus/equipments), PLC room, buildings for E&M equipment, security guard room, staff quarters with size and FSI as per the  *Revised Plinth Area Norms for General Pool Residential Accommodation (GPRA) to be constructed for Central Govt. Employees and its applicability to all Govt. Departments, MoUD* ***[Executing Agency]*** standards and as necessary in the proposed STP/FSTP complex and carry out the operation and maintenance throughout the Concession Period. | | | | | | |  |
| 2. | Design, supply, installation, testing and commissioning of Main Sewage pumping station of ***[Capacity OF STP/FSTP Plant in MLD]*** MLD capacity with necessary civil works, electro-mechanical items, including rising main and all standard accessories / fittings complete with fully automatic Y/D starters / VFD starters/ ATS starter panels (for both working and standby pumps), power backup, CI pipes & specials, level switches, earthing, cabling, structural supports  / duck foot bends etc., as required as per site requirements, sanitary and plumbing works, cleaning of site and approach road, gate, peripheral drain, internal drainage, internal road, streetlight, plastering, painting, flooring, lights and fans, wiring, rubber mats in front of electrical switch boards/panel boards, first air boxes, firefighting system, voltage stabilizer etc. And carry out operation and maintenance for the Concession Period.  Provision of Diesel Generator set and electric substation, internal and external electrification as per CPWD/Applicable guidelines/codes. | | | | | | | ***[As decided by the Executing Agency]*** |
| 3. | Design, supply, construction, testing & commissioning of civil, mechanical and electrical & instrumentation works for I&D works at ***[name of the Drain(s)]***, as necessary and carry out the operation and maintenance for the Concession Period. The Concessionaire needs to install flow measurement instrument and actuator gates at I&D structure. Provision of manual and mechanical screen at  each I&Ds. | | | | | | | ***[As decided by the Executing Agency]*** |
| 4. | Design, supply, construction of trapezoidal type RCC drain at upstream of each I&Ds and carry out operation and maintenance for the Concession Period. | | | | | | | ***[As decided by the Executing Agency]*** |
|  |  | **I&D** | **Top**  **width(m)** | **Bottom**  **width (m)** | **Depth**  **(m)** | **Length (m)** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Location** | **No. of Manholes** | **NP3 Class**  **Pipe (mm)** | **Length (m)** |
| 1 | ***[Name of the drain]*** | ***[xx]*** | ***[xx]*** | ***[xx]*** |
| 2 | ***[Name of the***  ***drain]*** | ***[xx]*** | ***[xx]*** | ***[xx]*** |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Description** | | | | | | | **Quantity** |
|  |  | 1. | ***[Name of the***  ***drain]*** | ***[xx]*** | ***[xx]*** | ***[xx]*** | ***[xx]*** |  |
| 2. | ***[Name of the***  ***drain]*** | ***[xx]*** | ***[xx]*** | ***[xx]*** | ***[xx]*** |
|  | | | | | | |
| 5. | Design, supply, Laying of intercept sewer line from I&D to connecting manhole, intercept sewer shall be RCC NP-3 class complying to IS 458-2003 (up to date amendment) with rubber ring and complete including cutting of existing roads and restoration/ use of trenchless technology, excavation of earth to required depth(s), painting of the inside of pipes with 30/40 grade bitumen, providing new sewer pipes, reconnecting the removed connections, jointing of pipes, leak testing, backfilling the excavated trench, ramming, consolidating and bringing back the surface to original condition including black topping, shoring, shuttering etc. and testing, commissioning and carry out operation and maintenance. The pipe shall be ISI marked.  Providing and constructing brick masonry / RCC manhole for various depths and bringing back the surface to original condition including blacktopping, providing Gully chambers in appropriate places etc., and carry out the operation and maintenance for the Concession Period.  The intercept sewer shall be connected to the manholes of trunk sewer which is being laid by ***[Executing Agency]*** under ***[Name of Central Govt. Scheme/Other***  ***Convergance Project]*** project. | | | | | | | ***[As decided by the Executing Agency]*** |
| 6. | Design and Construction of inlet works of ***[xx]*** MLD with distribution chamber designed to feed proposed ***[Capacity of the STP/FSTP Plant in MLD]*** MLD STP/FSTP. The Concessionaire needs to install flow measurement instrument and actuator gates at distribution structure. The process control of distribution chamber shall be completely automated. | | | | | | | ***[As decided by the Executing Agency]*** |
| 7. | Design, supply, installation, testing and commissioning of all hardware and software items related to provision of Online Monitoring System at MPS, STP, FSTP and I&D for online real-time data transmission of various operating parameters from these proposed MPS/STP/FSTP/I&Ds to cloud-based web server over GSM / land telephony for monitoring from central office / sub- offices and by various authorized government agencies from fixed / portable devices / locations. The frequency of data storage for sewage / effluent quality  shall be for every 2 hours and shall be to the nearest millisecond of each event. | | | | | | | ***[As decided by the Executing Agency]*** |

|  |  |  |
| --- | --- | --- |
| **S.**  **No.** | **Description** | **Quantity** |
|  | The Sequence-of -event (SOE) data shall be collected by the RTOLMS system from PLCs. The description of each event shall include the database description name, device state, the date, and the time (to the nearest millisecond) of each event. Information Storage and Retrieval (ISR) system shall collect and store analog data (telemetered and calculated) periodically at every 5 minute  (configurable) and status data by exception. |  |
| 8. | Any other works as necessary for smooth operation of the sewerage system |  |

1. **Overview of procedural activities to be undertaken (Submissions by Concessionaire with timelines)**
2. Submit Basic Engineering Drawings as defined in the Agreement;
3. Submit the Construction Plan for the for the Facilities and the Associated Infrastructure;
4. Carry out all preparatory work like survey & investigations, clearing out debris and proper disposal of the extra surplus excavated earth to a suitable location as per Applicable Laws;
5. Develop the site, landscaping, arboriculture, and horticulture at the STP/FSTP Site and by providing earth filling, greenery, plantation, and diversion & extension of stormwater drainage network, etc. and maintain condition of landscape establishment;
6. Design and construct all necessary buildings for administrative, laboratory, PLC room buildings for E&M equipment as per Technical Specifications;
7. Undertake electrical and instrumentation works as per provisions detailed in key single line diagrams and plant control configuration diagrams.
8. Provide electrical substation, as required, in accordance with the requirements of State power corporation limited;
9. Keep the Facilities in clean, hygienic, tidy and safe conditions;
10. Illuminate the STP/FSTP with suitable arrangement, as per the Technical Specifications;
11. Undertake trial runs, testing, commissioning of Facilities as per the requirements of Concession Agreement;
12. Based on its assessment of the power supply, make necessary arrangements, as required, to ensure continuous uninterrupted operations of the Facilities during any power supply failure from the grid;
13. Undertake Operations and Maintenance of Facilities as per Technical Specifications and safe disposal of Treated Effluent, STP By-Products and FSTP By-Products;
14. Develop and implement the environment, social, health and safety plans as per the requirements of the Concession Agreement;
15. Implement quality system and environmental management system in accordance with ISO 9001 and ISO 14001;
16. Prepare appropriate records and reports as outlined in the Concession Agreement;
17. Undertake security control of the Facilities
18. Carry out the required tests and laboratory analysis;
19. Obtain and renew licenses, permits, and certificates necessary to operate the Facilities;
20. Hand-back the Facilities and the Associated Infrastructure to the ***[Executing Agency]*** at the end of the O&M Period;
21. Develop the necessary Design and Drawings and other submissions, as per the requirements of the Concession Agreement. These submissions, inter-alia are outlined in the table below:

**Submissions required from the Concessionaire**

|  |  |
| --- | --- |
| **Submission &**  **timeline** | **Description of submission** |
| Construction Plan before effectiveness | Detailed construction plan for the Facilities and the Associated Infrastructure setting out the work plan to achieve each of the Payment Milestones, such that the Facilities and the Associated Infrastructure are completed on or prior to the Scheduled Construction Completion Date. The should include the following sections at the minimum:  Site manpower and labor mobilization details. Details of project management and health & safety personnel to be deployed at the site to be provided separately.  Detailed implementation schedule (including details of construction milestones)  Construction method statements  Details of civil works and equipment control Quality assurance plans  Subcontracting details |
| Designs and Drawings before Effectiveness | Process design and calculations:  Description of Proposed Technology including proposed treatment process, process design calculations, and mass balance diagrams  Hydraulic calculations and Hydraulic Flow Diagram Details of the aeration device stating the turndown ratio  Details of the sludge digestion system stating maintenance mechanism from outside the digester (without draining its contents)  I&D design document  Site layout  Facilities layout: general arrangement drawings for the buildings, tanks, foundations, process units, approach road, Inlet Point, Outlet Point  Alignment drawings for Effluent Disposal Pipeline Location of site office, staff quarters,  Location of batching - plant, go-down / yard, store/workshop, etc. Details of the stormwater drainage inside the STP/FSTP  Layout of the earthen embankment I&D Layout drawing  Architectural Designs and Concepts  Architectural design proposals for interior and exterior architecture along with an appropriate landscaping scheme  Architectural statement explaining the factors considered in the design Architectural work shall include walls, roof, flooring and floor finish,  roof waterproofing, down water pipes, windows, ventilators, doors, glazing,  equipment access doors, painting and other ornamental works |



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| **Submission &**  **timeline** | **Description of submission** |
|  | Structural designs and calculations  Basic design calculations of foundations  General arrangement drawings and explanatory sketches  Methods statement describing work procedure before commencing concrete work  Power  Power single line diagrams  Process data sheets to define design criteria, installed capacities and loading rates of principal items of plant and equipment  Control philosophy report  Electrical load list |
|  | Instrumentation and Control  Process and Instrumentation Diagrams  Instrument schedule & I/O schedule for each Motor Control Centre Functional Design Specification - Comprising an overall description of  the plant, its functioning and control, and description of each section of the  control system covering modes of operation, manual overrides, set-point and  -  incorporated into the design for the event of failure of a plant item or system or loss of an input signal affecting a control loop or process sequence. It shall also describe control actions taken and monitoring functions which remain available during a power failure, and any automatic controls or sequencing which take place during system start-up and shut-down. It shall include figures or drawings where appropriate.  Drawings and schedules Including the following -  Process and instrumentation diagram which shall comply with BS 1646 (all parts) and BS 1553-1:1977.  General arrangement drawings of field-mounted instruments showing installation details.  General arrangement drawings of instrument and control panels, fully- dimensioned in plan and elevation views, showing foundation and fixing details, access doors, clearances, cable-entry positions, weight and lifting arrangement.  Layout drawings of panel showing instruments, controls, and details of all labels.  Layout drawings of panel interior showing equipment, terminal blocks & cableways.  Annunciator arrangement and engraving details.  Internal circuit and wiring diagrams for instrument and control panels. Schematic control diagrams.  Instrument loop diagrams.  Instrument wiring and piping diagrams. Interconnection wiring diagrams.  Cable block diagrams, drawings, and schedules. |



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| **Submission &**  **timeline** | **Description of submission** |
|  | Instrument system and panel power distribution diagrams.  Programmable-device functional design specifications which shall include hardware details, logic flow charts, ladder diagrams and program listings.  Schedules of inputs to and outputs from programmable controllers and telemetry outstations.  Labeling schedules.  Comprehensive testing schedules for all off-site, on-site, pre- commissioning and commissioning tests and take-over tests.  Drawings necessary for the provision of ducts, openings, trenches, fixing holes for panels etc.  Data and calculations    Calculations to support control system design Specification for protective coatings and painting Certificates  s tests  Pre-installation checks Pressure-testing schedules  Instrument loop test check sheets Installed instrument performance tests System tests  Statutory certificates of compliance (such as hazardous area equipment) Pipework layout diagrams including all valves and penstocks  Online Monitoring  SCADA/instrumentation/process control system architecture Geotechnical analysis and topography survey report  Topographical survey reports  Site details & topography of STP/FSTP Site, L-sections of channels & other works  Survey records, borehole records, and soil test reports  EHS Plan for Construction Period Health and Safety Standards  Environmental and Social Management Plan  Threshold Influent Standards proposed which are the minimum standards, beyond the Influent Standards, that the Sewage must meet for it to be treated at the Facilities, in line with clause 7.2 (a) of the Concession Agreement. |
| *During* | Detailed construction design and drawings: |

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| **Submission &**  **timeline** | **Description of submission** |
| Construction Period | Information on equipment during installation Performance curves and drawings of equipment Schedules of equipment  Quality plans for electrical, mechanical, instrumentation and SCADA  works  Test and inspection certificates |
| Upon Construction Completion | As-Built Drawings  Final version of the design calculations Key construction records and tests Asset sheets |
| At least 30  (thirty) days  prior to the Scheduled Construction Completion Date | O&M Manual including the following:  O&M Procedures  Overall description of permits and standards, operation, and control of Facilities and Associated Infrastructure, operation and control of sludge handling facilities, sampling and laboratory analysis, records and reporting, maintenance, emergency O&M procedures  Overall plan for O&M of the Facilities and Associated Infrastructure with due consideration to the reliability of performance, flexibility to cope with variability, diligence to maintain tidiness and cleanliness, capability to respond to emergency situations and effectiveness to handle complaints and to meet the KPIs;  Provision of spare parts and special tools with quantity and particulars throughout the O&M Period for effective and uninterrupted operation of the Facilities and Associated Infrastructure;  Sampling and testing methodologies to determine physical, chemical and biological characteristics of raw Sewage and Effluent Water as per CPHEEO manual;  Methodology for sampling and testing of heavy metals in line with the CPHEEO manual  Inventory control of consumables such as fuel, sand and various types of chemicals, dangerous goods and hazardous materials;  Safe and proper storage and transfer of various types of materials and chemicals, dangerous goods, and hazardous materials to assure the continuous operation of the Facilities and Associated Infrastructure, the compliance with statutory requirements and avoidance of environmental nuisance;  Upkeep of the central control and monitoring system to ensure availability of reliable online and archived data  Arrangements for ensuring data security and integrity, and prevention of unauthorized alteration  Arrangements for data recovery in case of accidental loss of essential operational data  Arrangements for allowing flexibility of the computer database to store |

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| **Submission &**  **timeline** | **Description of submission** |
|  | and process data upon introduction of new technologies and data management system  Preventative maintenance and corrective maintenance requirements Precautionary measures and arrangements for inclement weathers Procedures to record and handle complaints  Operational arrangements related to tests for KPIs  Procedures to prepare and submit routine records and reports to the  ***[Executing Agency]***  Operational Contingency Plan  Identification of potential problems that may cause disruptions to operation and assessment of potential impacts  Measures to handle potential problems and prevent disruptions to operation  Measures to handle emergency situations that may cause disruptions to operation and shutdown of the Facilities  Precautions and procedures to resume operation after addressing of the emergency situations; and  Fire and emergency drill plans  Human Resources Plan Mobilization of labor for O&M  Means and flow of communication among field staff, staff at control rooms and truck drivers for disposal of the Digested Sludge;  Scheduled Maintenance Program for the first year post-COD Emergency Procedures for:  Fire  Vehicle breakdown and accidents Facilities closure  Procedure to handle excessive incoming Sewage due to rain, storm or infiltration  Floods  Inclement weather conditions Unscheduled and Forced Outage Spillage of chemicals  Labor disputes  Asset Management Plan:  Composite manual describing the functions and operations of each equipment  Composite manual for testing and servicing every system and individual  item  Assets overview |

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| **Submission &**  **timeline** | **Description of submission** |
|  | description of various components of the Facilities and Associated Infrastructure  dependencies between the components asset management strategy  System performance  design lives of plant, buildings, and structures;  benchmarks, standards and guidelines adopted for performance tests, condition surveys and residual life assessments;  Asset remediation plans  schedules for overhaul and replacement of plant  schedules for refurbishment and renewal planned actions to bring or keep the assets above their minimum  conditions required under the Concession Agreement  Operational arrangements related to the survey of the Hand-back Conditions  EHS Plan:  Waste (Screenings & Grit and other waste) management plan  Sludge management plan, including a strategy and improvement measures and actions to treat and dispose of sludge, including sludge valorization opportunities in compliance with applicable standards  Health and safety standards Hazardous material management plan  Health and safety requirements to be followed by staff & sub-contractors Traffic management plan during construction  Identification, elimination, and mitigation of safety and health risks associated with the O&M of the Facilities and Associated Infrastructure; Environmental and social management system  Pollution prevention plan (water, air, noise)  Procedures, plans, and actions to achieve compliance with the requirements of the Concession Agreement;  Measures to enhance and sustain the good image of the Facilities and the Associated Infrastructure  Plan for maintaining good communication and relationship with all stakeholders  Guaranteed Energy Consumption in the format provided in the table below (refer to  clause 9.4 (e) (ii) (C)). The figures presented in the last column (which corresponds to peak flow) should be equal to those quoted in the Financial Proposal. |
| O&M Period | Annual scheduled maintenance program every year |

**Part C - Overview of SCADA system to be employed**

The schematic representation of the required RTOLMS architecture to be provided by the bidder as part of Basic engineering package to meet the KPI requirements as per schedule 1 and 10.

**Typical parameter and relayed to control monitoring station**

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| **Parameters** | **Description of soft signal** | **Main pumping station** | | **STP** | | |  |  |  |  |
|  |  |  |  |  |
| Date & Time | Real time |  |  |  |  |  |  |  |  |  |
| Liquid Level | High |  |  |  |  |  |  |  |  |  |
| Low |  |  |  |  |  |  |  |  |  |
| Liquid flow | Inlet flow  measurement |  |  |  |  |  |  |  |  |  |
| Sewage quality | pH, TOC bases BOD and COD, TSS, TP, TN and  residual chloride |  |  |  |  |  |  |  |  |  |
| Pump status for  individual pumps | On, OFF, Trip |  |  |  |  |  |  |  |  |  |
| Flow rate in common  header | Flow rate, head |  |  |  |  |  |  |  |  |  |
| Electrical parameter  for individual pumps & main switch board | Voltage, Current, KWH, PF, KVA |  |  |  |  |  |  |  |  |  |
| No of operating  personnel |  |  |  |  |  |  |  |  |  |  |
| Temperature - |  |  |  |  |  |  |  |  |  |  |

*Note:*

*For flow measurement at I&D, the Concessionaire is free adopt any available flow measuring instruments with compatibility for online monitoring*

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **Description of soft signal** | **Main pumping station** | | **STP** | | |  |  |  |  |
|  |  |  |  |  |
| Ambient, liquid |  |  |  |  |  |  |  |  |  |  |
| Bio gas monitoring | Online status for  various activity |  |  |  |  |  |  |  |  |  |
| Gas generation | Cum / day,  cumulative gas  generation, gas quality |  |  |  |  |  |  |  |  |  |
| Septage handling  monitoring | Online status for  various activity |  |  |  |  |  |  |  |  |  |
| Septage treatment | Cum / day, cumulative septage received,  quality |  |  |  |  |  |  |  |  |  |
| DG set running hours |  |  |  |  |  |  |  |  |  |  |
| Electrical parameter for individual Bio gas-based engine generator, DG set pumps & main switch  board | Voltage, Current, KWH, PF, KVA |  |  |  |  |  |  |  |  |  |





This Substitution Agreement (**Substitution Agreement**) is executed on this    9 at [***Location]***:

**AMONGST**

1. ***[Executing Agency]*,** a statutory body constituted under the ***[Act under which the Executing Agency is established]*** with its registered office at ***[Address of Executing Agency]***. (hereinafter referred to as ***[Executing Agency]***, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. [Name of the State / National Level Agency, if any]104, a statutory body constituted ,

with its registered office at ---------------- (hereinafter referred to as , which expression

shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. [ \_[***insert name of the Concessionaire***], a company organized, incorporated, registered and existing under the Companies Act, with its registered office at

[***insert address***] acting through

, [***insert name of the authorised signatory and his/her designation***] duly authorized by resolution dated

***[insert date of the Board Resolution***] (hereinafter referred to as the **Concessionaire**, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. [***Insert name of the Lenders' Representative***] a company organized, incorporated, registered and existing under the Companies Act, with its registered office at **[*insert address*]** (hereinafter referred to as the Lenders' Representative, which expression shall, unless it be repugnant to the context having its registered office at **[*insert address*]**, [acting for itself and for and on behalf of the Lenders listed in Annexure 1].

The ***[Executing Agency]***, (Name of the National/State Level Agency, if any), the Concessionaire and the Lenders' Representative are hereinafter collectively referred to as **Parties** and individually as **Party**.

**WHEREAS:**

1. With a view to implement (Name of the Projects/scheme), the ***[Executing Agency]*** in

association with (Name of the National/State Level Agency, if any), has decided to undertake

104 If there is a State Level/National Level intermediate agency funding the project and such an entity is part of the contract/procurement process the name of that agency can be inserted here. Otherwise all references to the National/State Level agency in the document are to be deleted.

integrated development, operation and maintenance of Sewage Treatment Plant(s) (the ) and Faecal Sludge Management System, with a proposed Design Capacity of ***[Capacity of STP in MLD]*** MLD of STP and [***Capacity of FSTP in MLD***] MLD of Faecal Sludge Treatment Plant(s) (the ), along with other Facilities and its Associated Infrastructure at ***[Location]***, on a PPP basis, through a hybrid annuity model.

1. For this purpose, the ***[Executing Agency]*** selected the Concessionaire post a bid process to: (i) design, develop, part-finance, construct, operate and maintain the Facilities on the Site and the Associated Infrastructure, and after the expiry of the Term, transfer the Facilities and the Associated Infrastructure to the ***[Executing Agency]*** (collectively the ).
2. The ***[Executing Agency]***, (Name of the National/State Level Agency, if any) and the Concessionaire executed a Concession Agreement dated [Insert date] to implement the Project (the **Concession Agreement** ).
3. The Lenders have agreed to finance the Project in accordance with the terms and conditions of the Financing Documents and have requested the ***[Executing Agency]*** and (Name of the National/State Level Agency, if any) to enter into this Substitution Agreement for securing their interests through substitution of the Concessionaire to a nominated Company, in accordance with this Substitution Agreement.
4. The Parties have agreed to execute this Substitution Agreement on the terms and conditions mentioned herein below.

**IT IS AGREED** as follows:

* 1. **DEFINITIONS AND INTERPRETATION**
     1. **Definitions**

The capitalised terms used but not defined in this Agreement shall have the meaning ascribed to them in the Concession Agreement:

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| **Annexure** | means an annexure to this Substitution Agreement. |
| **Arbitration** | has the meaning ascribed to it in Clause 8.2 |
| **Article** | means an article of this Substitution Agreement. |
| **Clause** | means a clause of this Substitution Agreement. |
| **Companies Act** | means the (Indian) Companies Act, 1956 or the (Indian)  Companies Act, 2013, as amended from time to time, as the context may require. |
| **Company** | means a company incorporated under the Companies Act or a  foreign company incorporated under the relevant statute of its jurisdiction. |
| **Concession Agreement** | has the meaning ascribed to it in Recital C. |
| **Concession Event of**  **Default** | means a Concessionaire Event of Default as defined under the  Concession Agreement |
| **Dispute** | means any difference or dispute of whatsoever nature relating to this Substitution Agreement between the Parties arising under,  out of or in connection with this Substitution Agreement. |

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| **Financial Assistance** | means all funded and non-funded financial assistance, including loans, advances and guarantees or any re-financing that the Concessionaire has availed of for the Project from the Lenders,  as set out in the Financing Documents. |
| **Financial Default** | means a Concessionaire event of default as set out under the  financing Documents. |
| **Financing Documents** | means, collectively, the documents entered into or to be entered into by the Concessionaire with the Lenders, in respect of all funded and non-funded financial assistance, including loans, advances and or any re-financing that the Concessionaire may avail of for the Project from the Lenders and includes any  document providing Security to the Lenders. |
| **Indemnified**  **Party** | has the meaning ascribed to it in Clause 7.2. |
| **Indemnifying**  **Party** | has the meaning ascribed to it in Clause 7.2. |
| **Lenders** | means the financial institutions set out in Annexure 1. |
| **Lenders' Dues** | means the aggregate of all monies owed by the Concessionaire to the Lenders under the Financing Documents on account of principal thereunder for funding the whole or any part of the cost to be incurred for implementing the Project and all accrued interest, additional interest, liquidated damages, commitment fees, commission, prepayment premium, costs, charges and other monies including financing charges and fees owed by the Concessionaire to the Lenders under the Financing Documents for the Project that are payable under the Financing Documents, up to the date of the Notice of Intent to Terminate or notice of termination issued under the Concession Agreement, or up to the date of issuance of the Notice of Financial Default under the Financial Documents, as the case  may be. |
| **Notice of Dispute** | has the meaning ascribed to it in Clause 8.1. |
| **Notice of**  **Financial Default** | has the meaning ascribed to it in Clause 3.2(a). |
| **Notice of Intent to Terminate** | means a notice issued by the ***[Executing Agency]*** upon occurrence of a Concessionaire Event of Default in accordance with the Concession Agreement, conveying its  intention to terminate the Concession Agreement. |
| **Person** | means any individual, company, corporation, partnership, joint venture, trust, society, sole proprietor, limited liability partnership, co-operative society, government company,  unincorporated organization or any other legal entity. |
| **Project** | has the meaning ascribed to it in Recital B. |
| **Proposal** | shall have the meaning ascribed to it in Clause 4.1(c). |
| **RFP** | means the request for proposal dated [insert date] issued by the  ***[Executing Agency]***, for conducting a bid process to implement the Project. |

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| **Selectee** | means a new Company proposed by the Lenders pursuant to this Substitution Agreement for performing the rights and obligations of the Concessionaire for the remaining Term of  the Concession Agreement. |
| **Substitution notice under Concession**  **Agreement** | has meaning ascribed to it in Clause 3.3(c). |
| **Substitution** | has meaning ascribed to it in Clause 3.3 (b) |

* + 1. **Interpretation**

In this Substitution Agreement, unless the context otherwise requires:

* + - 1. Any reference to a statutory provision shall include such provision as modified or re- enacted or consolidated from time to time.
      2. The words importing the singular shall mean the plural and vice-versa; and words importing the masculine shall include the feminine and neuter and vice-versa.
      3. Headings in this Substitution Agreement are for convenience of reference only.
      4. The references to the word 'include' or 'including' or to the phrase 'in particular', shall be construed without limitation.
      5. References to any date or time of day are to Indian Standard Time; any reference to day shall mean a reference to a calendar day; any reference to a month shall mean a reference to a calendar month, any reference to a year shall mean a reference to a calendar year.
      6. The references to any agreement or deed or other instrument shall be construed as a reference to such agreement, deed, or other instrument as may be amended, varied, supplemented or novated, from time to time.
      7. A requirement that a payment be made on a day which is not a Business Day shall be construed as a requirement that the payment be made on the next Business Day.
      8. Whenever provision is made for the giving or issuing of any notice, endorsement, consent, approval, permission, certificate or determination by any person, such notice, etc., shall be reasonably given, shall not be unreasonably withheld or delayed and shall be in writing and the words 'notify', 'endorse', 'approve', 'permit', 'certify' or 'determine' shall be construed accordingly. Where any notice, consent or approval is to be given by either of the Parties, the notice, consent or approval shall be given on their behalf only by any authorized persons.
      9. The words written and in writing include a facsimile transmission and any means of reproducing works in a tangible and permanently visible form.
      10. The provisions of the Articles, Clauses and Annexures of this Agreement shall be interpreted in such a manner that will ensure that there is no inconsistency in interpretation between the intent expressed in the Articles, Clauses or Annexures.
      11. In the event of any ambiguities or discrepancies between two Clauses of this Agreement, the provisions of the specific Clause relevant to the issue under consideration shall prevail over those in other Clauses.
      12. The rule of construction, if any, that an agreement should be interpreted against the Party responsible for the drafting and preparation thereof shall not apply to this Agreement.
  1. **ASSIGNMENT**

The Concessionaire hereby agrees to assign its rights, title and interest under the Concession Agreement to and in favour of the Lenders pursuant to and in accordance with this Substitution Agreement and the Concession Agreement by way of Security in respect of the Financial Assistance provided by the Lenders.

The***[Executing Agency] {***and (Name of the National/State Level Agency, if any)}105 hereby consent to assignment by the Concessionaire of its rights, title and interest under the Concession Agreement by way of Security to and in favour of the Lenders in connection with the Financial Assistance provided by the Lenders.

* 1. **SUBSTITUTION OF THE CONCESSIONAIRE**
     1. **Right of Substitution**
        1. The ***[Executing Agency]*** and {(Name of the National/State Level Agency, if any)} hereby irrevocably agree to substitute the Concessionaire with a Selectee, selected by the Lenders in accordance with the provisions of this Substitution Agreement and approved by the ***[Executing Agency]***,
        2. The Lenders shall, at their sole discretion, exercise one of the 2 (two) modes below for substituting the Concessionaire in accordance with the provisions set out in this Agreement and Applicable Laws:
           1. Novation: In this case, the Concession Agreement will be novated in favour of the Selectee. , and the Selectee will be a party to the Concession Agreement;

or

* + - * 1. Share sale: In this case, the Selectee will acquire the entire Capital of the Concessionaire, and upon such transfer, the 'Concessionaire' will be deemed to be the Selectee under and in accordance with this Agreement.

105 Contents in curly parenthesis may be deleted if not applicable.

* + - 1. The ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)} agree that they shall provide all necessary consents and assistance to effect such substitution of the Concessionaire with a Selectee.
      2. It is clarified that nothing contained herein shall entitle the Lenders to design, develop, construct, rehabilitate, complete, operate or maintain the Facilities or the Associated Infrastructure themselves under and in accordance with the Concession Agreement either individually or collectively
    1. **Procedure in case of a Financial Default**
       1. Upon occurrence of a Financial Default, the Lenders' Representative shall notify the Concessionaire by a notice, with a copy simultaneously sent to the ***[Executing Agency]***

{and (Name of the National/State Level Agency, if any)}, about the occurrence of a Financial Default and the amount of the Lenders' Dues (**Notice of Financial Default**).

The Notice of Financial Default shall be conclusive evidence of occurrence of the Financial Default and the Lenders' Dues, and shall be final, conclusive and binding upon the Concessionaire for the purpose of this Substitution Agreement and the Financing Documents.

The Parties agree that the ***[Executing Agency]*** shall have the right to trigger a Concessionaire Event of Default and issue a Notice of Intent to Terminate under the Concession Agreement upon receipt of a Notice of Financial Default.

* + - 1. The Lenders' Representative (on behalf of the Lenders) may, within 60 days after the issuance of the Notice of Intent to Terminate under Clause 3.2(a) above or such longer period as may be mutually agreed between the ***[Executing Agency]*** and the Lenders, make a representation to the ***[Executing Agency]***, stating the intention to substitute the Concessionaire by a Selectee (**Substitution Notice under Financing Documents**).

In the event that the Lenders' Representative issues the Substitution Notice under Financing Documents, then, within 90 days of issue of such notice, the Lenders shall be entitled to undertake and complete the substitution of the Concessionaire by a Selectee, in accordance with the provisions of this Substitution Agreement. The Lenders' right to substitute the Concessionaire shall be without prejudice to any other right or remedy available to the Lenders under the Financing Documents and/or this Substitution Agreement.

* + - 1. If the Lenders' Representative does not convey the intention to substitute the Concessionaire with a Selectee within 60 days of the Notice of Intent to Terminate under Clause 3.2(a) above or such longer period as may be mutually agreed between the ***[Executing Agency]*** and the Lenders, or the Lenders fail to substitute the Concessionaire within the time period set out in (b) above, the ***[Executing Agency]*** shall be entitled to terminate the Concession Agreement in accordance with its provisions.
    1. **Procedure in case of a Concessionaire Event of Default**
       1. Upon occurrence of a Concessionaire Event of Default, the ***[Executing Agency]*** shall issue a Notice of Intent to Terminate issued to the Concessionaire.
       2. If, within 60 days from the date of the Notice of Intent to Terminate, the Concessionaire does not rectify or remedy the Event of Default to the satisfaction of the ***[Executing Agency]*** or the ***[Executing Agency]*** is not satisfied with the steps taken or proposed to be taken by the Concessionaire to remedy the Event of Default, the ***[Executing Agency]***shall issue a Notice of Intent to Terminate to the Lenders to exercise their substitution rights. The Notice of Intent to Terminate issued by the ***[Executing Agency]*** to the Lenders under this Clause 3.3(b) shall be conclusive evidence of occurrence of the Financial Concessionaire Event of Default, and shall be final, conclusive and binding upon the Concessionaire for the purpose of this Substitution Agreement and the Financing Documents.
       3. The Lenders' Representative (on behalf of the Lenders) may, within 60 days after the issuance of the Notice of Intent to Terminate under Clause 3.3(b) above or such longer period as may be mutually agreed between the ***[Executing Agency]***and the Lenders make a representation to the ***[Executing Agency]***, stating the intention to substitute the Concessionaire by a Selectee (**Substitution Notice under Concession Agreement**). In the event that the Lenders' Representative issues the Substitution Notice under Concession Agreement, then, within 90 days of issue of such notice, the Lenders shall be entitled to undertake and complete the substitution of the Concessionaire by a Selectee, in accordance with the provisions of this Substitution Agreement. The Lenders' right to substitute the Concessionaire shall be without prejudice to any other right or remedy available to the Lenders under the Financing Documents and/or this Substitution Agreement.
       4. If the Lenders' Representative does not convey the intention to substitute the Concessionaire with a Selectee within 60 days of issuance of the Notice of Intent to Terminate under Clause 3.3(b) above or such longer period as may be mutually agreed between the ***[Executing Agency]*** and the Lenders, or the Lenders fail to substitute the Concessionaire within the time period set out in (c) above, the ***[Executing Agency]***shall be entitled to terminate the Concession Agreement in accordance with its provisions.
    2. **Criteria for Selection of Selectee**
       1. The Lenders' Representative shall apply the following criteria while selecting a Company as the Selectee:
          1. the Company shall meet the financial, eligibility and qualification criteria set out in the RFP, demonstrating that it has the necessary experience and technical qualification to construct and operate and maintain the Facilities and the Associated Infrastructure for the remaining Term. Provided that if the Financial Default or the Concessionaire Event of Default has occurred during the O&M Period, the Selectee shall be required to meet only the O&M qualification criteria set out in the RFP, in addition to the financial and eligibility criteria;
          2. the Company shall be capable of properly discharging the duties, obligations and liabilities of the Concessionaire under the Concession Agreement;
          3. the Company shall provide Security to the satisfaction of the Lenders for the repayment of Lenders' Dues;
          4. the Company shall have the capability and shall unconditionally consent to assume the liability for the payment and discharge of dues of the Concessionaire to the ***[Executing Agency]***under and in accordance with the Concession Agreement and of Lenders' Dues upon terms and conditions as agreed to with the Lenders;
          5. the Company shall have not been in breach of any agreement between itself {and (Name of the National/State Level Agency, if any)}106, the ***[Executing Agency]***, the GoI or the Go***[XX] [STATE OF Location]***; and
          6. any other appropriate condition or criterion determined by the Lenders [or the ***[Executing Agency]***], whereby continuity in the performance of the Concessionaire's obligations under the Concession Agreement is maintained and the Security in favour of the Lenders under the Financing Documents is preserved.
       2. At any time prior to the approval of a Company as the Selectee by the ***[Executing Agency]*** pursuant to this Substitution Agreement, the ***[Executing Agency]*** may require the Lenders' Representative to satisfy the ***[Executing Agency]*** as to the eligibility of such Selectee and the decision of the ***[Executing Agency]*** in this behalf shall be reasonable, final, conclusive and binding on the Lenders and such Selectee.
  1. **MODALITIES OF SUBSTITUTION**
     1. **Modalities**

The following modalities shall be applicable to any substitution of the Concessionaire by the Selectee:

* + - 1. the Lenders' Representative may invite, negotiate, procure offers either through private negotiations or public auction or process of tender or otherwise for the substitution of the Concessionaire by another Company; the Lenders' Representative shall on behalf of the Lenders propose to the ***[Executing Agency]***.
      2. with a copy to {(Name of the National/State Level Agency, if any)}, pursuant to Clause 4.1(c), the name of such Company proposed to be the Selectee for acceptance and shall apply to the ***[Executing Agency]*** for:
         1. grant to such Company, as substitute to the Concessionaire, the right to design, construct, rehabilitate, finance, operate, maintain and transfer the Facilities and the Associated Infrastructure under and in accordance with and subject to and on the terms and conditions set out in the Concession Agreement;
         2. In case the Lenders intend to exercise their substitution rights through share transfer, the Lenders' Representative shall also apply to the ***[Executing Agency]*** for permitting such share transfer to the Selectee upon approval in accordance with this Concession Agreement.

In case the Lenders intend to exercise their substitution rights through novation, the Lenders' Representative shall also apply to the ***[Executing Agency]*** for: (i) novation of the Concession Agreement to such Company, upon being approved as the Selectee, on the same terms and conditions for the remaining Term under the Concession Agreement; and

* + - * 1. the execution of a new substitution agreement with such Company, upon being approved as the Selectee, for the remaining Term, on the same terms and conditions as set out in this Substitution Agreement.
      1. the Lenders' Representative shall be entitled, within the time period set out in Clause 3.2(b) or Clause 3.3(c) above as the case may be, to select and propose a Company as the Selectee to the ***[Executing Agency]*** {(with a copy to (Name of the National/State Level Agency, if any))}107 for its approval (**Proposal**). The Proposal of the Lenders' Representative pursuant to this Clause 4.1(c) shall contain the details of such Company (including information in relation to the Company's ability to meet the technical and financial criteria set out in the RFP), the Lenders' Dues and any other data and information as may be relevant for the ***[Executing Agency]*** to consider and take a decision on the Proposal.
      2. Without prejudice to the foregoing, the Lenders' Representative agrees and undertakes to provide to the ***[Executing Agency]*** (and (Name of the National/State Level Agency, if any)), such further and other information and clarifications in respect of any data, details or information, furnished by the Lenders' Representative as the ***[Executing Agency]*** and/or (Name of the National/State Level Agency, if any) may reasonably require. The ***[Executing Agency]*** shall convey its approval or otherwise of such Proposal, including such Company proposed as the Selectee, in its sole discretion within [15] days of
         1. the date of receipt of the Proposal by the ***[Executing Agency]***; or (ii) the date when the last of any further information and clarifications in respect of any data, details or information comprised in the Proposal, have been provided by the Lenders' Representative to the ***[Executing Agency]***, whichever is later. It is expressly agreed between the Parties that the Proposal shall be accompanied by an unconditional undertaking of the Company proposed as the Selectee that it shall, upon approval by the ***[Executing Agency]*** of the Proposal, perform and fulfill the terms and conditions of the Concession Agreement as if such Company was the original signatory to the Concession Agreement and shall be liable for and shall assume, discharge and pay the Lenders' Dues under and in accordance with the terms and conditions of the Financing Documents. Upon approval of the Proposal by the ***[Executing Agency]***, the Company shall become the Selectee hereunder;
      3. the ***[Executing Agency]*** shall, upon its satisfaction of the eligibility of the Selectee and in accordance with the provisions of this Substitution Agreement and subject to the

provisions of Clause 4.1(e), proceed to substitute the Concessionaire with the Selectee by novation of the Concession Agreement or such other form of document as the ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)} may reasonably require, on the same terms and conditions as set out under the Concession Agreement for the remaining Term; or (ii) by requiring selectee to the substitution as aforesaid shall be subject to the Selectee completing corporate compliances for executing the documents and obtaining Applicable Permits necessary for implementing and/or operating and maintaining the Facilities and the Associated Infrastructure under and in accordance with the Concession Agreement;

* + - 1. the ***[Executing Agency]*** shall have the right to object to the choice of the proposed Selectee after hearing the Lenders' Representative, provided however, that in the event of a refusal as stated above, the Lenders' Representative may propose another Company as the Selectee, within 90 days of the issuance of the Substitution Notice under Financing Documents or Substitution Notice under Concession Agreement, as the case may be. In the event that no objection is raised with respect to the Company proposed to be the Selectee by the ***[Executing Agency]*** within the period set forth in Clause 4.1(c), the Company proposed as the Selectee shall be deemed to have been accepted by the ***[Executing Agency]***;
      2. the substitution as aforesaid, shall be deemed to be complete only upon the Selectee accepting and complying with the terms and conditions stipulated in the Concession Agreement; and
      3. all actions of the Lenders' Representative hereunder shall be deemed to be on behalf of the Lenders and be binding upon them. The Lenders' Representative is authorised to receive payment of compensation, payment to cure default and any other payments, consideration for transfer in accordance with the Substitution Notice under Financing Documents or Substitution Notice under the Concession Agreement, as the case may be, the Concession Agreement and the Financing Documents and give valid discharge on behalf of all the Lenders.
    1. **Waiver of Concessionaire's Right to Remedy**

The Concessionaire hereby irrevocably agrees and waives any right to challenge the Lenders' decision to apply to the ***[Executing Agency]*** for substitution as aforesaid and neither the Concessionaire nor the ***[Executing Agency]*** shall be entitled to prevent the Lenders' Representative from proceeding to seek such a substitution of the Concessionaire by the Selectee as provided in this Article 4. The Concessionaire agrees and confirms that the Concessionaire shall not have any right to seek re-evaluation of the Concessionaire's assets and the Concession Agreement, otherwise than as contracted in the Financing Documents while the ***[Executing Agency]*** permits substitution as hereinbefore provided, pursuant to the Lenders' Representative's request. The Parties acknowledge that the rights of the Lenders under this Article 4 are irrevocable and shall not be contested in any proceedings before any court of law and the Concessionaire shall not have any right or remedy to prevent, obstruct, injunct or restrain the ***[Executing Agency]*** and/or the Lenders from effecting or causing the substitution as aforesaid. No third party shall have the right to question the decision of the Lenders/Lenders' Representative, the ***[Executing Agency]*** {or (Name of the National/State Level Agency, if

any)}108 in relation to substitution of the Concessionaire.

* + 1. **No Guarantee**

Nothing contained in this Article 4 shall mean or be interpreted as provision of any guarantee or surety by the ***[Executing Agency]*** {or (Name of the National/State Level Agency, if any)} and it is expressly agreed that the ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)} have not provided any surety, guarantee or counter guarantee whether directly or indirectly for the recovery of amount of Financial Assistance advanced by the Lenders to the Concessionaire.

* 1. **INTERIM PROTECTION**

If the Lenders notify the ***[Executing Agency]*** of a Financial Default and until such time that a Selectee is approved in accordance with this Substitution Agreement, the Lenders agree that the ***[Executing Agency]*** shall (either itself or through an entity nominated by it) be entitled to maintain, preserve and protect the Facilities and the Associated Infrastructure if, in the ***[Executing Agency]***'s opinion, it is necessary and required for the construction or operation and maintenance of the Facilities and the Associated Infrastructure. In case of such interim protection during the O&M Period, the ***[Executing Agency]*** or an entity nominated by the ***[Executing Agency]*** shall operate and maintain the Facilities and the Associated Infrastructure pending the substitution of the Concessionaire by the Selectee.

* 1. **STAND-STILL**

The ***[Executing Agency]*** agrees that on the occurrence of any Concessionaire Event of Default or a Financial Default, it shall not exercise: (a) its ***[Executing Agency]*** right to step- in in place of the Concessionaire; (b) suspend or terminate the Concession Agreement; or (c) take any action for the winding-up of the Concessionaire or the appointment of a receiver or administrator in respect of the Concessionaire's business and assets, until expiry of the time period available to the Lenders to exercise the substitution rights, as set out in Article 3.

* 1. **INDEMNITY**
     1. **Indemnity**
        1. The Concessionaire shall indemnify, defend and hold harmless the ***[Executing Agency]***,

{(Name of the National/State Level Agency, if any)}, the Lenders and the Lenders' Representative against any and all proceedings, actions and third party claims for any loss, damage, cost and expenses of whatever kind and nature arising out of any breach by the Concessionaire of any of its obligations under this Substitution Agreement or on account of failure of the Concessionaire to comply with Applicable Laws and Applicable Permits.

* + - 1. The Lender shall indemnify, defend and hold harmless the ***[Executing Agency]*** and

{(Name of the National/State Level Agency, if any)}109 against any and all proceedings, actions and third party claims for any loss, damage, cost and expenses arising out of the Lenders' or the Lenders' Representative's failure to fulfill their obligations under this Substitution Agreement, materially or adversely affecting the performance of the Concessionaire's, the ***[Executing Agency]***'s {or (Name of the National/State Level Agency, if any)}'s obligations under the Concession Agreement, other than any loss, damage, cost and expenses arising out of acts done in discharge of their lawful functions by the Lenders/Lenders' Representative.

* + 1. **Notices and Contest of Claims**

In the event that any Party receives a claim from a third party in respect of which it is entitled to the benefit of an indemnity under Clause 7.1 or in respect of which it is entitled to reimbursement (**Indemnified Party**), it shall notify the other Party responsible for indemnifying such claim hereunder (**Indemnifying Party**) within 30 days of receipt of claim and shall not settle or pay the claim without prior approval of the Indemnifying Party, such approval not being unreasonably withheld or delayed. In the event that the Indemnifying Party wishes to contest or dispute the claim, it may conduct the proceedings in the name of the Indemnified Party and shall bear all costs involved in contesting it. The Indemnified Party shall provide all cooperation and assistance in contesting any claim and shall sign all such writings and documents as the Indemnified Party may reasonably require.

* 1. **DISPUTE RESOLUTION**
     1. **Amicable Settlement**

In the event of a Dispute, either Party may give the other written notice at any time of a Dispute having arisen (**Notice of Dispute**). The Notice of Dispute shall set out brief details of the nature of the Dispute.

The Parties agree that they shall endeavor to resolve any Dispute amicably and in good faith within 30 days of a Notice of Dispute being served by one Party on the other Party in respect of that Dispute. In the event that resolution of the Dispute is reached pursuant to this Clause 8.1, the resolution and its terms shall be recorded in writing and signed by one representative from each of the Parties.

* + 1. **Dispute Resolution by Arbitration**

Failing amicable settlement and/or settlement of a Dispute pursuant to the provisions of Clause 8.1, each of the Parties unconditionally and irrevocably agrees to the submission of such Dispute to binding arbitration governed by the Arbitration and Conciliation Act, 1996.

Any arbitration proceedings commenced pursuant to this Clause 8.2 shall be referred to as the

**Arbitration**.

If a Dispute is referred to Arbitration by any Party, such Dispute shall be resolved by a sole arbitrator to be appointed by mutual agreement of the Parties. If Parties fail to appoint an arbitrator within 30 days after service of the notice of Arbitration, such arbitrator shall be appointed in accordance with the provisions of the Arbitration Act.

* + 1. **Place of Arbitration**

The place of the Arbitration shall be ***[Location OF CHOICE OF Executing Agency]***

* + 1. **English Language**

The request for the Arbitration, the answer to the request, the terms of reference, any written submissions, any orders and rulings pursuant to the Arbitration shall be in English and, if oral hearings take place, English shall be the language to be used in the hearings.

* + 1. **Fees and Expenses**

The fees and expenses of the arbitrator and all other expenses of the Arbitration shall be initially borne and paid by respective Parties, subject to determination by the arbitrator. The arbitrator may provide in the award for the reimbursement to the prevailing Party of its costs and expenses in bringing or defending the Arbitration claim, including legal fees and expenses incurred by such Party.

* + 1. **Performance of Obligations during the Pendency of the Arbitration Proceedings**

The Substitution Agreement and rights and obligations of the Parties shall remain in full force and effect pending the award under any Arbitration proceedings pursuant to this Article 8.

* + 1. **Survival**

The provisions of this Article 8 shall survive the termination of the Substitution Agreement.

* 1. **GOVERNING LAW AND JURISDICTION**

The Substitution Agreement shall be construed and interpreted in accordance with and governed by the laws of India, and the courts in Allahabad shall have exclusive jurisdiction over matters arising out of or relating to this Substitution Agreement.

* 1. **MISCELLANEOUS**
     1. **Duration of this Agreement**

This Agreement shall come into force from the date hereof and shall expire at the earliest to occur of the following events:

* + - 1. termination of the Concession Agreement; or
      2. no sum remains to be advanced and no sum are outstanding to the Lenders, under the Financing Documents.
    1. **Survival**
       1. Any cause or action which may have occurred in favour of any Party or any right which is vested in any Party under this Agreement as a result of any act, omission, deed, matter or thing done or omitted to be done by any Party before the expiry of the Term by efflux of time or otherwise in accordance with this Agreement, shall survive the expiry of the Agreement.
       2. The provisions of this Agreement, to the fullest extent necessary to give effect thereto, survive the Term or the termination of this Agreement and the obligations of Parties to be performed or discharged following the termination of this Agreement, shall accordingly be performed or discharged by the Parties.
    2. **Counterparts**

This Agreement may be executed in four counterparts, each of which, when executed and delivered, will be an original, and all four counterparts together shall constitute one and the same instrument.

* + 1. **Waivers and Consents**
       1. Unless otherwise specified, any provision or breach of any provision of this Agreement may be waived before or after it occurs only if evidenced by an agreement in writing signed by the Parties.
       2. Any consent under or pursuant to any provision of this Agreement must also be in writing and given prior to the event, action or omission for which it is sought.
       3. Any such waiver or consent may be given subject to any conditions thought fit by the Party giving it and shall be effective only in the instance and for the purpose for which it is given.
    2. **Severability**
       1. If any provision of this Agreement is or becomes illegal, invalid or unenforceable in any respect under any Applicable Law, the legality, validity or enforceability of the remaining provisions will not, in any way, be affected or impaired.
       2. The Parties shall negotiate in good faith with a view to agreeing one or more provisions which may be substituted for any such invalid, illegal or unenforceable

provision and which produce as nearly as is practicable in all the circumstances the appropriate balance of the commercial interests of the Parties.

* + 1. **Waiver of sovereign immunity**

The ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)}110 unconditionally and irrevocably:

* + - 1. agree that the execution, delivery and performance by it of this Agreement constitute commercial acts done and performed for commercial purpose;
      2. agree that, should any proceedings be brought against it or its assets, property or revenues in any jurisdiction in relation to this Agreement or any transaction contemplated by this Agreement, no immunity (whether by reason of sovereignty or otherwise) from such proceedings shall be claimed by or on behalf of the ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)} with respect to its assets; and
      3. consent to the enforcement of any judgment or award against them in any such proceedings.
    1. **Language**
       1. The formal text of this Agreement and other agreements in relation to the Project shall be in the English language.
       2. All notices and communications between the Parties under this Agreement shall be in English.
    2. **Third Parties**

This Agreement and all rights hereunder are intended for the sole benefit of the Parties and shall not imply or create any rights on the part of, or obligations to, any other Person.

* + 1. **Representations and Warranties**

The Parties hereto expressly represent and warrant that they are duly empowered to sign and execute this Substitution Agreement.

* + 1. **Notices**

Notices under this Substitution Agreement shall be sent to the addresses first hereinabove mentioned and Annexure 1 (in case of Lenders). Any change in the address of any Party shall be duly notified by registered post acknowledgement due and delivered to other Parties.

* + 1. **Amendments to Substitution Agreement**
       1. This Substitution Agreement shall not be affected by re-organisation of any Lender, Lenders' Representative, the ***[Executing Agency]***, {or (Name of the National/State

110 Contents in the curly parenthesis may be deleted if not applicable

Level Agency, if any)}111 and the successor-in-interest of such Lender, Lenders' Representative, the ***[Executing Agency]*** {or (Name of the National/State Level Agency, if any)} shall have the benefit of this Substitution Agreement.

* + - 1. No amendment, variation or modification to this Substitution Agreement shall be valid and effectual unless made in writing and executed by the duly authorised representatives of all the Parties.
      2. All stamp duties or other imposts and charges as are applicable on this Substitution Agreement or on novation of the Concession Agreement for the purpose of substitution as specified in this Substitution Agreement shall be borne by the Concessionaire. In the event of Lenders making such payment in the interim, such amount shall be deemed to be a part of the Lenders' Dues.
    1. **Harmonious Construction**
       1. For the purpose of giving full and proper effect to this Substitution Agreement, the Concession Agreement and this Substitution Agreement shall be read together and construed harmoniously. The terms of the Concession Agreement shall prevail in the event of any inconsistencies with this Substitution Agreement.
       2. The consultation, recommendation or approval of the Lenders' Representative under this Substitution Agreement shall always be taken as consultation, recommendation or approval of every concerned Lender and each such Lender shall be bound by the same and hereby waives its right to question or dispute it.
       3. This Substitution Agreement shall be in addition to and shall not be in derogation of the terms of the Financing Documents.
       4. It shall not be necessary for the Lenders or the Lenders' Representative to enforce or exhaust any other remedy available to them before invoking the provisions of this Substitution Agreement.

In witness whereof the Parties hereto have signed this Agreement on this 20\*\*.

***[Executing Agency]***

By:

Name:

Title:

(**Name of the National/State Level Agency, if any**)112

By:

\_\_\_\_\_\_\_\_\_\_\_\_ day of

111 Contents in the curly parenthesis may be deleted if not applicable

112 Delete if not applicable.

Name:

Title:

[**CONCESSIONAIRE**]

By:

Name:

Title:

[**LENDERS' REPRESENTATIVE**]

By: Name: Title:

# ANNEXURE 1

|  |  |
| --- | --- |
| **S.No.** | **Details of Lenders** |
| 1. | **[ [*insert name of the Lender*]],** a company organized, |
| incorporated, registered and existing under the Companies Act, with its registered office [***insert address]*** and branch office [***insert address]*** |
| Company Identification Number [***insert company identification number]*** |
| 2. | **[ [*insert name of the Lender*]],** a company organized, |
| incorporated, registered and existing under the Companies Act, with its registered office [[***insert address]*** and branch office [***insert address]*** |
| Company Identification Number [***insert company identification number]*** |





**THIS ESCROW AGREEMENT** (this **Escrow Agreement**) is entered into at [ ] on [ ] by and among:

1. ***[Executing Agency]*,** a statutory body constituted under the ***[Act under which the Executing Agency is established]*** with its registered office at ***[Address of Executing Agency]***. (hereinafter referred to as ***[Executing Agency]***, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. [Name of the State / National Level Agency, if any]113, a statutory body constituted , with

its registered office at ---------------- (hereinafter referred to as ---------, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

AND

1. [ [***insert name of the Concessionaire***], a company organized, incorporated, registered and existing under the Companies Act, with its registered office at

[***insert address***] acting through

, [***insert name of the authorised signatory and his/her designation***] duly authorized by resolution dated

***[insert date of the Board Resolution***] (hereinafter referred to as the **Concessionaire**, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns)

AND

(4) [***Insert name of Escrow Bank***], a bank duly constituted in accordance with Applicable Laws and carrying on the business of banking in India as a Scheduled Commercial Bank, with its registered office at [*insert address*] and acting for the purposes of this Escrow Agreement through its branch office at [*insert address*] (hereinafter referred to as **Escrow Bank**, which expression shall unless repugnant to the context or meaning thereof includes its successors and permitted assigns).

The ***[Executing Agency]***, {(Name of the National/State Level Agency, if any)}114, the Concessionaire and the Escrow Bank are collectively referred to as **Parties** and individually as **Party**.

# WHEREAS:

113 If there is a State Level/National Level intermediate agency funding the project and such an entity is part of the contract/procurement process the name of that agency can be inserted here. Otherwise all references to the National/State Level agency in the document are to be deleted.

114 Contents in the curly parenthesis may be deleted if not applicable.

1. ***[Executing Agency]***, {in association with (Name of the National/State Level Agency, if any)}, has decided to undertake the development of STP along with other Facilities and Associated Infrastructure at ***[Location]*** on a PPP basis, through a hybrid annuity model.
2. For this purpose, the ***[Executing Agency]*** selected the Concessionaire post a bid process to undertake integrated development, operation and maintenance of Sewage Treatment Plant(s) (the **STP ** [Capacity of

STP in MLD] MLD of STP and [***Capacity of FSTP in MLD***] MLD of Faecal Sludge Treatment

**FSTP ** *[****Location****]*,

on a PPP basis, through a hybrid annuity model.. While the Executing Agency i.e., ***[Executing Agency]*** will be the principal executing agency and bidding authority for the Project, [***Executing Agency***] / (Name of the National/State Level Agency, if any)115 will be responsible for making payments to the Concessionaire.

1. The ***[Executing Agency]***, {(Name of the National/State Level Agency, if any)}116 and the Concessionaire executed a Concession Agreement dated [ ] to implement the Project (the **Concession Agreement** ), which is annexed to this Escrow Agreement.
2. In consideration of the Concessionaire designing, developing, financing, constructing, operating and maintaining the Facilities and the Associated Infrastructure on the Site for the Term, [***Executing Agency***] /(Name of the National/State Level Agency, if any)117 is required to pay the Concessionaire: (i) during the Construction Period, the Construction Payments upon satisfactory completion of works corresponding to Payment Milestones; and (ii) during the O&M Period, O&M Payments comprising the Capex Annuity (along with interest), the O&M Charges and the Power Charges for the Facilities at actuals (subject to a cap based on the Guaranteed Energy Consumption), and the Power Charges for the Associated Infrastructure at actuals.
3. As per the provisions of the Concession Agreement, {(Name of the National/State Level Agency, if any)}, the ***[Executing Agency]***, the Concessionaire are required to enter into an escrow agreement with an escrow bank and [***Executing Agency***] / (Name of the National/State Level Agency, if any)118 is required to open an escrow account with such escrow bank and maintain the Minimum Escrow Balance for the payment of the Construction Payments and the O&M Payments.
4. The escrow account shall be funded by [***Executing Agency***]119 / (Name of the National/State Level Agency, if any) in accordance with the terms of this Escrow Agreement and such account shall serve to secure [***Executing Agency***] / (Name of the National/State Level Agency, if any)'s120 payment obligations towards the Concessionaire under the Concession Agreement.

115 Delete whichever not applicable.

116 Contents in the curly parenthesis may be deleted if not applicable.

117 Delete whichever not applicable 118 Delete whichever not applicable 119 Delete whichever not applicable 120 Delete whichever not applicable

1. The Escrow Bank is willing to serve as an escrow bank in accordance with the terms and conditions of this Escrow Agreement.

**NOW, THEREFORE,** the Parties hereto agree as follows:

# DEFINITIONS AND INTERPRETATION

* + 1. Capitalized terms used but not defined in this Escrow Agreement shall have the meaning given to them in the Concession Agreement.
    2. In this Escrow Agreement, unless the context otherwise requires:
       1. Any reference to a statutory provision shall include such provision as modified or reenacted or consolidated from time to time.
       2. The words importing the singular shall mean the plural and vice-versa; and words importing the masculine shall include the feminine and neuter and vice-versa.
       3. Headings in this Escrow Agreement are for convenience of reference only.
       4. The references to the word 'include' or 'including' or to the phrase 'in particular', shall be construed without limitation.
       5. References to any date or time of day are to Indian Standard Time; any reference to day shall mean a reference to a calendar day; any reference to a month shall mean a reference to a calendar month, any reference to a year shall mean a reference to a calendar year.
       6. The references to any agreement or deed or other instrument shall be construed as a reference to such agreement, deed, or other instrument as may be amended, varied, supplemented or novated, from time to time.
       7. Whenever provision is made for the giving or issuing of any notice, endorsement, consent, approval, permission, certificate or determination by any person, such notice, etc., shall be reasonably given, shall not be unreasonably withheld or delayed and shall be in writing. Where any notice, consent or approval is to be given by either of the Parties, the notice, consent or approval shall be given on their behalf only by any authorized persons.
       8. The words written and in writing include a facsimile transmission and any means of reproducing works in a tangible and permanently visible form.
       9. The provisions of the clauses of this Escrow Agreement shall be interpreted in such a manner that will ensure that there is no inconsistency in interpretation between the intent

expressed in the clauses.

* + - 1. In the event of any ambiguities or discrepancies between two clauses of this Escrow Agreement, the provisions of the specific clause relevant to the issue under consideration shall prevail over those in other clauses.
      2. The rule of construction, if any, that an agreement should be interpreted against the Party responsible for the drafting and preparation thereof shall not apply to this Escrow Agreement.

# ESCROW ACCOUNT

* + 1. **Appointment**
       1. {(Name of the National/State Level Agency, if any)}121, the ***[Executing Agency]*** and the Concessionaire hereby appoint the Escrow Bank to serve as the escrow bank for the purposes of this Escrow Agreement and the Escrow Bank hereby accepts this appointment.
       2. {(Name of the National/State Level Agency, if any}) hereby settles in trust with the Escrow Bank a sum of INR 1,000 (Rupees one thousand). The Escrow Bank has accepted the above amount of INR 1,000 (Rupees one thousand) in trust declared and, subject to the terms and conditions in this Escrow Agreement, agreed to act as trustee for the benefit of the Concessionaire, {(Name of the National/State Level Agency, if any)} and the ***[Executing Agency]***.
       3. The Escrow Bank shall hold and safeguard the Escrow Account and any monies held therein, during the term of this Escrow Agreement and shall treat the amount in the Escrow Account as monies deposited by [Executing Agency] / (Name of the National/State Level Agency, if any)122 with the Escrow Bank in trust in accordance with the provisions of this Escrow Agreement. In performing its functions and duties under this Escrow Agreement, the Escrow Bank shall act as an agent of {(Name of the National/State Level Agency, if any)}123, the ***[Executing Agency]*** and the Concessionaire.

# Escrow Account

* + - 1. [***Executing Agency***]/(Name of the National/State Level Agency, if any)124 has established a bank account in the name of **[** *name of account and account number*), with **[** *name of the bank*), which shall be an interest bearing, no lien account, denominated in Indian Rupees for the benefit of the Concessionaire (the **Escrow**

121 Contents in the curly parenthesis may be deleted if not applicable.

122 Delete whichever not applicable.

123 Contents in curly parenthesis may be deleted if not applicable.

124 Delete whichever not applicable.

**Account**).

* + - 1. The Escrow Bank shall provide details of the Escrow Account in writing to the Concessionaire and the ***[Executing Agency]***, including the date of opening of the Escrow Account.
      2. The Parties agree and acknowledge that:
         1. the Escrow Account shall be opened pursuant to, and specifically for the purposes of, this Escrow Agreement and shall be used and operated only for the purposes and in the manner provided in this Escrow Agreement and for no other use or purposes and in no other manner;
         2. the Escrow Bank shall maintain the Escrow Account in accordance with the terms of this Escrow Agreement and its usual practices and applicable regulations;
         3. the Escrow Bank and the Concessionaire, after consultation with [Executing Agency] / (Name of the National/State Level Agency, if any)125, shall agree on the detailed mandates, terms and conditions and operating procedures for the Escrow Account but in the event of any inconsistency between this Escrow Agreement and such mandates, terms and conditions or procedures in this Escrow Agreement shall prevail; and
         4. no instruction shall be given to the Escrow Bank which is not contemplated by or which is contrary to or inconsistent with this Escrow Agreement. In the event any such inconsistent or contrary instruction is given, the same shall be null and void and the Escrow Bank shall not be obliged to act upon, and shall ignore, such instructions and continue to comply with the provisions of this Escrow Agreement.

# Deposits into Escrow Account

* + - 1. Minimum Escrow Balance

At all times, to maintain the minimum balance in the Escrow Account (the

):

* + - * 1. [***Executing Agency***] / (Name of the National/State Level Agency, if any)126 shall deposit in the Escrow Account an amount equivalent to the first 2 Payment Milestones prior to the Effective Date. From the Effective Date and during the Construction

125 Delete whichever not applicable.

126 Delete whichever not applicable.

Period, [Executing Agency] / (Name of the National/State Level Agency, if any)127 shall ensure that the Escrow Account is funded with an amount equivalent to the next 2 Payment Milestones until the Facilities COD; and

* + - * 1. on and from the COD and during the O&M Period, [Executing Agency] / (Name of the National/State Level Agency, if any)128 shall deposit the O&M Payments in the Escrow Account such that the Escrow Account is funded at all times with the Capex Annuities (along with interest), the O&M Charges and the estimated Power Charges for the next 2 years for the Facilities,
      1. [***Executing Agency***] / (Name of the National/State Level Agency, if any)129 shall ensure that the minimum balance in the Escrow Account at all times during the Term is not less than the Minimum Escrow Balance.

If at any time during the Construction Period or the O&M Period, the balance in the Escrow Account falls below the Minimum Escrow Balance, [Executing Agency] / (Name of the National/State Level Agency, if any)130 shall promptly, and in any event, no later than 90 days, fund the Escrow Account such that the Minimum Escrow Balance is maintained.

* + - 1. The Parties agree that a failure to maintain the Minimum Escrow Balance for 90 days would be treated as a [***Executing Agency***] / (Name of the National/State Level Agency, if any)131 Event of Default and in such case, the consequences set out in the Concession Agreement shall apply.
      2. It is clarified that any interest earned on the amounts deposited by [***Executing Agency***] / (Name of the National/State Level Agency, if any)132 in the Escrow Account will be counted towards the Minimum Escrow Balance.

# Withdrawals from Escrow Account during the Construction Period

* + - 1. Upon successful completion and verification of a Payment Milestone as per the Concession Agreement, the ***[Executing Agency]*** is required to approve the Invoice raised by the Concessionaire within 10 days of receipt of the Invoice and issue a Payment Certificate to the Escrow Bank. The Payment Certificate shall convey the ***[Executing Agency]***'s approval for

127 Delete whichever not applicable. 128 Delete whichever not applicable. 129 Delete whichever not applicable. 130 Delete whichever not applicable. 131 Delete whichever not applicable. 132 Delete whichever not applicable.

the release of the amount specified in the Invoice for the relevant Payment Milestone, less any necessary deductions or adjustments in accordance with the Concession Agreement and/or Applicable Laws (including for payments to be made by the Concessionaire under applicable labour laws).

* + - 1. If, within 10 days from the date of receipt of an Invoice, the ***[Executing Agency]*** does not dispute an Invoice, then the Invoice shall be deemed to have been accepted by the ***[Executing Agency]***, and the Concessionaire may issue instructions to the Escrow Bank (with a copy to the ***[Executing Agency]*** and (Name of the National/State Level Agency, if any))133 to release the amounts specified in the Invoice, upon the expiry of the 10-day period. Any such instruction issued by the Concessionaire to the Escrow Bank shall be accompanied with the Invoice raised by the Concessionaire for the relevant Payment Milestone.
      2. Immediately upon receipt of a Payment Certificate from the ***[Executing Agency]*** in accordance

with clause 2.4(a) above or upon receipt of instructions from the Concessionaire in accordance with clause 2.4(b), the Escrow Bank shall release the amount specified in the Payment Certificate or if no Payment Certificate has been issued, then the amount specified in the relevant Invoice to the bank account of the Concessionaire mentioned below:

Bank:

Account number: BIC (SWIFT):

Address of Bank:

# [Insert bank account details]

The Concessionaire may change the above bank account details by giving a 5-day prior written notice to the Escrow Bank, (Name of the National/State Level Agency, if any)134 and the ***[Executing Agency]***.

* + - 1. Upon any termination of the Concession Agreement during the Construction Period of the Facilities, [***Executing Agency***] / (Name of the National/State Level Agency, if any)135 shall issue instructions to the Escrow Bank requesting it to release and transfer any amounts due and payable to the Concessionaire, including termination payments, if any, as certified by [***Executing Agency***] / (Name of the National/State Level Agency, if any)136 in a statement and any remaining amounts standing to the credit of the Escrow Account shall be transferred to the following account of [***Executing Agency***] / (Name of the National/State Level Agency, if any)137:

Bank:

Account number: BIC (SWIFT): Address of Bank:

133 Delete if not applicable. 134 Delete if not applicable 135 Delete if not applicable 136 Delete if not applicable 137 Delete if not applicable

# [Insert bank account details]

[***Executing Agency***] / (Name of the National/State Level Agency, if any)138 may change the above bank account details by giving 5 (five) day prior written notice to the Escrow Bank, the Concessionaire and the ***[Executing Agency]***.

# Withdrawals from Escrow Account during the O&M Period

* + - 1. For O&M Payments in each quarter, the ***[Executing Agency]*** is required to approve the Invoice raised by the Concessionaire within 10 days of receipt of the Invoice and issue a Payment Certificate to the Escrow Bank. The Payment Certificate shall convey the ***[Executing Agency]*** any necessary deductions or adjustments in accordance with the Concession Agreement and/or Applicable Laws (including for payments to be made by the Concessionaire under applicable labour laws).
      2. If, within 10 days from the date of receipt of an Invoice, the ***[Executing Agency]*** does not dispute an Invoice, then the Invoice shall be deemed to have been accepted by the ***[Executing Agency]***, and the Concessionaire may issue instructions to the Escrow Bank (with a copy to the ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any))}139 to release the amounts specified in the Invoice, upon the expiry of the 10-day period. Any such instruction issued by the Concessionaire to the Escrow Bank shall be accompanied with the Invoice raised by the Concessionaire.
      3. Immediately upon receipt of a Payment Certificate from the ***[Executing Agency]*** in accordance with clause 2.5(a) above or upon receipt of instructions from the Concessionaire in accordance with clause 2.5(b), the Escrow Bank shall release the amount specified in the Payment Certificate, or if no Payment Certificate has been issued, then the amount specified in the relevant Invoice to the bank account of the Concessionaire mentioned below:

Bank:

Account number:

BIC (SWIFT):

Address of Bank:

[Insert bank account details]

The Concessionaire may change the above bank account details by giving a 5-day prior written notice to the Escrow Bank, {(Name of the National/State Level Agency, if any)} and the ***[Executing Agency]***.

* + - 1. Upon any termination of the Concession Agreement during the O&M Period, [***Executing***

138 Delete if not applicable

139 Contents in curly parenthesis may be deleted if not applicable.

***Agency]*** / (Name of the National/State Level Agency, if any)140 shall issue instructions to the Escrow Bank requesting it to release and transfer any amounts due and payable to the Concessionaire, including termination payments, if any, as certified by [***Executing Agency]***

/ (Name of the National/State Level Agency, if any)141 in a statement and any remaining amounts standing to the credit of the Escrow Account shall be transferred to the following account of [***Executing Agency***] / (Name of the National/State Level Agency, if any)142: Bank:

Account number:

BIC (SWIFT):

Address of Bank:

[Insert bank account details]

[***Executing Agency***] / (Name of the National/State Level Agency, if any)143 may change the above bank account details by giving 5 (five) - day prior written notice to the Escrow Bank, and the Concessionaire***.***.

# Identification and Separation

The Escrow Bank shall clearly identify in its records the Escrow Account as an escrow account and shall keep the funds standing to the credit of the Escrow Account separated and segregated from the Escrow Bank's own funds or funds of any of its other customers or third parties.

# Fees

[Executing Agency] / (Name of the National/State Level Agency, if any)144 shall pay [Rs. [ ] per annum] as fees to the Escrow Bank for the establishment and management of the Escrow Account. [Executing Agency] / (Name of the National/State Level Agency, if any)145 shall pay such fees to the Escrow Bank within 10 days of receipt of an invoice from the Escrow Bank.

# Escrow Account Statements

The Escrow Bank shall provide monthly statements regarding the Escrow Account to{ (Name of the National/State Level Agency, if any)}146, the ***[Executing Agency]*** and the Concessionaire.

# ESCROW AMOUNT

* + 1. Promptly upon ***[Executing Agency]*** / (Name of the National/State Level Agency, if any)147

140 Delete whichever not applicable. 141 Delete whichever not applicable 142 Delete whichever not applicable 143 Delete whichever not applicable 144 Delete whichever not applicable 145 Delete whichever not applicable

146 Contents in the curly parenthesis may be deleted if not applicable.

147 Delete whichever not applicable.

transferring any amount to the Escrow Account, the Escrow Bank shall send a notice to the Concessionaire and the ***[Executing Agency]*** notice informing them of the transfer.

* + 1. The Escrow Bank shall hold all amounts in the Escrow for the benefit of both the Concessionaire and the ***[Executing Agency]***. Subject to clause 2.4(d) and clause 2.5(d) of this Escrow Agreement, the Escrow Bank shall not release any amount in the Escrow Account to any person other than the Concessionaire.
    2. The Escrow Bank shall not apply any right of set-off against the amount in the Escrow Account, grant any lien over such amount, or apply any fee or deduction in relation to such amount.

# RIGHTS, DUTIES AND OBLIGATIONS OF THE ESCROW BANK

* + 1. **The Escrow Bank**
       1. may, in the absence of bad faith, fraud, wilful default or gross negligence on its part, rely as to any matters of fact which might reasonably be expected to be within the knowledge of {(Name of the National/State Level Agency, if any) or}148 the ***[Executing Agency]***, as the case may be, upon a certificate signed by or on behalf of {(Name of the National/State Level Agency, if any) or} the ***[Executing Agency]***, as the case may be;
       2. may, in the absence of bad faith, fraud, wilful default or gross negligence on its part, rely upon the authenticity of any communication or documents believed by it to be authentic;
       3. shall, within 5 days after receipt, deliver a copy to the ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)} of any notice or document received by the Escrow Bank from the Concessionaire or any other Person hereunder or in connection herewith;
       4. shall, within 5 days after receipt, deliver a copy to the Concessionaire of any notice or document received by the Escrow Bank from the ***[Executing Agency]*** {or (Name of the National/State Level Agency, if any)} in connection herewith; and
       5. shall maintain all records of deposits and withdrawals from the Escrow Account for the term of this Escrow Agreement.
    2. The duties of the Escrow Bank are only as herein specifically provided, and are purely administrative in nature. The Escrow Bank shall neither be liable for, nor chargeable with knowledge of, the terms and conditions of any other agreement, instrument or document in connection herewith, including, without limitation, the Concession Agreement, and shall be required to act in respect of the amounts in the Escrow Account only as provided in this Escrow

148 Contents in the curly parenthesis may be deleted if not applicable.

Agreement. This Escrow Agreement sets out all the obligations of the Escrow Bank with respect to any and all matters pertinent to the Escrow Account contemplated hereunder and no additional obligations of the Escrow Bank shall be implied from the terms of any other agreement. The Escrow Bank shall incur no liability in connection with the discharge of its obligations under this Escrow Agreement or in connection therewith, except such liability as may arise from the Escrow Bank's negligence, wilful misconduct or otherwise from any breach of this Escrow Agreement. Such liability, however, shall not exceed the amount in the Escrow Account at the date of the said breach by the Escrow Bank.

* + 1. The Escrow Bank shall not be required to perform any act which will violate any Applicable Laws.
    2. In the event of any bankruptcy proceedings or enforcement proceedings against any of the Parties pursuant to Applicable Laws, the Escrow Bank shall, notwithstanding the provisions of this Escrow Agreement, act and perform in accordance with Applicable Laws.

# ESCROW AGREEMENT DEFAULTS

* + 1. The following events shall constitute an event of default by the Concessionaire (an **Escrow Default**), unless such event of default has occurred as a result of any act or omission of{ (Name of the National/State Level Agency, if any) or}149 the ***[Executing Agency]***:
       1. in case the Concessionaire diverts funds drawn from the Escrow Account for a project/activity/usage other than the Project, and fails to cure such breach by not depositing an equal amount in the Escrow Account within 5 days; or
       2. in the case of any other breach, by failing to remedy the breach within 5 days to the satisfaction of the ***[Executing Agency]*** {and (Name of the National/State Level Agency, if any)}.
    2. The Parties agree that an Escrow Default in terms of this Escrow Agreement shall be treated as a Concessionaire Event of Default under the Concession Agreement, and the consequences of an Escrow Default shall be dealt with in accordance with the Concession Agreement.
    3. Upon the occurrence of an Escrow Default, the Concessionaire agrees that [Executing Agency] / (Name of the National/State Level Agency, if any)150 shall have the right to direct the Escrow Bank to suspend withdrawals from the Escrow Account until further notice from [Executing Agency] / (Name of the National/State Level Agency, if any)151.

149 Contents in the curly parenthesis may be deleted if not applicable.

150 Delete if not applicable.

151 Delete if not applicable

# MISCELLANEOUS

* + 1. **Representations and Warranties**

Each Party represents and warrants that:

* + - 1. it has the authority to enter into this Escrow Agreement;
      2. this Escrow Agreement constitutes a legally valid and binding obligation, enforceable against it in accordance with its terms;
      3. its entry into and/or performance under this Escrow Agreement will not be in breach of any express or implied terms of any contract with or other obligation to any third party; and
      4. it is solvent and able to perform all of its obligations under this Escrow Agreement.

# Notices

Any notice or other communication to be given or made under this Escrow Agreement to the Parties shall be in writing. Except as otherwise provided in this Escrow Agreement, such notice, request or other communication shall be delivered by registered mail or facsimile to the Party(ies) at the following addresses:

# (Name of the National/State Level Agency, if any)152:

Attention:

Tel:

Fax:

Email:

## [Executing Agency]:

Attention: Address: Email:

# [Concessionaire]: [ ]

**Escrow Bank:** [ ]

# Entire Agreement

This Escrow Agreement and the Concession Agreement constitutes the entire agreement and understanding between the Parties with respect to its subject matter (i.e., escrow arrangement),

152 Delete if not applicable.

and replaces and supersedes all prior agreements, arrangements, undertakings or statements regarding such subject matter.

# Amendments

No variation of or amendment to this Escrow Agreement shall be effective unless made in writing and executed by all the Parties hereto.

# Harmonious Construction

For the purpose of giving full and proper effect to this Escrow Agreement, the Concession Agreement and this Escrow Agreement shall be read together and construed harmoniously. The terms of the Concession Agreement shall prevail in the event of any inconsistencies with this Escrow Agreement.

# Assignment

Neither this Escrow Agreement nor any of the rights or obligations hereunder may be assigned by a Party without the prior written consent of the other Parties, provided that the Concessionaire shall be entitled, to the extent permitted by Applicable Law and as may be required under any Financing Documents entered into by the Concessionaire, to assign or create liens over its rights and interests under or pursuant to this Escrow Agreement.

# Severability

Whenever possible, each provision of this Escrow Agreement shall be interpreted in such a way as to be effective and valid under Applicable Law, but if any provision of this Escrow Agreement is unenforceable or invalid under Applicable Law, such provision shall be ineffective only to the extent of such unenforceability or invalidity, and the remaining provisions of this Escrow Agreement shall continue to be binding and in full force and effect.

# Confidentiality

The Parties, their employees, representatives and agents shall keep the provisions of this Escrow Agreement strictly confidential and, except as may be required by Applicable Laws, shall make no disclosure thereof to any Person, except the Parties' respective legal counsels and professional advisers, without the prior written consent of the other Parties.

# Termination

This Escrow Agreement shall be automatically terminated upon the expiry of the Term or termination of the Concession Agreement and after disbursement of all amounts due and payable to the Concessionaire under the Concession Agreement, including Termination Compensation, if any, and any remaining amounts to [Executing Agency] / (Name of the

National/State Level Agency, if any)153 in accordance with clause 2.4(d) and clause 2.5(d) of this Escrow Agreement.

# Dispute Resolution Mechanism

* + - 1. If any dispute arises out of or in connection with this Escrow Agreement, this dispute shall not affect the Parties' duty to continue the performance of all of their undisputed obligations.
      2. If any dispute arises, a Party shall give notice to the other Parties of the same, whereupon the Parties shall meet promptly and in good faith to attempt to reach an amicable settlement.
      3. All disputes not settled amicably pursuant to (b) above shall be heard by the competent courts of ***[State of Location]***.

# Governing Law

This Escrow Agreement shall be governed by and construed in accordance with the laws of India.

**IN WITNESS WHEREOF**, the Parties hereto have caused these presents to be executed by its authorized representatives as of the date first written above.

# For (Name of the National/State Level Agency, if any)154

By:

Name:

Title:

## For [Executing Agency]

By:

Name: [ ] Designation:

# For Concessionaire

By:

Name: [ ] Designation: [ ]

# For Escrow Bank

153 Delete whichever not applicable.

154 Delete if not applicable

By: Name: [ ]

Designation: [ ]





Guarantee No. :  Amount of Guarantee : 

This Mobilization Advance Guarantee is executed on this [ ] day of [ ] at [ ]

# BY

[ ] with its registered office at [ ] and a branch office at [ ] (hereinafter referred to as the "**Bank**", which expression shall unless repugnant to the context thereof, be deemed to include its successors-in- interest and permitted assigns)

# IN FAVOUR OF

***[Executing Agency]*,** a statutory body constituted under the ***[Act under which the Executing Agency is established]*** with its registered office at ***[Address of Executing Agency]***. (hereinafter referred to as ***[Executing Agency]***, which expression shall, unless it be repugnant to the context or meaning thereof, include its successors and permitted assigns);

# WHEREAS

1. [ \_ \_\_\_\_ [***insert name of the Concessionaire***] with its registered office at

\_ \_ \_ \_ \_ \_ \_ \_ \_ [***insert address***], hereinafter referred to as the

"**Concessionaire**", which expression shall unless repugnant to the context thereof, be deemed to include its successors-in-interest and permitted assigns) has executed a concession agreement dated [insert date.] with the ***[Executing Agency]*** {and National/State level agency if any}155 ("**Concession Agreement**") in relation to design, construction, operation and maintenance of sewage treatment plants along with other facilities and associated infrastructure at ***[Location]*** by concessionaire.

1. In terms of Clause 5.21 of the Concession Agreement, the Concessionaire is required to furnish a Mobilization Advance Guarantee to the ***[Executing Agency]*** in the form of an unconditional, irrevocable and on demand bank guarantee for securing the Mobilization Advance made to the Concessionaire in accordance with the Concession Agreement ("**Mobilization Advance Guarantee**") for INR [***insert amount equal to 110 % of the Mobilization Advance***] (Rupees [ ]) ("**Guaranteed Amount**").
2. At the request of the Concessionaire and for sufficient consideration, the Bank has agreed to issue this guarantee in favor of the ***[Executing Agency]***.

# NOW THEREFORE THIS DEED WITNESSETH AS FOLLOWS:

* 1. Capitalised terms used herein but not defined shall have the meaning ascribed to them in the Concession Agreement.

155 Contents in the flower parenthesis may be deleted if not applicable.

* 1. The Bank shall upon a written demand from the ***[Executing Agency]*** informing the Bank of the Concessionaire's failure to fulfill its obligations under the Concession Agreement, pay to the ***[Executing Agency]***, within 5 (five) days of receipt of such written demand from the ***[Executing Agency]***, without further proof or conditions and without contest, recourse, demur or protest and without any enquiry to the ***[Executing Agency]*** or the Concessionaire, forthwith and in full amount, without any deductions or set off or counter claims whatsoever, the sum claimed by the ***[Executing Agency]*** in such demand not exceeding an amount equivalent to the Guaranteed Amount. The Bank will pay the amount specified in the demand notwithstanding any direction to the contrary given or any dispute raised by the Concessionaire or any other person.

The Bank agrees that this Mobilization Advance Guarantee does not limit the number of claims that may be made by the ***[Executing Agency]*** against the Bank provided that such claims taken together shall not exceed the Guaranteed Amount.

Any payment made hereunder shall be made free and clear of and without deduction for, or on account of, any present or future taxes, deductions or withholdings of any nature whatsoever and by whomsoever imposed, and where any withholding on a payment is required by any Applicable Law, the Bank shall comply with such withholding obligations and shall pay such additional amount in respect of such payment such that the ***[Executing Agency]*** receives the full amount due hereunder as if no such withholding had occurred.

* 1. This Mobilization Advance Guarantee shall be a continuing guarantee during its currency and shall remain in force and effect until 21 months from the Effective Date or until the entire Mobilization Advance has been adjusted against the Construction Payments in accordance with the Concession Agreement, whichever is later, upon which the obligations of the Bank under this Mobilization Advance Guarantee shall stand discharged
  2. The obligations of the Bank herein are absolute and unconditional, irrespective of the value, genuineness, validity, regularity or enforceability of the Concession Agreement or the insolvency, bankruptcy, reorganisation, dissolution or liquidation of the Concessionaire or any change in ownership of the Concessionaire or any purported assignment by the Concessionaire or any other circumstance whatsoever which might otherwise constitute a discharge or defence of a guarantor or a surety.
     1. Further, this Mobilization Advance Guarantee is in no way conditional upon any requirement that the ***[Executing Agency]*** first attempts to procure the Guaranteed Amount from the Concessionaire or any other person, or resort to any other means of obtaining payment of the Guaranteed Amount.
  3. The Bank hereby agrees that its liability under this Mobilization Advance Guarantee shall not be discharged by virtue of any agreement between the Concessionaire and the ***[Executing Agency]***, whether with or without the Bank's knowledge, or by reason of the ***[Executing Agency]*** showing any indulgence or forbearance to the Concessionaire.
  4. The Bank's obligations under this Mobilization Advance Guarantee for the Guaranteed

Amount is primary, independent and absolute and not by way of surety only.

* 1. The obligations of the Bank under this Mobilization Advance Guarantee shall not be affected by any act, omission, matter or thing which, but for this provision, would prejudice or diminish the Guaranteed Amount in whole or in part, including (whether or not known to it or the ***[Executing Agency]***):

1. any time or waiver granted to, or composition with, the Concessionaire or any other person;
2. any incapacity or lack of powers, authority or legal personality of or dissolutions or change in the status of the Concessionaire or any other person;
3. any variation of the Concession Agreement so that references to the Concession Agreement in this Mobilization Advance Guarantee shall include each variation;
4. any unenforceability, illegality or invalidity of any obligation of any person under the Concession Agreement or any unenforceability, illegality or invalidity of the obligations of the Bank under this Mobilization Advance Guarantee or the unenforceability, illegality or invalidity of the obligations of any person under any other document or guarantee, to the extent that each obligation under this Mobilization Advance Guarantee shall remain in full force as a separate, continuing and primary obligation, and its obligations be construed accordingly, as if there were no unenforceability, illegality or invalidity;
5. any extension, waiver, or amendment whatsoever which may release a guarantor or the Bank (other than performance or indefeasible payment of a Guaranteed Amount); or
6. any part performance of the Concession Agreement by the Concessionaire or by any failure by the [***Executing Agency***] / (National/State level agency if any)156 to timely pay or any failure by {(and National/State level agency if any) or} the ***[Executing Agency]*** to timely perform any of its obligations under the Concession Agreement.
   1. So long as any sum remains due from the Concessionaire to the ***[Executing Agency]***, the Bank shall not exercise any right of subrogation or any other rights of a guarantor or enforce any guarantee or other right or claim against the Concessionaire (whether in respect of its liability under this Mobilization Advance Guarantee or otherwise) or claim in the insolvency or liquidation of the Concessionaire or any such other person in competition with the ***[Executing Agency]***. If the Bank receives any payment or benefit in breach of this Clause 8, it shall hold the same in trust for the ***[Executing Agency]***.
   2. The Bank represents, warrants and undertakes to the [***Executing Agency***] that:
7. it has the power to execute, deliver and perform the terms and provisions of this Mobilization Advance Guarantee and has taken all necessary action(s) to authorize the execution, delivery and performance by it of this Mobilization Advance Guarantee;
8. the Bank has duly executed and delivered this Mobilization Advance Guarantee, and this Mobilization Advance Guarantee constitutes its legal, valid and binding obligation enforceable

156 Delete whichever not applicable.

in accordance with its terms except as the enforceability thereof may be limited by applicable bankruptcy, insolvency, moratorium or other similar laws affecting the

 principles;

1. neither the execution, delivery or performance by the Bank of this Mobilization Advance Guarantee, nor compliance by it with the terms and provisions hereof will: (i) contravene any material provision of any law, statute, rule or regulations or any order, writ, injunction or decree of any court or governmental instrumentality; (ii) conflict or be inconsistent with or result in any breach of any of the material terms, covenants, conditions or provisions of, or constitute a default under any agreement, contract or instrument to which the Bank is a party or by which it or any of its property or assets is bound; or (iii) violate any provision of the Bank's constituent documents;
2. no order, consent, approval, license, authorization or validation of, or filing, recording or registration with (except as have been obtained or made prior to the date hereof), or exemption by, any governmental or public body or authority, or any subdivision thereof, is required to authorize, or is required in connection with: (i) the execution, delivery and performance of this Mobilization Advance Guarantee; or (ii) the legality, validity, binding effect or enforceability of this Mobilization Advance Guarantee; and
3. this Mobilization Advance Guarantee will be enforceable when presented for payment to a Scheduled Commercial Bank (as defined by the Reserve Bank of India Act, 1934) at ***[Location]***.
   1. This Mobilization Advance Guarantee is a continuing one and all liabilities to which it applies or may apply under the terms hereof shall be conclusively presumed to have been created in reliance hereon. No failure or delay on the part of the ***[Executing Agency]*** in exercising any right, power or privilege hereunder and no course of dealing between the ***[Executing Agency]*** and the Bank, or the Concessionaire, shall operate as a waiver thereof, nor shall any single or partial exercise of any right, power or privilege hereunder preclude any other or further exercise thereof or the exercise of any other right, power or privilege.
   2. If any one or more of the provisions contained in this Mobilization Advance Guarantee are or become invalid, illegal or unenforceable in any respect, the validity, legality and enforceability of the remaining provisions shall not in any way be affected or impaired thereby, and the Bank shall enter into good faith negotiations with the ***[Executing Agency]*** to replace the invalid, illegal or unenforceable provision.
   3. The Bank hereby agrees to execute and deliver all such instruments and take all such actions as may be necessary to make effective fully the purposes of this Mobilization Advance Guarantee.
   4. This Mobilization Advance Guarantee may be executed in one or more duplicate counterparts, and when executed and delivered by the Bank and the ***[Executing Agency]*** shall constitute a single binding agreement.
   5. Any demand, notice, request or other communication to be given or made under this Mobilization Advance Guarantee shall be deemed to have been duly given or served:
4. Upon, ***[Executing Agency]***, ***[LOCAL ADDRESS OF THE Executing Agency]***, marked for the attention of the ***[OFFICER IN CHARGE]***;
5. Upon a Scheduled Commercial Bank (as defined by the Reserve Bank of India Act, 1934),

at ***[Location]***, India.

* 1. The Bank:

1. acknowledges that the Lenders will review this Mobilization Advance Guarantee and may require changes thereto as a condition of granting any Financial Assistance and/or providing political risk insurance; and
2. shall consider any such requirements in good faith.
   1. This Mobilization Advance Guarantee shall be governed by, and construed in accordance

with, the laws of India. The Bank irrevocably agrees that any legal action, suit or proceeding arising out of or relating to this Mobilization Advance Guarantee may be brought in the courts in ***[STATE OF Location]***.

* 1. The ***[Executing Agency]*** may assign or transfer all or any part of its interest herein together with the Concession Agreement to any other person with prior consent of to the Bank. The Bank may not assign or transfer any of its rights or obligations under this Mobilization Advance Guarantee.

**IN WITNESS WHEREOF** the Bank has set its hands hereunto on the day, month and year first hereinabove written.

Signed and delivered by [*insert name of Bank*] Bank by hand



*[map/layout/google image of the discharge point for the proposed site to be inserted]*



The Project Engineer shall assist the ***[Executing Agency]*** in supervising the construction, rehabilitation, operation and maintenance of the Facilities and shall work closely with the ***[Executing Agency]*** to monitor compliance with the KPIs. The detailed scope of work of the Project Engineer, to be read in conjunction with the provisions of the Concession Agreement, is outlined below:

1. The Project Engineer shall review the Designs and Drawings to be provided by the Concessionaire. These will include, *inter-alia*, the site layout plan, process design, drawings, structural calculations, mechanical, electrical and instrumentation works, quality plans, implementation schedules, and the environment, health & safety plans for all Facilities. On the basis of its review, the Project Engineer shall provide its recommendations to the ***[Executing Agency]***.
2. During relevant Construction Periods, the Project Engineer shall inspect the relevant Facilities at least once a month and prepare an inspection report, setting out the progress of the construction of the relevant Facilities, defects or deficiencies, if any, and status of compliance with the Construction Plan, Technical Specifications and Designs and Drawings and the Guaranteed Interim Availability.
3. The Project Engineer shall be responsible to monitor the implementation of the approved environment, health & safety plan by the Concessionaire. The Project Engineer shall also verify the material safety data sheets of hazardous chemicals if any.
4. The Project Engineer shall review the construction progress of the project as per the Payment Milestones proposed by the Concessionaire and provide necessary recommendations to the ***[Executing Agency]*** for the purpose of issuance of Milestone Construction Certificates.
5. The Project Engineer shall assist ***[Executing Agency]*** in estimating the Interim Availability Liquidated Damages and Delay Liquidated Damages as applicable.
6. At the end of the Construction Period for different Facilities, the Project Engineer shall review the relevant Facilities and provide necessary recommendations to the ***[Executing Agency]*** with regards to the issuance of the respective Construction Completion Certificates to the Concessionaire to certify completion of construction of such Facilities, and the satisfaction of all other conditions required to be fulfilled by the Concessionaire.
7. The Project Engineer shall monitor the Trial Operations of different Facilities during their respective Trial Periods and provide necessary recommendations to the ***[Executing Agency]*** for the purpose of the issuance of the respective COD Certificates to the Concessionaire. The review shall be based on the Trial Operations Procedures outlined in the Concession Agreement and include the following.

Verify quality of installations, operation of equipment and workmanship;

Verify the Discharge Standard of the Treated Effluent, Treated Water and Facilities By- Products;

Verify the consumption of electricity and generation of power if any vis-à-vis the Guaranteed Energy Consumption.

1. The Project Engineer shall review the O&M Manual and the Scheduled Maintenance Program submitted by the Concessionaire and provide its recommendations to the ***[Executing Agency]***.
2. During the O&M Period, the Project Engineer shall inspect all the Facilities at least once a month and prepare an inspection report, setting out the defects or deficiencies, if any, and status of compliance with the relevant KPIs (including specifically, the Influent Standards and the Discharge Standards).
3. The Project Engineer shall review the reports generated form the Online Monitoring Systems of different Facilities to assess adherence to their relevant KPIs and submit the monthly KPI Adherence Reports to the ***[Executing Agency]***.
4. The Project Engineer shall assist ***[Executing Agency]*** in estimating the Availability Liquidated Damages, the Performance Liquidated Damages and the Power Consumption Liquidated Damages as applicable.
5. The Project Engineer shall inspect laboratories where tests are conducted on samples to ensure conformance and compliance with laboratory procedures and requirements.
6. During the Term, and as requested by the ***[Executing Agency]***, the Project Engineer shall provide its opinion and assessment on the implications of the events related to Emergency, Change in Law, Force Majeure, Fundamental Change in Law, Minor casualty, Total casualty, Variation and Unforeseen Site Conditions.
7. The Project Engineer shall participate in the survey to determine the Hand-back Conditions as per the Hand-back Requirements. It shall review the survey report of the Hand-back Conditions submitted by the Concessionaire and provide its recommendations to the ***[Executing Agency]*** on the compliance with the Hand-back Requirements.



# Availability of Main Pumping Stations

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| During construction period- Guaranteed Interim  Availability | -- |
| Guaranteed Availability of pumping station after COD | 100% |
| Hours in the month for which a specific pumping station  was not Available (A) |  |
| Non-Availability for the specific pumping station (B) | =[(A) / 720] x100 |
| LDs for non- adherence for the specific pumping station  (INR) | = (B) x 2,000 |

1. **Availability of [Location] STP/FSTP157**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| After COD - Guaranteed Availability | 100% |
| Hours in the month for which the relevant Facilities were not  Available (A) | ---- |
| Non-Availability (B) | = [(A) / 720] x100 |
| LDs for non- adherence (INR) | (B) x 30,000 |

# Treated Effluent and Digested/dewatered Sludge liquidated damages for [Location] STP/FSTP (Performance Liquidated Damages)

|  |  |
| --- | --- |
| **Parameter** | **Liquidated Damages (INR)** |
| **A. Liquidated Damages** | |
| BOD | 5,000 |
| COD | 5,000 |
| TSS | 5,000 |
| Nitrogen Total | 5,000 |
| Phosphorus Total | 5,000 |
| Fecal Coliform | 5,000 |
| **B. Sludge to be disposed** | |
| Outlet Concentration of dewatered sludge | 3,000 |
| Volatile suspended solids | 3,000 |
| Faecal coliform | 3,000 |
| Salmonella | 3,000 |
| Viruses | 3,000 |
| Helminth egg | 3,000 |

157 Availability Liquidated Damages for Faecal Sludge Collection and Transportation Vehicles or any other assets/faciltiies forming part of the Associated Infrastructure may be decided by the Executing Agency.

# SCHEDULE 8: APPLICABLE PERMITS158

1. **Concessionaire Applicable Permits**

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Applicable Permit** | **Authority** |
| 1. | Temporary Power Connection (During Construction Period) | Electricity Board/ other temporary sources |
| 2. | Consent to Operate | State Pollution Control Board |
| 3. | Consent for storage of hazardous materials | Director of Explosives |
| 4. | Consent Firefighting system | Firefighting Department |
| 5. | CEIG approval stage 1 for construction & stage 2 on completion of project | Chief Electrical Inspector to Government |

The Concessionaire will be liable to obtain all Applicable Permits (other than the ***[Executing Agency]***

Applicable Permits) that are necessary for construction, operation and maintenance of the Facilities.

***[Executing Agency]*** shall assist the Concessionaire in obtaining all the required permits.

1. ***[Executing Agency]* Applicable Permits**

|  |  |  |
| --- | --- | --- |
| S **No.** | **Applicable Permit** | **Authority** |
| 1. | Electricity Board approval during various stages request for load sanction, remittance of deposit, installation of incomings, etc | Electricity Board |
| 2. | Layout and building plan approval | ULB/DTCP |
| 3. | Consent to establish | State Pollution Control Board (SPCB) |
| 4. | Tree cutting | Forest Department |
| 5. | Road cutting & crossing | Public Works Department |
| 6. | Railway Crossing | Commissioner Railway safety |
| 7. | Revenue road cutting & crossing | Panchayat/Local Authority |
| 8. | Obtaining No Objection Certificate for various sewerage facilities under the ULB for handing them over to ***[Executing Agency]*** | ULB/District Administration |
| 9. | Construction of weirs/pipeline crossings | Irrigation Department/ULB |
| 10. | Approach Road to new Facilities | Forest Department/ Panchayat/Local Authority/Irrigation Department |

158 The List of Applicable Permits provided herein is indicative and non-exhaustive.

|  |  |  |
| --- | --- | --- |
| 11. | Consent to Operate for Existing Facilities | ULB and SPCB |

The Concessionaire shall proactively assist the ***[Executing Agency]*** in obtaining all the required permits.



1. **Link to the Environment and Social Management Framework (ESMF) to be followed for Projects**

Environmental and Social Management Framework of Project:

http://

1. **Requirements for preparation of ESHS Management Strategies and Implementation Plans (ESHS-MSIP)**

The Concessionaire shall submit comprehensive and concise Environmental, Social, Health and Safety Management Strategies and Implementation Plans (ESHS-MSIP). These strategies and plans shall describe in detail the actions, materials, equipment, management processes etc. that will be implemented by the Concessionaire, and its subcontractors.

In developing these strategies and plans, the Concessionaire shall have regard to the ESHS provisions of the Concession Agreement including those as may be more fully described in the following:

* 1. Works Requirements described in Concession Agreement;
  2. Environmental and Social Impact Assessment (ESIA);
  3. Environmental and Social Management Plan (ESMP);
  4. Consent Conditions (regulatory authority conditions attached to any permits or approvals for the project).



# Metrics for Progress Reports

*The following Metrics should be used for regular reporting:*

1. *environmental incidents or non-compliances with Concession Agreement requirements, including contamination, pollution or damage to ground or water supplies;*
2. *health and safety incidents, accidents, injuries and all fatalities that require treatment;*
3. *interactions with regulators: identify agency, dates, subjects, outcomes (report the negative if none);*
4. *status of all permits and agreements:*
   1. *work permits: number required, number received, actions taken for those not received;*
   2. *status of permits and consents:*

*list areas/facilities with permits required (quarries, asphalt & batch plants), dates of application, dates issued (actions to follow up if not issued), dates submitted to resident engineer (or equivalent), status of area (waiting for permits, working, abandoned without reclamation, decommissioning plan being implemented, etc.);*

*list areas with landowner agreements required (borrow and spoil areas, camp sites), dates of agreements, dates submitted to resident engineer (or equivalent);*

*identify major activities undertaken in each area this month and highlights of environmental and social protection (land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation);*

*for quarries: status of relocation and compensation (completed, or details of monthly activities and current status).*

1. *health and safety supervision:*
   1. *safety officer: number days worked, number of full inspections & partial inspections, reports to construction/project management;*
   2. *number of workers, work hours, metric of PPE use (percentage of workers with full personal protection equipment (PPE), partial, etc.), worker violations observed (by type of violation, PPE or otherwise), warnings given, repeat warnings given, follow-up actions taken (if any);*
2. *worker accommodations:*
   1. *number of expats housed in accommodations, number of locals;*
   2. **     

*compliance with national and local law and good practice, including sanitation, space, etc.;*

* 1. *actions taken to recommend/require improved conditions, or to improve conditions.*

1. *HIV/AIDS: provider of health services, information and/or training, location of clinic, number of non-safety disease or illness treatments and diagnoses (no names to be provided);*
2. *gender (for expats and locals separately): number of female workers, percentage of workforce, gender issues raised and dealt with (cross-reference grievances or other sections as needed);.*
3. *training:*
   1. *number of new workers, number receiving induction training, dates of induction training;*
   2. *number and dates of toolbox talks, number of workers receiving Occupational Health and Safety (OHS), environmental and social training;*
   3. *number and dates of HIV/AIDS sensitization training, no. workers receiving training (this month and in the past); same questions for gender sensitization, flaglady/flagman training.*
4. *environmental and social supervision:*
   1. *environmentalist: days worked, areas inspected and numbers of inspections of each part of the Facilities created, highlights of activities/findings (including violations of environmental and/or social best practices, actions taken), reports to environmental and/or social specialist/construction/site management;*
   2. *sociologist: days worked, number of partial and full site inspections of each part of the Facilities created, highlights of activities (including violations of environmental and/or social requirements observed, actions taken), reports to environmental and/or social specialist/construction/site management; and*
   3. *community liaison person(s): days worked (hours community center open), number of people met, highlights of activities (issues raised, etc.), reports to environmental and/or social specialist*

*/construction/site management.*

*k. * 

*received, to whom referred to for action, resolution and date (if completed), data resolution reported to complainant, any required follow-up (Cross-reference other sections as needed):*

1. *Worker grievances;*
2. *Community grievances*
3. *Traffic and vehicles/equipment:*
   1. *traffic accidents involving project vehicles & equipment: provide date, location, damage, cause, follow-up;*
   2. *accidents involving non-project vehicles or property (also reported under immediate metrics): provide date, location, damage, cause, follow-up;*
   3. *overall condition of vehicles/equipment (subjective judgment by environmentalist); non- routine repairs and maintenance needed to improve safety and/or environmental performance (to control smoke, etc.).*
4. *Environmental mitigations and issues (what has been done):*
   1. *dust: number of working bowsers, number of waterings/day, number of complaints, warnings given by environmentalist, actions taken to resolve; highlights of quarry dust control (covers, sprays, operational status); % of rock/muram/spoil lorries with covers, actions taken for uncovered vehicles;*
   2. *erosion control: controls implemented by location, status of water crossings, environmentalist inspections and results, actions taken to resolve issues, emergency repairs needed to control erosion/sedimentation;*
   3. *quarries, borrow areas, spoil areas, asphalt plants, batch plants: identify major activities undertaken this month at each, and highlights of environmental and social protection: land clearing, boundary marking, topsoil salvage, traffic management, decommissioning planning, decommissioning implementation;*
   4. *blasting: number of blasts (and locations), status of implementation of blasting plan (including notices, evacuations, etc.), incidents of off-site damage or complaints (cross-reference other sections as needed);*
   5. *spill cleanups, if any: material spilled, location, amount, actions taken, material disposal (report all spills that result in water or soil contamination);*
   6. *waste management: types and quantities generated and managed, including amount taken offsite (and by whom) or reused/recycled/disposed on-site;*
   7. *details of tree plantings and other mitigations required undertaken this month;*
   8. *details of water and swamp protection mitigations required undertaken this month.*
5. *compliance:*
   1. *compliance status for conditions of all relevant consents/permits, for the Work, including quarries, etc.): statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance;*
   2. *compliance status of ESMP/ESIP requirements: statement of compliance or listing of issues and actions taken (or to be taken) to reach compliance*
   3. *other unresolved issues from previous months related to environmental and social: continued violations, continued failure of equipment, continued lack of vehicle covers, spills not dealt with, continued compensation or blasting issues, etc. Cross-reference other sections as needed.*
6. **Requirements for the preparation of the Code of Conduct**



and subcontractors. The Code of Conduct shall ensure compliance with the ESHS provisions of the Concession Agreement, including those as may be more fully described in the following:

* 1. Works Requirements described in Concession Agreement;
  2. Environmental and Social Impact Assessment (ESIA);
  3. Environmental Management Plan (EMP);
  4. Consent Conditions (regulatory authority conditions attached to any permits or approvals for the project).

**MINIMUM REQUIREMENTS FOR THE CODE OF CONDUCT**

A minimum requirement for the Code of Conduct should be set out, taking into consideration the issues, impacts, and mitigation measures identified in:

project reports e.g. ESIA/ESMP

consent/permit conditions

required standards including World Bank Group EHS Guidelines and Performance Standards

national legal and/or regulatory requirements and standards (where these represent higher standards than the WBG EHS Guidelines and PS)





and in the absence of such Indian Standards those of IFC and EBRD)

relevant sector standards e.g. workers accommodation

grievances redress mechanisms.

The types of issues identified could include risks associated with: labor influx, spread of communicable diseases, sexual harassment, gender based violence, illicit behavior and crime, and maintaining a safe environment etc.

A satisfactory code of conduct will contain obligations on all project staff (including sub-contractors and day workers) that are suitable to address the following issues, as a minimum.

Compliance with applicable laws, rules, and regulations of the jurisdiction

1. Compliance with applicable health and safety requirements (including wearing prescribed personal protective equipment, preventing avoidable accidents and a duty to report conditions or practices that pose a safety hazard or threaten the environment)
2. The use of illegal substances
3. Non-Discrimination (for example on the basis of family status, ethnicity, race, gender, religion, language, marital status, birth, age, disability, or political conviction)
4. Interactions with community members (for example to convey an attitude of respect and non- discrimination)
5. Sexual harassment (for example to prohibit use of language or behavior, in particular towards women or children, that is inappropriate, harassing, abusive, sexually provocative, demeaning or culturally inappropriate)
6. Violence or exploitation (for example the prohibition of the exchange of money, employment, goods, or services for sex, including sexual favors or other forms of humiliating, degrading or exploitative behavior)
7. Protection of children (including prohibitions against abuse, defilement, or otherwise unacceptable behavior with children, limiting interactions with children, and ensuring their safety in project areas)
8. Sanitation requirements (for example, to ensure workers use specified sanitary facilities provided by their employer and not open areas)
9. Avoidance of conflicts of interest (such that benefits, Concession Agreement, or employment, or any sort of preferential treatment or favors, are not provided to any person with whom there is a financial, family, or personal connection)
10. Respecting reasonable work instructions (including regarding environmental and social norms)
11. Protection and proper use of property (for example, to prohibit theft, carelessness or waste)
12. Duty to report violations of this Code
13. Non retaliation against workers who report violations of the Code, if that report is made in good faith.

The Code of Conduct should be written in plain language and signed by each worker to indicate that they have:

received a copy of the code; had the code explained to them;

acknowledged that adherence to this Code of Conduct is a condition of employment; and understood that violations of the Code can result in serious consequences, up to and including dismissal, or referral to legal authorities.

1. **Guidelines for staffing of a Core team of 3 people for implementation of the Concessionaire's ESHS obligations**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No** | **Key Position** | **Minimum Qualifying Requirement** | | |
| **Total Work Experience (years)** | **Experience in Similar Works (years)** | **Minimum Education Qualification** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.No** | **Key Position** | **Minimum Qualifying Requirement** | | |
| **Total Work Experience (years)** | **Experience in Similar Works (years)** | **Minimum Education Qualification** |
| 1. | Health Expert & Safety Specialist\* | 10 | 5 | B.E. /B. Tech or Equivalent with Specialization / additional qualification in EHS related field. |
| 2. | Environmental Specialist \* | 10 | 5 | B.E./B. Tech or Equivalent with Specialization / additional qualification in Environment related field |
| 3. | Social Specialist\* | 10 | 5 | Work or equivalent |

\* He/she should have worked as a sole expert for Urban Infrastructure projects. Experience in environment / safety / Social Risk Assessment, resettlement and rehabilitation and Management plans related to similar project would be preferred.

1. **Minimum Requirements and Guidelines for the preparation of the Screening Report**

The extent of assessment required to identify and mitigate the impacts largely depends upon the complexities of project activities. The scrutiny and screening will be based on a detailed Environment and Social Screening exercise, summarized in the following Format:

|  |  |  |  |
| --- | --- | --- | --- |
| **Environment and Social information format for screening** | | | |
|  | Project Title: Implementing agency: Project cost:  Project components:  Project location (Area/ district) | | |
|  | **Screening Criteria** | **Assessment of category (High/ low)** | **Explanatory note for categorisation** |
| 1 | Is the project in an eco-sensitive area or adjoining an eco-sensitive area? (Yes/No) If Yes, which is the area? Elaborate impact accordingly. |  |  |
| 2 | Will the project create significant/ limited/ no social impacts?  Involuntary land taking resulting in loss of income from |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | agricultural land, plantation or other existing land-use. Involuntary land taking resulting in relocation of title holder or non-titleholder households.  Any reduction of access to traditional and river dependent communities (to river and areas where they earn for their primary or substantial livelihood).  Any displacement or adverse impact on tribal settlement(s).  Any specific gender issues. |  |  |
| 3 | Will the project create significant / limited / no environmental impacts during the construction stage? (Significant / limited / no impacts)  Clearance of vegetation/ tree-cover  Direct discharge of construction run-off, improper storage and disposal of excavation spoils, wastes and other construction materials adversely affecting water quality and flow regimes.  Flooding of adjacent areas  Improper storage and handling of substances leading to contamination of soil and water  Elevated noise and dust emission Disruption to traffic movements  Damage to existing infrastructure, public utilities, amenities etc.  Failure to restore temporary construction sites  Possible conflicts with and/or disruption to local community    Safety hazards during construction |  |  |
| 4 | Will the project create significant / limited / no environmental impacts during the operational stage? (Significant / limited / no impacts)  Flooding of adjacent areas  Impacts to water quality due to effluent discharge Gas emissions  Safety hazards |  |  |
| 5 | Do projects of this nature / type require prior environmental clearance either from the MOEF&CC or from a relevant state Government department? (MOEF&CC/ relevant State Government department/ No clearance at all) |  |  |
| 6 | Does the project involve any prior clearance from the MOEF&CC  or State Forest department for either the conversion of forest land |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | or for tree-cutting? (Yes/ No).  If yes, which? |  |  |
| 7 | Please attach photographs and location maps along with this  completed Environmental Information Format For Screening. |  |  |
| **Overall assessment** | |  |  |

\*Detailed explanation/ justification for arriving at specific category (high/ low) to be provided in the specified column



# Availability

The Concessionaire shall ensure that the Availability of the Facilities and the Associated Infrastructure on every day during the O&M Period shall be 100% (one hundred per cent) (the ).

# Treated Effluent Quality

The Treated Effluent shall meet the following requirements:

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value for *[Location]* STP/FSTP** |
| pH |  | 5.5-9.0 |
| BOD | mg/L | 10 |
| TSS | mg/L |  |
| COD | mg/L |  |
| Nitrogen Total | mg/L |  |
| Phosphorus Total | mg/L |  |
| Faecal Coliform | MPN/100 mL |  |

The Concessionaire shall not be responsible for adherence to the above requirements of Treated Effluent in an event the values of the Influent Standards are as per table below.

|  |  |  |
| --- | --- | --- |
| **Item/ Parameter/**  **Description** | **Units** | **Value for *[Location]* STP/FSTP** |
| pH |  | >9.00 |
| BOD | mg/L | <80 and >250 |
| TSS | mg/L | >500 |
| COD | mg/L | >500 |
| TKN | mg/L | >60 |
| Phosphorus Total | mg/L | >7 |

# Digested/dewatered sludge

The Sludge to be disposed shall meet the following requirements.

|  |  |
| --- | --- |
| **Units** | **Value** |
| Outlet Concentration of  dewatered sludge | More than 20% solids |
| Volatile suspended solids | least 38% of reduction |
| Faecal coliform limit |  |

[The Sludge to be disposed shall meet the following requirements.]159

|  |  |
| --- | --- |
| **Units** | **Value** |
| Salmonella |  |
| Viruses |  |

159 If co-treatment of Faecal sludge is proposed.

|  |  |
| --- | --- |
| Helminth egg |  |

# Energy guarantee

The concessionaire shall guarantee the maximum number of units of power per MLD of treated sewage/faecal sludge/septage. This should be less or equivalent to consumption power units in terms of units in each of during the O&M period (other than any units expected to be generated and consumed from any power plant proposed to be set up by the Concessionaire), to operate and maintain the Facilities including STP/FSTP, pump houses and other associated Infrastructure (at varying volumes and BOD of sewage).

# Assessment of compliance to KPIs

The assessment of compliance to KPIs for each of the parameters shall be checked in accordance with the reports from online monitoring system or laboratory tests as set out in the Schedule 12 (Part D).



***[Project specific Information as available to be provided in this schedule for the Bidders. Indicative headings for the Schedule are as below:]***

# Project background

1. **[*Location*] town at a glance:**

# Introduction

* 1. **Geography :**

# Topography:

1. **Population:**

# 3.1.1.Zone-wise population projection:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Zone | Population | | | Sewage Generation | | |
| **2020** | **2035** | **2050** | **2020** | **2035** | **2050** |
| Zone WISE/ Ward  wise |  |  |  |  |  |  |
| **Total City** |  |  |  |  |  |  |
| **Total** |  |  |  |  |  |  |

|  |  |  |
| --- | --- | --- |
| **S.**  **No.** | **Sewerage**  **Zone** | **Ward covered** |
| 1 | Zone No. 1 |  |
| 2 | Zone No. 2 |  |

* 1. **Existing water supply infrastructure: 3.2.1.Water Supply System**

# 3.2.2.Source, supply levels and treatment facilities

* 1. **Sewerage schemes under implementation**

# Details of existing drains 3.4.1.Flow Measured in The Drains

**3.4.2.Wastewater Characteristics of Drains**

# Drain Catchment

1. **Drain I&Ds**

# Existing Power Supply source

**Contents**

|  |  |  |
| --- | --- | --- |
| **Part** | **Section** | **Title** |
| A |  | Process requirements and design criteria of sewage/faecal  sludge/septage work |
| B |  | Technical specifications |
|  | G1 | General requirement |
|  | G2 | Materials and workmanship |
|  | G3 | General civil specifications |
|  | G4.1 | General Mechanical Specifications |
|  | G5.1 | General Electrical Specifications |
|  | G5.2 | Technical specification for Diesel generator set |
|  | G5.3 | Erection, testing and commissioning |
|  | G5.4 | Instrumentation works |
|  | G5.5 | SCADA (Online Monitoring System) for STP(s)/FSTP(s) and LS/ PS |
|  | G5.6 |  |
| C |  | Testing and Commissioning |
| D |  | Specifications for Operation and Maintenance |
| E |  | Electrical load list |

**PART A - PROCESS REQUIREMENTS AND DESIGN CRITERIA OF SEWERAGE WORK**

**PART A - PROCESS REQUIREMENTS AND DESIGN CRITERIA OF SEWERAGE WORK**

1. **Flow and Raw sewage/faecal sludge/septage characteristic for *[LOCATION]***

# STP(s)/FSTP(s)

The Influent standards for STP(s)/FSTP(s) design purpose are stated below.

|  |  |  |
| --- | --- | --- |
| **Item/Parameter/Description** | **Units** | **Design Capacity** |
| Design capacity for sewage/faecal  sludge/septage (Average) | MLD | ***[xx]*** |

|  |  |  |
| --- | --- | --- |
| **Item/Parameter/Description** | **Units** | **Proposed STP/FSTP** |
| pH |  | 5.5-9.0 |
| BOD5 at 20°C | mg/L | 80-250 |
| TSS | mg/L |  |
| COD | mg/L |  |
| TKN | mg/L |  |
| Phosphorus Total | mg/L |  |

*Note: Influent standards provided above is the influent sewage/faecal sludge/septage characteristic. In addition to the above, The concessionaire must make sure that the treated effluent and digested sludge meet the disposal standards as mentioned in the KPI.*

# General design requirements

The Concessionaire shall design the Facilities in accordance with the provisions of the IS codes, Central Public Health and Environmental Engineering Organisation (CPHEEO) manual on Sewerage and Sewage Treatment, Good Industry Practices and Applicable Laws.

The precedence for process and hydraulics shall be CPHEEO manual followed by the IS codes and Good Industry Practices. The precedence for civil, structural, mechanical & electrical processes shall be ISO/BIS Codes followed by CPHEEO manual and Good Industry Practices.

The STP(s)/FSTP(s) shall be designed by the Concessionaire to receive and treat all combinations of sewage/faecal sludge/septage influent flows and loads in accordance with the Influent Standards specified above.

Concessionaire's plant design shall fully comply with the minimum retluirements specified in this schedule and other schedules, regardless of whether or not such requirements or any related components are shown in any drawings included or document issued by the Employer.

All interconnecting channels, launders, pipe line shall be designed for peak flows.

## Design life

The Facilities shall be designed and constructed to provide the minimum service life as prescribed

in CPHEEO guidelines (2013) Chapter-2 Table 2.1 Design period of sewerage components.

## Per Capita Water Supply and Sewage/Faecal Sludge/Septage Generation

Per Capita water supply and Sewage/Faecal Sludge/Septage Generation shall be considered as per CPHEEO Sewerage manual.

## Infiltration

Estimate of flow in sanitary sewers have to include flows due to infiltration of ground water. In light of general geological structure, ground water occurrence and topography, the ground water infiltration is considered for the proposed networks. For the design purpose, infiltration is considered as 10% (ten per cent).

## Peak factors

The peak factor shall be considered as per CPHEEO guidelines (2013).

## Design flows

Design flows are essentially peak dry weather flows. Peak dry weather flows would comprise of peak domestic sewage/faecal sludge/septage flow plus infiltration as per below.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pipe** | **Sectional**  **Average flow** | **Cumulative Average**  **flow** | **Cumulative**  **Infiltration** | **Peak flow** |
| **(a)** | **(b)** | **(c)** | **(d)** | **(e)** |
|  | = Sectional | = Sectional | = 10% of | = (c) x Peak Factor + (d) |
| population x | sewage/faecal | Cumulative | = Cumulative |
| sewage/faecal | sludge/septage Average | sewage/faecal | sewage/faecal |
| sludge/septage | flow + cumulative | sludge/septage | sludge/septage Average |
| (water supply rate | average flow from | Average flow | flow x Peak Factor + |
| x return factor) | previous connecting |  | Cumulative Infiltration |
|  | node(s) |  |  |

## IS codes for Sewerage System

Proposed sewerage system shall generally conform to the following publications of the Indian Standards Institution and applicable Indian standards:

|  |  |
| --- | --- |
| IS: 458 | Precast Concrete Pipes (With and Without Reinforcement) Specification |
| IS: 14333 | High density polyethylene pipe for sewerage |
| IS: 15328 | Un-plasticised Non-Pressure Polyvinyl Chloride (PVC-U) Pipes for use in  Underground Drainage and Sewerage Systems |
| IS: 783 | Code of Practice for Laying of Concrete Pipes |
| IS:4111 (Part 1) | Code of Practice for Ancillary Structures in Sewerage System: Part 1 Manholes |

|  |  |
| --- | --- |
| IS:4111 (Part 4) | Code of Practice for Ancillary Structures in Sewerage system: Part 4 Pumping  stations and pumping mains (rising mains) |
| IS: 5455 | Specification for Cast Iron Steps for Manholes |
| IS: 10151 | Polyvinyl Chloride (PVC) and its Copolymers for its Safe Use in Contact with  Foodstuffs, Pharmaceuticals and Drinking Water |
| IS: 6280 | Specification for Sewage/Faecal Sludge/Septage Screens |
| IS: 5600 | Pumps- Sewage/Faecal Sludge/Septage and Drainage |
| IS: 8329 | Centrifugally Cast (Spun) Ductile Iron Pressure Pipes for Water, Gas and  Sewage/Faecal Sludge/Septage Specification`` |
| IS: 11972 | Code of practice for safety precautions to be taken when entering a sewerage  System |
| IS: 12592 | Precast Concrete Manhole Cover And Frame Specification |
| IS: 13496 | General Requirements of Suction Machine for Cleaning Sewers, Manholes and  Ancillary Structures Provided On Sewer Line and Closed Storm Water Drains |
| IRC: 6 | Standard Specifications and Code of Practice for Road Bridges Section II  Loads and Stresses |

## Design parameters for gravity collection system

* + 1. ***Design formula(As per CPHEEO)***

is adopted for design of gravity sewers.

|  |  |  |
| --- | --- | --- |
| Qf | = | A x Vf |
| Vf | = | 1/N x R**2/3** x S**1/2** |
| Where, |  |  |
| Qf | = | Flow rate when pipe flows full in cumecs |
| Vf | = | Velocity when pipe flows full in mps |

## Coefficient of Roughness

For sewers with diameters within range of 150-1400mm, RCC pipes with S&S joints have been



## Pipe Material for Gravity Sewers

RCC NP3 class pipes conforming to IS: 458 with Sulphate Resistant Cement and rubber ring joints shall be proposed. For highway crossings and pipe jacking, RCC NP4 pipes are proposed.

## Design Capacity of Sewers

Sewers are designed to carry estimated peak flows generated in the design year. As far as

possible, they will be designed to run maximum 80% full at ultimate peak flow as per the CPHEEO Manual. This is to ensure proper ventilation and to prevent the sewage/faecal sludge/septage getting septic.

## Self Cleansing Velocities

To ensure that deposition of suspended solids does not take place, self-cleansing velocities using



V= (1/n) x R1/6 {KS (SS 1) x dp}1/2

KS = Dimensionless constant @ 0.04 to start motion of granular particle and @ 0.8 for adequate self cleansing velocity.

SS = Specific Gravity of Particle dp = Particle size

The above formula indicates that velocity required to transport material in sewers is mainly dependent on the particle size and specific gravity and only slightly dependent on conduit shape and depth of flow.

The sewers are designed on the assumption that although silting might occur at minimum flow, it would be flushed out during peak flows. Erosion of sewers is caused by sand and other gritty material in the sewer and also by excessive velocity.

Based on above, the velocity criteria which is considered is as given below.

Minimum velocity = 0.80 m/s Maximum velocity = 3.00 m/s

An attempt shall be made to obtain adequate self cleansing velocities in the design of sanitary sewer at the average or at least at the maximum flow at the beginning of the design period. If the velocity criteria do not meet for initial stretches of sewers due to less flow, these stretches will need to be flushed at regular intervals to avoid clogging of sewers.

## Minimum size and gradient of sewers

The gradients adopted for the sewers shall be in concurrence with the CPHEEO manual. The gradients adopted for the sewers shall be based on flow and velocity requirements. The crown levels of incoming and outgoing sewers shall be kept same.Whenever required drop manholes shall be provided.

* + 1. ***Depth of cover***

# Minimum depth of cover

To facilitate house sewer connections and future laterals connections to the street manholes and to provide sewer protection from external loads, the minimum depth of cover is considered as 1 m.

## Design parameters for rising mains / pressure pipes (As per CPHEEO)

For Pressure pipe, Hazen William formula is adopted V= 0.85 x C x R 0.63 x S 0.54

for circular conduits, the expression becomes V = 4 .567 x 10 - 3 C D 0.63 S 0.54

where,

Q : Discharge in m3/hr

D : Internal diameter of pipe in mm V : Velocity in m/s

R : Hydraulic radius in m

S : Slope of hydraulic gradient and

C : Hazen - Williams coefficient as in Table 3.14 (CPHEEO Manual)

For Rising Mains, Ductile Iron (DI) of Class K9 pipes with internally smooth cement mortar lining are proposed.

|  |  |  |
| --- | --- | --- |
| Minimum velocity | = | 0.80 m/s |
| Maximum velocity | = | 3.00 m/s |

Losses in fitting shall be computed as per latest CPHEEO Manual.

## Bedding for sewers

The type of bedding (Granular Bedding, Plain Cement Concrete Cradle Bedding, Reinforced Cement Concrete Cradle Bedding and Reinforced Cement Concrete Encasement) depends on the weight of soil above the pipe based on width of trench, depth at which the sewer pipe is laid and the class of superimposed vehicular load considered based on the traffic condition.

For RCC (NP3 class) pipes, the appropriate bedding shall be provided based on the bedding factor calculated considering load due to backfill, the superimposed (live) load and the three edge bearing strength of RCC pipes as per IS:458.

The bedding factor is calculated by following formula. Bedding Factor = Total Load (kN/m) x Factor of Safety

Three Edge Bearing Strength (kN/m)

Where, Total load is sum of Earth load, Vehicular load and Water load

Three Edge Bearing Strength of RCC pipe is considered as per IS: 458 Factor of safety is considered as 1.1.

Impact factor for vehicular traffic depends on cover above top of pipes. For sewers, the depth of cover is more than 900mm, hence impact factor is considered as 1.0 as per IS:783.

The type of bedding to be used, depending on the bedding factor shall be as indicated.

|  |  |  |
| --- | --- | --- |
| **Bedding factor** | **Type of bedding** | **Class of bedding** |
| Up to 1.9 | Granular Bedding with Carefully Compacted  Backfill (GRB) | B |
| For more than 1.9 and  upto 2.8 | Concrete Cradle Bedding with Carefully  Compacted Backfill (PCCB) | A b |
| For more than 2.8 and up to 3.4 | Reinforced concrete cradle with percentage    compacted backfill (RCCB) | A c |
| For more than 3.4 and up to 4.8 | Reinforced Concrete Encasement with    (RCE) | A d |

 *is the ratio of the area of transverse reinforcement to the area of concrete cradle at the pipe invert above the base)*



## Manholes

* + 1. ***Ordinary manhole***

Manholes are to be provided at all junctions, change of sewer size, gradient and direction. The sizes of manholes adopted are in line with the recommendations of CPHEEO Manual for Sewerage and Sewage treatment. In general, to facilitate the cleaning and maintenance the Manhole spacing is kept as per CPHEEO Manual.

The clear opening at the top in case of ordinary manholes is kept as 560 mm. The manhole frame and cover is proposed of Steel Fiber Reinforced Concrete (SFRC) capable of withstanding heavy- duty loads (HD-20 for side lanes), (HD-35 for main roads) conforming to IS: 12592-2002.

The street manholes will be circular in shape with concentric cone depending on the depth and diameter of sewers. Based on the sewer diameters CPHEEO Manual for Sewerage and sewage treatment recommends the internal diameter of the manhole should not be less than internal diameter of largest sewer plus 150mm of benching on both sides. However, from practical considerations the benching width for sewer diameter greater than 450mm is kept as 300mm on both sides. The internal diameters of manholes for varying depths as recommended by CPHEEO Manual for Sewerage and sewage treatment will be as follows.

**Dimension**

**Description**

|  |  |
| --- | --- |
| **Description** | **Dimension** |
| For depths above 0.90m and up to 1.65m | 900mm diameter |
| For depths above 1.65m and up to 2.30m | 1200mm diameter |
| For depths above 2.30m and up to 9.00m | 1500mm diameter |
| For depths above 9.00m and up to 14.0m | 1800mm diameter |

It is desirable to place the first pipe joint (S/S) outside the manhole as close as practicable. This pipe shall be built inside the wall of the manhole flush with the internal periphery protected with an arch of masonry or cement concrete to prevent it from being crushed.

The inside and outside of brickwork should be plastered with cement mortar (1:3) inside finished smooth with a coat of neat cement.

Due to availability of plenty of bricks locally and less cost, Brick Masonry manholes are proposed wherein house connections / lateral sewers can be done conveniently. However, RCC manholes are also considered for sub-soil water conditions. RCC manholes are considered as square for ease in construction as the cost difference between circular and square type of RCC manholes are marginal. Precast concrete manholes are also considered for congested and narrow lanes for speedy construction for manhole depth upto 1.65m for pipes upto 400mm dia.

The type and size of manholes (depth-wise) is given below.

# Type and size of manholes for proposed sewerage works

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of**  **manhole** | **Depth of manhole** | **Diameter of**  **pipe** | **Size of**  **manhole** | **Size of**  **opening** |
| ***BRICK***  ***MASONRY*** |  |  |  |  |
| *Rectangular* |  |  |  |  |
| R2-Type  Manhole | For depth upto 2.5 m | Upto 400 mm | 1200 X 900mm | 560mm dia. |
| *Circular* |  |  |  |  |
| A-Type  Manhole | For depth 1.2 m and upto 1.65m | Upto 400 mm | 900 mm dia | 560mm dia. |
|  |  |  |  |  |
| B-Type  Manhole | For depth 1.66 m and upto 2.0 m | Upto 600 mm | 1200 mm dia | 560mm dia. |
|  | For depth 2.01 m and upto 2.3 m |  |  |  |
| C-Type  Manhole | For depth 2.31 m and upto 3.0 m | Upto 900 mm | 1500 mm dia | 560mm dia. |
|  | For depth 3.01 m and upto 4.5 m |  |  |  |
|  | For depth 4.51 m and upto 6.0 m |  |  |  |
|  | For depth 6.01 m and upto 7.5 m |  |  |  |
|  | For depth 7.51 m and upto 9.0 m |  |  |  |
| D-Type  Manhole | For depth 3.01 m and upto 4.5 m | 1000 to 1200  mm | 1800 mm dia | 560mm dia. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of**  **manhole** | **Depth of manhole** | **Diameter of**  **pipe** | **Size of**  **manhole** | **Size of**  **opening** |
|  | For depth 4.51 m and upto 6.0 m |  |  |  |
|  | For depth 6.01 m and upto 7.5 m |  |  |  |
|  | For depth 7.51 m and upto 9.0 m |  |  |  |
|  | For depth 9.0 m and upto 12.0 m |  |  |  |
| *Scraper*  *Manhole* |  |  |  |  |
| S1-Type  Manhole | For depth upto 1.5 m | 500 to 900mm | 1500mm  X1500 mm | 2 nos. 900 x  600mm |
|  | For depth 1.5 m and up to 3 m |  |  |  |
|  | For depth 3 m and up to 4.5 m |  |  |  |
|  | For depth 4.5 m and up to 6 m |  |  |  |
|  | For depth 6 m and up to 7.5 m |  |  |  |
|  | For depth 7.5 m and up to 9 m |  |  |  |
|  | For depth 9 m and up to 10.5 m |  |  |  |
|  | For depth 10.5 m and up to 12 m |  |  |  |
|  | For depth 12 m and up to 14 m |  |  |  |
| S2-Type  Manhole | For depth upto 1.5 m | 1000 to  1200mm | 1800mm X1500  mm | 2 nos. 900 x  600mm |
|  |  |  |  |  |
|  | For depth 1.5 m and upto 3 m |  |  |  |
|  | For depth 3 m and upto 4.5 m |  |  |  |
|  | For depth 4.5 m and upto 6 m |  |  |  |
|  | For depth 6 m and upto 7.5 m |  |  |  |
|  | For depth 7.5 m and upto 9 m |  |  |  |
|  | For depth 9 m and upto 10.5 m |  |  |  |
|  | For depth 10.5 m and upto 12 m |  |  |  |
|  | For depth 12 m and upto 14 m |  |  |  |
| ***RCC MANHOLE***  ***S*** |  |  |  |  |
| Type-A | For depth upto 1.5 m | Upto 300mm  Dia. | 1500mm X1500  mm | 560mm dia. |
|  | For depth 1.5 m and upto 3.0 m | Upto 450mm  Dia. |  |  |
| Type-B | For depth 3.0 m and upto 4.5 m | Upto 600mm  Dia. | 1500mm X1500  mm | 560mm dia. |
|  | For depth 4.5 m and upto 6.0 m | Upto 900mm  Dia. |  |  |
| Type-C | For depth 6.0 m and upto 7.5 m | 1000- 1200mm  Dia. | 1800mm X1800  mm | 560mm dia. |
|  | For depth 7.5 m and upto 9.0 m |  |  |  |
| Type-D0 | For depth 9.0 m and upto 10.5 m | Above  1200mm Dia. | 2200mm X2200  mm | 560mm dia |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of**  **manhole** | **Depth of manhole** | **Diameter of**  **pipe** | **Size of**  **manhole** | **Size of**  **opening** |
|  | For depth 10.5 m and upto 12.0 m |  |  |  |
| **PRECAST CONCRETE MANHOLES** | | | | |
| Type-E | For depth 1.2 m and upto 1.65m | Upto 400 mm | 1000 mm dia | 560mm dia. |

## Drop arrangement

Drop arrangement is proposed for the laterals joining the manholes of main sewer wherein level between maximum water line (peak flow level) of main line and invert level of lateral/branch sewer is greater than 600mm.

# Interception and Diversion of Nala

Interception and diversion of Nala shall be carried out as per the CPHEEO manual/ applicable standards.The design shall include Nala/drain Catchment area estimation, Design flood discharge, DWF, water way at weir, discharge per unit width, Head over weir, depth of cut-off and creep length required. Mechanical & manual screens shall be provided at each I&Ds. Periodic removal of trash and cleaning of screens need to be undertaken by the concessionaire during O&M period. Actuator gates and flow measuring instrument need to be provided at I&Ds.

Necessary power arrangement including standby need to be provided at the I&Ds.

DWF shall be considered as per actual flow measurement to be carriedout by the concessionaire for a minimum period 14 days at all Nalas/Drains. Peak flow shall be considered for the designing of the I&Ds.

# Sewage pumping station(SPS)

1. Sewage Pumping Stations are provided to lift sewage so as to discharge into another gravity sewer or inlet chamber of treatment plant. Hydraulic criteria adopted in the design of Sewage Pumping Station will be follows:-
   1. Peak Factors ranging from 2 to 3 are considered for design peak flows.
   2. Velocity in pumping main range from 0.8 m/sec (minimum) to 3 m/sec (maximum).
   3. Wet well volume is generally computed based on the pump capacity & no. of starts and stops per hour as given below. Also it is calculated based on 3.75 minutes detention time at peak flow as per NRCD Guidelines.

Wet Well volume, V=0.25\* Q / N (Considering design year flows)

Where Q pumping rate in cum/hr of largest pump installed for parallel arrangement.

N- No. of starts & stops per hour considering manual start/stop also.

* 1. Velocity through the screen is 0.9 m/sec at peak flow.
  2. Hazen William`s Coefficient will be considered as 120 for DI pipe.
  3. Minimum residual head is considered as 2 m for pump head design.
  4. The Pumps, Electro-Mechanical Units and other related accessories are designed considering present and ultimate design peak flows.

1. The selection of pumps , pumping main size, Electro-Mechanical Units design shall be based on the following criteria besides head & discharge requirements.
   1. Submersible non clog pumps will be considered for medium/small PS (<= 50 MLD), whereas horizontal type non-clog centrifugal pumps with positive suction pumps as appropriate are proposed for large pumping station (>= 50 MLD).
   2. The pumps shall have single speed with low rpm (less than 1000 rpm) & as far as possible, of equal capacities.
   3. The pump configurations will be selected as per NRCD/MoEF Guidelines as given in following table.

|  |  |  |
| --- | --- | --- |
| **Length of Rising Main** | **Pumps** | **No. of Pumps** |
| Where rising main is long and where head losses are the dominant factor | Peak Flow/2  pumps | 3 nos. (including 1  standby) |
| Non Peak Flow  pumps | 2 nos. (including 1  standby) |
| Where rising main is short  and static head is dominant | Peak Flow/4 pumps | 6 nos. (including 2 standby) |

* 1. In case the rising mains are long ,head losses are dominant factor, in case the rising mains length is short, static head is dominant factor.
  2. Depending on present & future flows (minimum, average and peak) suitable capacity of pumps will be selected.
  3. For small sewage pumping stations upto 15.00MLD, equal duty pumps of half peak flow with the provision of 100% standby peak flow shall be considered.
  4. For medium & large pumping stations above 15.00MLD capacity, equal duty pumps of 1/4th of peak flow with 50% standby and 50% spare shall be provided. 10% additional capacity for pumps shall be considered. Parallel operation of more than four number of pumps shall be avoided. A/C deficiency (losses) due to parallel operation of pump shall be minimized.
  5. For pumping station, provision should be made for automatic start & stop, the system would be capable of being operated manually.
  6. A maximum of two starts & two stops per hour should be considered for manual operations of the pump. A higher no. of starts & stops shall be considered for the automatic operation.
  7. Pump shall have semi open impeller having not more than two vanes.
  8. MOC of pumps shall be as per mentioned below ,

|  |  |
| --- | --- |
| Casing | Cast Iron as IS 210 Grade F260 with Ni 2% |
| Impeller | Stain less Steel (CF 8M) |
| Shaft | AISI 410 |

* 1. HT motors for more than 250 kW rating shall be considered. The incoming power supply for these pumps shall be preferable at 33 kV
  2. Motor H.P rating shall be considered with additional margin over BKW at duty point as per section 11.1.9 latest CPHEEO Manual .
  3. Mechanically operated Stainless steel screens for SPS would be provided ahead of the wet well to prevent large size solids entering the pump. Selection of rack shall vary on depth. Drum type screens shall be avoided. Rectangular screen to be installed on approx. 60° to 70° angles. Bar screens are to be avoided. Motors provided for screens, clarifiers, Detroiters shall have sufficient margin for overloading due to foreign materials such as jutes, plastics, nylon ropes etc.
  4. All the sluice gates in the SPS area will be made from Cast Iron Flush bottom Rising Spindle type.
  5. Natural or forced ventilation system would be provided for deep pumping station, with dry-wet well configuration.
  6. Level indicators would be provided for SPS.
  7. Overhead travelling cranes of capacity as required shall be electrically operated. Also adequate loading platform shall be provided for material handling.
  8. The material for rising main is considered as Ductile Iron as per IS: 8239:2000.
  9. Electrically operated overhead travelling cranes of adequate capacity shall be provided . Also, adequate loading platform shall be provided for material handling.

# Process requirements of STP(s)/FSTP(s)

The following main treatment processes and requirements must be provided: Preliminary treatment (screenings & grit removal)

Secondary biological treatment Sludge digestion

Sludge thickening, dewatering & storage

[Any other facilities as required for co-treatment of septage ]160

Transportation of Screenings, Residual Grit and Digested Sludge from the Facilities and Associated Infrastructure to the Waste Disposal Site.

Disinfection system

# Description of process and facilities

This section outlines the major processes and Facilities that the Concessionaire is required to design, construct, and operate as per this Concession Agreement.

## Stilling chamber

A stilling chamber shall be provided at the inlet of STP(s)/FSTP(s) to receive the raw sewage/faecal sludge/septage from the pumping station. The stilling chamber shall reduce the turbulence of raw water entering into it. The stilling chamber should be kept clean by removing silt, sand deposited and the algae growth at the bottom and sides.

## Fine screens

The raw sewage/faecal sludge/septage from rising main shall flow to fine screen inlet channel by gravity. The mechanical fine screen shall be either bar /perforated screen. The screens shall have clear openings not exceeding 6 mm. The screens shall be equipped with an automatic cleaning system and can be controlled by both an adjustable timed cycle and a pre-set differential head across the screen using ultrasonic level sensors. All screens shall be provided with thimble

160 If Co-treatment of faecal sludge is proposed.

mounted isolation sluice gates (actuator operated with manual override) both on upstream and downstream. The Concessionaire should provide bypass channel with manual screen considering the overall screening capacity shall be 100% peak flow with one screen out of service.

## Grit basins with Grit washers and classifiers

The Concessionaire shall provide Grit separators downstream of the screens. The Grit separators shall be capable of removing at least 95% of particles with a specific gravity of 2.65 g/cm3 and with a diameter of at least 0.2 mm. A Parshall Flume shall be provided downstream of Grit separators. The flow measurement shall be instantaneous and capable to transmit the data automatically to SCADA

## Primary clarifiers

If proposed, the primary clarifiers with scum removal shall be designed as per CPHEEO manual.

## Aeration systems

The aeration system shall be designed to maximise oxygen transfer and to adapt to the changing oxygen demands in biological treatment systems. The aeration system shall be capable of complete and uniform mixing and suspension of mixed liquor suspended solids.

## Disinfection

Disinfection shall be provided to comply with KPIs as required by the Concession Agreement, through chlorination systems or UV disinfection or ozonation. The Concessionaire shall ensure that disinfectants used shall not exceed the limits as per the provisions of the Environment (Protection) Rules, 1986. Such excess disinfectant levels, if any, need to be neutralized before disposal to inland surface water or land for irrigation.

## Sludge Thickeners

The sludge thickeners may be either gravity thickeners or mechanical thickeners. All associated ancillaries such as all pumps and polymer dosing equipment shall be arranged. Required standby arrangement shall be provided.

## Sludge digestion

The design of the sludge digestion system shall ensure that maintenance of all equipment and components can be safely and easily accomplished from outside the digester and without draining its contents.

If anaerobic digestion is proposed, the Concessionaire shall provide gas holders and gas burners. If provided, the sludge heating system may be complete with heat exchangers, sludge re- circulation pumps, hot water pumps. The heat requirement of digesters during winter season will

be met through the heat available from bio gas engine and additional requirement to be fulfil through boiler, if required.

The Concessionaire shall ensure safety and security of operation as the result of the presence of biogas in both normal and abnormal operation.

## Dewatering system

Digested Sludge shall be dewatered to produce a cake concentration of at least 20% dry solids and the solids recovery shall not be less than 95%. The dewatering facility and associated ancillaries such as all pumps and polymer dosing equipment shall be arranged in at least two parallel streams (1 working + 1 standby), each sized to handle the average daily sludge quantities over not more than 16 hours perday.The dewatered sludge shall be disposed off .

The concessionaire shall ensure at least 38% of reduction of Volatile solids for Vector Attraction Reduction during sludge treatment. The Concessionaire shall also ensure less than 20,00,000 most probable number per gram of total dry solids (20,00,000 MPN/gTS) in sludge before disposal.

## Facilities drain sump and pump station

A drain pump station shall be provided to collect recyclables such as filtrates from thickener/dewatering units and other miscellaneous waste flows such as sewage/faecal sludge/septage generated from Facilities, cleaning and wash-down flows and pump them back up to the inlet chamber of the Facilities.

## Treated Effluent disposal pipe line

A Treated Effluent disposal pipe line shall be provided to discharge the effluent to the Discharge Point either by gravity or by pumping as per site codition.

## Co-Treatment of septage in the Proposed STP(s)/FSTP(s)

Process involved in co-treatment of septage in the STP(s)/FSTP(s) shall be as per CPHEEO Manual. The facilities shall be designed with adequate capacity to accept the septage without hampering the functioning of the STP(s)/FSTP(s). Increase in hydralic and influent characteristic due addition of septage in liquid/solid stream of STP(s)/FSTP(s) should be considered in designing of facilities.

# Facilities within STP(s)/FSTP(s)

## Energy generation

The Concessionaire shall generate heat and electrical energy from the biogas produced by the sludge digestion process. The Concessionaire shall design the energy generation system to be

capable of using the maximum biogas produced by the sludge digestion process at design loadings to produce energy. The Concessionaire shall utilize electrical power generated by the energy recovery system where possible within the Facilities.

The design and specification of the units shall take into account the contaminants that will be present in the biogas from the digesters, such as hydrogen sulphide (H2S) and ammonia (NH3), and any harmful effects resulting from their combustion. The Concessionaire shall provide a H2S gas scrubbing system, to protect the engine and maintain its design life.

## Gas holders

The gas holders shall as per CPHEEO manual. A flame arrestor and flow meter shall be provided on the gas line from each digester.

## Biogas burner

The bio gas burner (if provided) shall be designed as per CPHEEO manual and should be provided in 2 numbers (1working /1 standby) for complete destruction of all contaminants in the gas. All gas pipework and weld on flanges shall be stainless steel 316L.

## Flood protection:

The Finshed ground level (FGL) of the Facilities to be at or above the High flood level. Building plinth, top of wet wells , I&Ds ,and other structures shall be at 0.45 m above HFL.

# PART - B TECHNICAL SPECIFICATIONS

**Section G1: General requirements**

# 1.



provided by the Executing Agency as illustrative of the Specification.

All data and information furnished in the drawings by the Executing Agency is given in good faith but the Executing Agency does not accept the responsibility for the completeness and accuracy thereof. The same shall be verified by the Concessionaire promptly pointing out errors or discrepancies thereof to the Executing Agency.

# Drawing sheet format

All drawings provided by the Concessionaire shall be on standard size sheets, in the form of black or blue lines on a white background and shall show the following particulars in a title block located in the lower right hand corner, in addition to the name of Concessionaire and equipment manufacturer, date, scale, drawing number, revision number (RO for drawings submitted initially, R1, R2. etc. for drawings submitted subsequently)

A blank     stamp and provision shall be made for details of revisions to be recorded.



All drawings submitted by the Concessionaire shall use the English language and preferably SI units. All drawings shall be clearly and fully cross referenced to the other drawings as relevant.

# Operation and maintenance manuals

The operation and maintenance manuals shall be arranged to provide separate volumes for each principal section of the Works an -

necessary drawings and diagrams for a proper understanding of the works.

The operation and maintenance manual shall be approved in draft form initially prior to commencement of erection by the Executing Agency and shall cover all items of the Works. For this purpose, three draft copies shall be submitted to the Executing Agency. A mere

Clause. The operation & maintenance manual shall comprise both operating instructions and maintenance instructions.

The manuals shall include, but not be limited to the following information:

* 1. Descriptive overview of the whole of the works.
  2. Descriptions of all systems installed, including mechanical, electrical, instrumentation, control systems with relevant design and operating parameters.
  3. 

scheduled for easy reference.

* 1.     

electrical load, etc.

* 1. Schedules of all equipment suppliers (and their local agents) including names, addresses, telephone, fax and e-mail numbers.
  2. Start-up, operation and shutdown instruction for all parts of the Works. These shall include step-by-step directions on setting the Plant to work listing all adjustments and settings necessary for the current functioning of the Plant.
  3. Instructions on monitoring of Plant performance and sample log sheets for each Plant item, to be filled by operators on a routine basis.
  4. 



operations considered dangerous to operators or likely to cause damage to the Plant.

* 1. Procedures to deal with breakdown and emergencies.
  2. Safety requirements.
  3. Checking, testing and replacement procedures to be carried out on all Plant items on a daily, weekly and monthly basis or at longer intervals to ensure trouble free operation. Full maintenance instructions for all equipment including planned maintenance schedules or charts giving daily, weekly, monthly, quarterly, half yearly annually and overall instructions, together with recommended lubricants and spares. These shall also include details of routine maintenance work that will be within the competence of the normal maintenance staff and notification of maintenance work that will have to be done by the manufacturer, his agent or other specialist operator.
  4. Fault locations and remedy charts to facilitate tracing the cause of malfunctions or breakdown and correcting faults.
  5. Complete list of recommended lubricants and lubrications charts.
  6.   consist of a complete list of item wise spares for all Plant items with ordering references and part numbers.
  7.  

bought out equipment. The list shall be tabulated in alphabetical order, giving the name of supplier / manufacturer, identification of the Plant item, giving the model number and the literature provided including instruction leaflets and drawing numbers.

* 1. Step by step procedure for the dismantling, repair and re-assembly of all items of

equipment.

* 1. Part-list and drawings or exploded diagrams for each item of Plant with construction particulars, materials of construction, mating components, clearances and tolerances, maximum wear permitted before replacements are to be done, etc.
  2. Record drawings of all systems installed, including general arrangements, conduit and wiring trunking systems, wiring diagrams, control schematics and valve charts etc., to a reduced scale.
  3.   of all equipment supplied, which shall be scheduled for easy reference.
  4. Site test reports for all mechanical, electrical and instrumentation systems. Site test

.

* 1. Copies of performance curves.

Each volume shall be durable and permanently bound within a stiff binder of a design to be approved by the Executing Agency.

# Protection and Packing for Transportation

Before any Plant is dispatched



from manufact

notice that these preparations are to commence.

Prior to dispatch, the Plant shall be adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and incidental damage, including the effects of vermin, sunlight, rain, high temperatures and humid atmosphere. The Concessionaire shall be responsible for the Plant being so packed and / or protected as to ensure that it reached the Site intact and undamaged. The Plant shall be packed to withstand rough handling in transit and all packages shall be suitable for storage including possible delays in transit.

The Concessionaire shall be deemed to have included in the schedule of prices for all materials and packing cases necessary for the safe package, conveyance and delivery and storage of the Plant with all protective and preservation measures.

Cases containing rubber rings, bolts and other small items shall not normally weigh more than 50 kg, gross per case. No one package or bundle shall contain items of Plant intended for incorporation in more than one section of the Works. All items of Plant shall be clearly marked for identification against the packing list.

Eyebolts, lifting hooks and brackets shall be provided for lifting the boxes, crates and packages. Every crate or package shall contain a packing list in a waterproof envelope. A duplicate copy of

the packing list shall be sent by post to the Executing Agency at site. Consignments imported by ocean freight shall be packed and preserved as stipulated above.

All crates, packages, etc. shall be clearly marked with a waterproof material to show the weight and where the slings should be attached, and shall also have an indelible identification mark relating them to the packing lists. Packing cases shall be non-returnable. Concessionaire shall have to clear the site including packing material.

Electrical equipment shall be enclosed in sealed airtight package with hygroscopic material, before being placed in packing cases on shock absorbent materials and secured by means of battens.

# Delivery, Unloading and Storing at Site

The Concessionaire shall be responsible for checking all materials delivered to site and shall keep



Concessionaire shall carry out, at his cost, all instructions of Executing Agency for proper unloading, preservation, maintenance, storage and security of materials delivered to site until he fulfills all his obligations under the Contract.

The Concessionaire shall erect and maintain on the site any temporary storage facility as required and approved by the Executing Agency. If built up shed or area is provided by the Executing Agency depending upon availability, the Concessionaire shall have to pay rent as finalised by the Executing Agency.

Multiple handling and movement of materials during storage and retrieval shall be avoided.

# Spare Parts

Spares during pre-commissioning trials, commissioning tests / maintenance, guarantee etc. shall be provided by the Concessionaire. The spares also include the consumables such as bulbs, fuses, wires, lubricating oil, gaskets, packing seals etc. The necessary spares shall be brought by the Concessionaire prior to the pre-commissioning test so as to avoid the downtime of equipment due to non-availability of them. All the spares have to be provided as required, by Concessionaire free of cost.

All spare parts shall be new, unused and strictly interchangeable with the parts for which they are intended to be replacements and shall be treated and packed for long storage under the climatic conditions prevailing at the site. Each spare part shall be clearly marked or labelled on the outside of its packing with its description, number and purpose. When more than one spare is packed in a single case or other container, a general description of its contents shall be shown on the outside of such case or container and a detailed list enclosed. All cases, containers and other packages shall be marked and numbered in an approved manner for the purpose of identification. Spares shall be delivered to site after the completion of erection but before start of commissioning of Plant along with technical leaflets and details. Spare parts shall be indicated in the assembly drawing showing clearly the part numbers.

All cases, containers or other packages are liable to be opened for such examination as the Executing Agency may require and packing shall be designed to facilitate opening and thereafter repacking. In the event of the some specific spares offered in the Contract being withdrawn from manufacture owing to changes in design of equipment or similar reasons viz., model being obsolete etc., the Concessionaire shall inform the Executing Agency before such withdrawal, so that the Executing Agency can take timely alternative steps.

# Tools

Tools shall be delivered to site just prior to Tests on Completion.

The specified tools shall not be used for the erection of the Plant being supplied and except that the Executing Agency may call upon the Concessionaire to demonstrate their use or effectiveness, they must be handed over to the Employer in a completely new and unused condition. Should the Concessionaire require any such tools at site for erection, he shall provide his own.

The test equipment shall include special purpose items essential to the testing or recalibration of related items of Facilities.

# Works to be kept clear of water

The Concessionaire shall keep the Works well drained until the Executing Agency certifies that the whole of the Works is substantially complete and shall ensure that so far as is practicable, work is carried out in the dry condition. Excavated areas shall be kept well drained and free from standing water.



for the exclusion of water, the Concessionaire shall be responsible for the sufficiency thereof and for keeping the Works safe at all times, particularly during any floods and for making good at his own expense any damage to the Works, including any that may be attributable to floods. Any loss of production or additional costs of any kind that may result from floods shall be at the



# 9.

The Concessionaire shall provide all necessary assistance to the Executing Agency and his staff in carrying out their duties of checking the setting out, inspecting and measuring the Works. The Concessionaire shall provide staff men, office attendants and labourers, as may be needed, from time to time by the Executing Agency.

The Concessionaire shall provide for the Executing Agency and his staff such protective clothing, safety helmets and rubber boots of suitable sizes, hand lamps and the like, as may reasonably be required by them. These articles shall remain the property of the Concessionaire. No separate payment shall be made on this account.

# Section G2 Materials and workmanship

**Section G2: Materials and Workmanship**

# Introduction

This part of the Specification sets out the general standards of materials to be supplied and the workmanship required to be ensured by the Concessionaire. All components parts of the Works shall, unless otherwise specified, comply with the provisions of this part or be subject to the approval of the Executing Agency. Particular attention shall be paid to a neat orderly well- arranged installation carried out in a methodical competent manner.

# Reference Specifications and Standards

Where reference is made in the Specification to a British Standard Specification (hereinafter abbreviated to 'B.S') issued by the British Standards Institution of 2, Park street, London W.I., or to an Indian Standard Specification (I.S.) issued by the Bureau of Indian Standards, (earlier known as Indian Standard Institution), Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002 or American Society for testing and materials (ASTM) issued by ASTM 1916 Race Street, Philadelphia, P.A., 19103, U.S.A. or American National Standards Institute (ANSI) issued by ANSI 1430, Broadway, New York, N.Y., 10018, U.S.A. or Japanese Industrial Standards (JIS) issued by Japanese Standards Association, 4-1-24, Akasaka, Minato-Ku, Tokyo 107, Japan or to any other equivalent Standard it shall be to the latest revision of that Standard at the Tender opening date.

The Concessionaire may propose at no extra cost to the Executing Agency, the use of any relevant authoritative internationally recognised Reference Standard, including Indian Standard (IS).

All details, materials and equipment supplied and workmanship performed shall comply with these Standards. If Concessionaire offers equipment to other Standards, the equipment/material should be equal or superior to those specified and full details of the difference shall be supplied.

In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decision of Project Engineer in such case shall be final and binding on the Concessionaire.Certain specifications issued by national or other widely recognised bodies are referred to in this Specification. Such specifications shall be defined and referred to hereinafter as Standard Specification. In referring to the Standard Specifications the following abbreviations are used:

IS : Indian Standard

ANSI : American National Standards Institute

API : American Petroleum Institute

ASME : American Society of Mechanical Engineers

ASTM : American Society of Testing and Materials

AWS : American Welding Society

AWWA : American Water Works Association

ISO : International Organisation for Standardisation

JIS : Japanese Industrial Standard

DIN : Deutsches Institute for Normung

BS : British Standards

JWWA : Japanese Water Works Association

IEC : International Electro technical Commission

IEE : Institution of Electrical Engineers

IEEE : Institution of Electrical and Electronic Engineers

NEMA : National Electrical Manufacturer's Association

AGMA : American Gear Manufacturer's Association

# Materials - General

All materials incorporated in the Works shall be the most suitable for the duty concerned and shall be new and of reputed make/approved quality, free from imperfections and selected for long life and minimum maintenance. Non-destructive tests, if called for in the Specification, shall be carried out. All submerged moving parts of the Plant, or shafts and spindles, etc. of the submerged moving parts or the faces etc. in contact with them shall be of corrosion resistant materials. All parts in direct contact with various chemicals, shall be completely resistant to corrosion, or abrasion by these chemicals, and shall maintain their properties without ageing due to the passage of time, exposure to light or any other cause.

# Workmanship - General

Workmanship and general finish shall be of first class quality and in accordance with best workshop practice.

All similar items of the Plant and their component parts shall be interchangeable. Spare parts shall be manufactured from the same materials as the originals and shall fit all similar items. Machining fits on renewable parts shall be accurate and to specified tolerances so that replacements can be readily installed. All equipment shall operate without excessive vibration and with minimum noise. All revolving parts shall be truly balanced both statically and dynamically so that when running at normal speeds at any load upto the maximum there shall be no vibration due to lack of balance.

All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings. All materials incorporated in the Works shall be the most suitable for the duty concerned, free from imperfections and selected for long life and minimum maintenance. All necessary accessories required for satisfactory and safe operation of the Plant shall be supplied by the Concessionaire unless it is specifically excluded from his scope. Suitable provision by means of eyebolts or other means are to be provided to facilitate handling of all items that are too heavy or bulky for lifting and carrying by two men.

If, after installation, the operation or use of the materials or equipment furnished by the Concessionaire proves to be unsatisfactory, the Executing Agency shall have the right to operate or use such materials or equipment until correction of defects, errors or omissions, by repair or by partial or complete replacement, can be made without interfering with the Plant operations.

# Welding

Welding shall comply with the latest revision of the BS 5135 Code.

Welders shall be qualified in accordance with the requirement of the appropriate section of BS 4871. The Executing Agency shall have the right to call for further qualifications from time to time from any welder who in the opinion of the Engineer does not produce weld in accordance with the qualifications. Each welder shall be assigned a number and letter. Each weldments shall clearly be identified as to its welder marking the welder's Code adjacent to the welds. A record chart shall be maintained for each welder showing the procedures for which he has qualified, the date of such qualification, the type of defects produced and their frequency. The Executing Agency shall disqualify the welder whose Work requires disproportionate repairs.

Inspection and quality of surveillance shall not be limited to the examination of finished welds. The techniques employed shall be based on methods which are known to produce good results and which have been verified at Site by actual demonstration.

Haphazard striking of the electrodes for establishing an arc shall not be permitted. The arc shall be struck either on the joint or on a starting tag, The starting tag shall be of the same material or a material compatible with the base metal base being welded. In case of any inadvertent strike on place other than the welding, the area affected shall be ground flushed and examined by liquid penetration method.

Generally, a stringer bead technique shall be used with a slight oscillation if necessary to avoid slag and to minimise the number of beads needed to fill exceed 3 times the wire diameter. Vertical welds shall be made in upward direction. For all pipes above 300 mm dia, welding shall be done wherever possible, by two (2) welders working simultaneously along both sides of the pipe.

The root pass shall have less than 1.5 mm internal reinforcement.

Final welds shall be suitable for appropriate fabrication of the non-destructive examination of the weld. If grinding is necessary, the weld shall be blended into the parent metal without gouging or thinning of the parent metal in any way. Uneven and excessive grinding may be a cause for rejection. Fillet weld shall preferably be convex and free from undercutting and overlap at the toe of weld. Convexity and concavity shall not exceed 1.5 mm. The leg lengths shall not exceed the specified size by more than 1.5 mm.

All attachments such as lugs, brackets and other non-pressure parts shall also be done by qualified welders in accordance with the design details and materials specifications. Temporary attachments shall be removed in a manner that will not damage the parent metal. Area of temporary attachments shall be dressed smooth and examined by ultrasonic or liquid penetration methods.

All tack welds shall be made using qualified procedure and welders, the number of size of tack

welds shall be kept as small as to consist of adequate strength and joint alignments. All tack welds shall be examined visually for defects and if found defective shall be completely removed. As welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their starting ends so that they may be satisfactorily incorporated in the welds. Unacceptable defects shall be removed by grinding machine or chipping or gouging. Flame gouging may be permitted provided gouged surfaces are ground at least by 1.0 mm below the deepest indentation.

All weld repairs shall be carried out using the approved welding procedures and welders. Re- welded areas shall be re-examined by the methods specified for the original welds and repair procedures shall be duly qualified by the Executing Agency's Representative.

# Pre-heating and Post-heating Treatment

Pre-heating and post heating treatment shall conform to the relevant application Codes. Pre- heating not exceeding 121 deg. C for all carbon steel construction above 25 mm thickness would be mandatory. Such pre-heating would be maintained during flame cutting, flame or arc gouging, welding and repairs and may be done by gas heating by gas torches/gas rings with neutral flame. The temperature shall be checked by temperature indicating crayons. However, such pre-heating will not be necessary for welds less than 6 mm size.

# Electrodes

All electrodes shall be stored in their original sealed containers under dry conditions. Electrodes shall remain identified until consumed. All electrodes shall be dried before use. Drying ovens shall be provided in Work areas for drying purposes. Electrodes withdrawn from oven shall be promptly used and excess unused electrodes shall be promptly returned to oven.

# Examination / NDT / Radiography

The various stages of examination and types shall be as stipulated in the respective fabrication Codes subject to the Executing Agency's approval.

# Stainless Steel welding

All welding consumable such as electrodes, filler weirs, argon gas for shielding and purging shall be of high quality and the proposed brand shall be furnished for approval of the Executing Agency. Weld deposits shall have similar or higher physical properties and similar chemical composition to the members joined.

All electrodes shall be purchased in sealed containers only and stored in their packing intact. The packets opened shall be consumed as early as possible. The electrodes removed from the containers shall be kept in holding ovens at temperatures recommended by electrode manufacturer. Special care shall be taken in avoiding mixing of electrodes in the oven. The electrodes and filling wires shall be free from rust, oil, grease, earth and other foreign matter.

Argon gas with purity 99.5% shall be used for shielding and purging. The purity of gas shall be certified by the gas manufacturers.

Non-destructive examination of the welds shall be carried out to ensure quality of weld.

The electric current for welding shall be direct current, straight polarity (electrode negative). The welding current shall be kept minimum possible to ensure minimum heat affected zone in the parent material. Other side of the weld joint shall be periodically flushed with argon gas.

# Castings

Cast iron shall be of standard grey close-grained quality. The structure of the castings shall be homogeneous and free from non-metallic inclusions and other injurious defects. All surfaces of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Minor defects in depth not exceeding 12.5 percent of total metal thickness and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Executing Agency shall be notified of large defects and no repair welding of such defects shall be carried out without prior approval of the Executing Agency. If the removal of metal for repair should reduce the stress resisting cross section of the casting by more than 25 percent, or to such extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25 percent, then casting shall be rejected. Test coupons cast simultaneously with the main castings shall be identified to check physical, chemical analysis of casting. Major defects on casting are not acceptable. Castings repaired by welding for minor defects shall be stress-relieved after such welding. Non-destructive tests as directed by the Executing Agency will be required for any casting containing defects whose extent cannot otherwise be judged, or to determine where repair welds have been properly made.

# Forging

All major stress-bearing forging shall be made to a Standard Specification. Forging shall be subjected to magnetic particle testing or dye penetration test at the areas of fillets and change in section. The testing shall be conducted after rough machining (10 microns). Any defect which will not machine out during the final machining, will be gouged out fully, inspected by dye penetration or magnetic particle inspection to ensure that the defect is fully removed and repaired using an approved repair procedure. Any indication, which proves to penetrate deeper than 2.5% of the finished thickness of the component, shall be reported to the Executing Agency giving the details like location, length, width and depth. For the magnetic particle inspection, the choice of wet or dry particles shall be at the Concessionaire's discretion.

All forging shall be demagnetised after test and shall be heat treated for the relief of residual stresses.

# Design life

The Works as a whole shall be new, of sound workmanship, robustly designed for a long reliable

operating life and shall be capable of 24 hours per day continuous operation for prolonged period in the climatic and working conditions prevailing at the Site, and with the minimum of maintenance. Particular attention shall be given to temperature changes, the stability of paint finish for high temperatures, the rating of engines, electrical machinery, thermal overload services, cooling systems and the choice of lubricants for possible high and prolonged operating temperatures. The Concessionaire shall be called upon to demonstrate this for any component part either by service records, or evidence of similar equipment already installed elsewhere or relevant type tests. Routine maintenance and repair shall as far as possible not require the services of highly skilled personnel. All equipment covered by this specification shall be designed to provide a minimum design service life of 20 years.

The plant shall be designed to provide easy access to and replacement of components parts, which are subject to wear, without the need to replace whole units. No parts in contact with water shall have a life from new to replacement or repair of less than five years. Where major dismantling is unavoidable to replace a part, the life of such part shall not be less than ten years.

Design features shall include the protection of Plant against damage caused by vermin, dirt, dust and dampness and to reduce risk of fire. Plant shall operate without undue vibration, and parts shall be designed to withstand the maximum stresses under the most severe condition of normal service. Materials shall have a high resistance to change in their properties due to the passage of time, exposure to light, temperature and any other cause, which may have a detrimental effect upon the performance of life of the Works.

Plant located outside lockable areas/building shall have additional features to prevent unauthorised operation.

# Lubrication

A complete schedule of recommended oils and other lubricants shall be furnished by the Concessionaire. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Executing Agency.

Concessionaire shall indicate indigenously available equivalent lubricants, with complete specification, to enable the Executing Agency to arrange for regular supply.

Where lubrication is effected by means of grease, preference shall be given to a pressure system, which does not require frequent adjustment or recharging. Frequent, for this purpose, means more than once in a month and grease systems having shorter periods between greasing should be avoided. Where necessary for accessibility grease nipples shall be placed at the end of the extension piping, and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. All grease nipples shall be of the same size and type for every part of the Plant. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

Where more than one special grease is required, a grease gun for each special type shall be

supplied and permanently labelled.

Oil containers shall be supplied complete with oil level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all temperatures likely to be experienced in service. The levels shall be clearly visible in the sight glass type from the normal access floor to the particular item of Plant and they shall be easily dismantled for cleaning. All sight glasses shall be firmly held and enclosed in metal protection in such manner that they cannot be accidentally dislodged.

All lubrication systems shall be designed so as not to cause a fire or pollution hazard and particular care shall be taken to prevent leakage of lubricants and to avoid leaking lubricants coming into contact with any electrical equipment, heated surfaces or any other potential source of fire.

# Name Plate

Each item of the Plant shall have permanently attached to it in a conspicuous position, a nameplate and rating plate. Upon these shall be engraved or stamped, the manufacturer's name, type and serial number of Plant, details of the loading any duty at which the item of Plant has been designed to operate, and such diagrams as may be required by the Executing Agency. All indicating and operating devices shall have securely attached to them or marked upon them designations as to their function and proper manner of use.

Nameplates, rating plates and labels shall be of a no flame propagating materials, either non- hygroscopic or transparent plastic with engraved lettering of a contrasting colour. Fixing shall be by means of non-corrosive screws; drive rivets or adhesives shall not be used.

Warning labels shall be provided where necessary to warn of dangerous circumstances or substances. Inscriptions or graphic symbols shall be black on a yellow background.

Instruction labels shall be provided where safety procedures such as wearing of protective clothing are essential to protect personnel from hazardous or potentially hazardous conditions. These labels shall have inscriptions or graphic symbols in white on a blue background.

# Nuts, Bolts, Studs and Washers

Nuts, bolts, studs and washers for incorporation in the Plant shall conform to the requirements of the appropriate standard. Nuts and bolts shall be of the best quality of specified grade, machined on the shank and under the head and nut. Bolts shall be of one piece construction and shall be of sufficient length so that only one thread shall show through the nut in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at Site.

Washers, locking devices & anti-vibration arrangements shall be provided where necessary.

Jointing hardware for the entire Plant shall be provided with sufficient spares to cater for site losses.

Where bolts pass through structural members taper washers shall be fitted, where necessary, to ensure that no bending stress is caused in the bolt. Where there is a risk of corrosion, bolts, nuts and studs shall be designed so that the maximum stress does not exceed half the yield stress of the material under any conditions. All bolts, nuts and washers which are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

The Concessionaire shall supply all holding down, alignment and levelling bolts complete with

bedplates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

# Allowance for Wastage

The Concessionaire shall supply reasonable excess quantities to cover wastages of those consumable, which will be normally subject to waste during erection, commissioning and setting to Work.

# Painting - General

The Concessionaire shall be responsible for the cleaning, preparation for painting and priming or otherwise protecting, as specified, all parts of the plant at the place of manufacture prior to packing.

Parts may be cleaned but surface defects may not be filled in before testing at the manufacturer's works. Parts subject to hydraulic test shall be tested before any surface treatment. After test, all surfaces shall be thoroughly cleaned and dried out, if necessary by washing with an approved dewatering fluid prior to surface treatment. Except where the specification provides to the contrary all painting materials shall be applied in strict accordance with the paint manufacturer's instructions.

All protective coatings shall be suitable for use in warm humid climates. All primers, under coats and finishes shall be applied by brush or airless spray, except where otherwise specified. Consecutive coats shall be in distinct but appropriate shades. All paints shall be supplied from the store to the painters, ready for application, and addition of thinners or any other material shall be prohibited.

# Painting at Place of Manufacture

Steel and cast iron parts shall be sand blasted to near white cleaning before painting. Edges, sharp curves etc. shall be ground to a curve before sand blasting. A primer coat of zinc rich epoxy resin- based coating with atleast a 50 microns dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats coal tar epoxy polyamine coating to dry the

thickness of 150 microns including primer coating.

# Painting at Site

Immediately on arrival at the site, all items of plant shall be examined for damage to the paint coat applied at the manufacturer's works, and any damaged portions shall be cleaned down to the bare metal, all rust removed and the paint coat made good with similar paint.

Before final painting is commenced, the Concessionaire shall submit for the approval of Executing Agency's Representative, full details of the paints he proposes to use together with colour charts for the gloss finishes. After erection, such items, which are not finish painted, shall be done so and, items that have been finish painted at the manufacturer's works shall be touched up for any damaged paintwork.

The dry paint film thickness shall be measured by Electrometer or other instruments approved by the Executing Agency. In order to obtain the dry film thickness specified, the Concessionaires shall ensure that the coverage rate given by the paint manufacturer will enable the thickness to be obtained. Painted fabricated steel work which is to be stored prior to erection shall be kept clear of the ground and shall be laid out or stacked in an orderly manner that will ensure that no water or dirt can accumulate on the surface. Suitable packagings shall be laid between the stacked materials. Where cover is provided, it shall be ventilated.

# Noise and Vibration

The Concessionaire shall provide a quiet installation. All items of Plant and equipment shall be carefully chosen with a view to minimising sound levels.

The Concessionaire shall provide and fix all material for the prevention of transmission of noise and vibration through the structure. Where appropriate Plant shall be mounted on resilient mountings in such a manner that the Plant foundations are isolated from the floor or structure. In addition, all rotating Plant shall be statically and dynamically balanced. Mechanical vibration shall be eliminated by the use of anti-vibration mountings and flexible connections to ensure an isolation efficiency of 95% from the building structure.

# Galvanising

Wherever galvanising has been specified, the hot dip process shall be used. The galvanised coating shall be of uniform thickness. Weight of zinc coatings for various applications shall not be less than those indicated below:

* 1. Fabricated steel Thickness less than 2 mm

but not less than 1.2 mm 340 gms/sq.m

Thickness 2 mm and above 460 gms/sq.m

* 1. Fasteners

Up to nominal size M10 270 gms/sq.m

Over M10 300 gms/sq.m

Galvanising shall be carried out after all drilling, punching, cutting, bending and welding operations have been carried out. Burrs shall be removed before galvanizing. Any site modification of galvanised parts should be covered well by zinc rich primer and aluminium paint.

# Support for pipework & Valves

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work. Valve and other facilities mounted in the pipe work shall be supported independent of the pipes to which they connect.

# Section G3 General Civil Specifications

**Section G3: General civil specifications**

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| --- | --- | --- |
| **Sl. No.** | **Sub-Section** | **Title** |
| 1. | C1 | Earthwork in grading, excavation and backfilling |
| 2. | C2 | Technical specifications for properties, storage and handling of common  building materials. |
| 3. | C3 | Technical specifications for Cast-in-situ concrete & allied works |
| 4. | C4 | Technical specifications for masonry & allied works |
| 5. | C5 | Technical specifications for plastering & allied works |
| 6. | C6 | Technical specifications for flooring and other allied works |
| 7. | C7 | Technical specifications for roof water proofing insulation and allied  works |
| 8. | C8 | Technical specifications for painting, white washing etc. |
| 9. | C9 | Technical specifications for fabrication and erection of structural steel  works |
|  |  | Annexure B - Inspection, testing and quality checklist along with  addendum. |
| 10. | C10 | Technical specifications for Glass and Glazing |
| 11. | C11 | Technical specifications for MS doors, windows, ventilators and louvers |
| 12. | C12 | Technical specifications for rolling steel shutters / grills |
| 13. | WS1 | Technical specifications for laying of pipes and fittings / specials |
| 14. | WS2 | Technical specifications for laying and jointing of cast iron pipes and  fittings (Cast iron). |

# Sub-section - C1

**Technical specification for excavation and backfilling**

**Sub Section - C1**

**Technical specification for excavation and backfilling**

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**Sub Section - C1: Technical specification for excavation and backfilling**

* 1. **Scope**

This section of the specification covers the technical requirements for excavation and filling for industrial plots in & around structures, buildings, pipes, foundations, trenches, pits, drains, channels, cable ducts, underground facilities & similar works. It also covers filling areas and plinths with selected materials, conveyance and disposal of surplus soils and/or stacking them properly as directed by the Project Engineer and Executing Agency.

The Concessionaire shall be fully responsible for proper setting out of works, profiling in excavation, stacking, etc., taking adequate safety measures etc. The Concessionaire shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein. All work shall be executed to the satisfaction of the Project Engineer and Executing Agency.

Existing trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, drains, sewers, or other surface or subsurface systems/drains/facilities within or adjacent to the works being carried out which are not to be disturbed, shall be protected from damage by the Concessionaire shall provide and install suitable safeguards approved by the Project Engineer and Executing Agency for this purpose.

During excavation, the Concessionaire shall take all necessary precautions against soil erosion, water & environmental pollution and where required to undertake additional works to achieve this objective. Before start of operations, the Concessionaire shall submit to the Project Engineer and Executing Agency for approval, his work plan and the procedure he intends to follow for disposal of waste materials etc. and the schedule for carrying out temporary and permanent control works. However, the approval of the Project Engineer and Executing Agency to such plans and procedures shall not absolve the Concessionaire of his responsibility for safe and sound work.

# General requirements

The Concessionaire shall make his own surveying arrangements for locating the coordinates and

reference grid lines and one benchmark, which will be furnished by the Executing Agency. The Concessionaire has to provide at site all the required survey instruments, along with qualified surveyors, to the satisfaction of the Project Engineer and Executing Agency so that the work can be carried out accurately and according to the specification and drawings.

The Concessionaire shall furnish all skilled and unskilled labour, plant, tools, tackle, equipment, men, materials required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Project Engineer and Executing Agency.

The Concessionaire shall control the grade in the vicinity of all excavations so that the surface of the ground will be properly sloped or dyed to prevent surface water from running into the excavated areas during construction.

All materials obtained from excavation s



materials of archeological importance or of value (in the opinion of the Project Engineer and Executing Agency) shall be segregated from the other materials and both stacked separately and in regular manner at locations indicated by the Project Engineer and Executing Agency.

Excavation shall include removal of trees including roots & organic remains, vegetation, grass, bushes, shrubs, plants, poles, fences, etc. that are in the area to be excavated as well as beyond the excavation line so as to ensure safety of the excavated side slopes, and of men and equipment operating in the area. Before start of excavation work, joint measurements of ground level shall be taken after cleaning all grass, vegetation, etc.

Excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance as decided by the Project Engineer and Executing Agency to permit the placing and setting of forms, inspection and completion of all works to the satisfaction of the Project Engineer and Executing Agency for which the excavation was done.



approved drawings.

# Codes and standards

All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of conflict between this specification and those (IS standards, codes etc.) referred to herein (in para 3.3) the former shall prevail.

Some of the relevant Indian standards, Acts and Codes are referred to here below: IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.

IS:2720 - (Part - II, IV to VIII, Methods of tests for soils - determination of water XIV, XXI,

XXIII, XXIV content etc. XXVII to XXIX, XL) IS:3764 - Safety code for excavation work

IS:4081 - Safety code for blasting and related drilling operations IS:4701 - Code of Practice for earth work on canals

IS:9759 - Guide lines for Dewatering during construction.

IS:10379 - Code of practice for field control of moisture and compaction of soils for embankment and sub-grade.

IS:3812 - Pulverized fuel ash - specification part 2 for use as admixture in cement mortar and concrete

# Excavation

Excavation in all types of soils, soft and disintegrated rock (ordinary rock), and hard rock shall be done up to the required level. Excavation shall also include breaking of existing concrete RCC,

Masonry work, tar and bitumen surfaces, and paving works etc. In case blasting is required, the same shall be subject to the approval of Project Engineer and Executing Agency. Sides and bottoms of excavation shall be cut sharp and true to line and level. Undercutting shall not be permitted. When machines are used for excavation, the last 300 mm before reaching the required level shall be excavated manually or by such equipment that soil at the required final level will be left in its natural condition. Suitability of strata (at the bottom of excavations) for laying the foundation thereon shall be determined by the Project Engineer and Executing Agency.

Excavation for foundations shall be to the bottom of lean concrete and as shown on drawings or as directed by the Project Engineer and Executing Agency. The bottom of all excavations shall be trimmed to required levels and when excavation is carried below such levels, by error, it shall be brought back to specified level by filling with concrete of nominal mix 1:3:6/1:4:8 (cement & Fly ash (20% replacement ratio of cement with fly ash): coarse sand : 20 mm down aggregates) as directed by the Project Engineer and Executing Agency.

The Concessionaire shall ascertain for himself the nature of materials to be excavated and the difficulties, if any, likely to be encountered in executing this work. Cofferdams, Sheeting, shoring, bracing, maintaining suitable slopes, draining etc. shall be provided and installed by the Concessionaire, to the satisfaction of the Project Engineer and Executing Agency.

All excavation for installation of underground facilities, such as piping, sewer lines, drain lines, etc. shall be open cuts. For deep and huge excavations and in other excavations, if required by the Project Engineer and Executing Agency, the Concessionaire shall submit for Project Engineer

order to maintain the stability of side slopes, means for ensuring safety of existing facilities nearby, dewatering as required etc. However, the Concessionaire shall be fully responsible for the scheme irrespective of any approvals granted. Benching shall be provided for deeper excavation wherever required.

When excavation requires bracing, sheeting or shoring etc., the Concessionaire shall submit drawings to the Project Engineer and Executing Agency, showing arrangements and details of proposed installation. The Concessionaire shall also furnish all supporting calculations as called for and shall not proceed until he has received written approval from the Project Engineer and Executing Agency. However, the responsibility for adequacy of such bracing, sheeting, shoring etc. will rest with the Concessionaire, irrespective of any approval of the Project Engineer and Executing Agency. All precautions shall be taken while excavations near existing structures are to be carried out till the backfilling is completed.

The Concessionaire shall have to constantly pump out any water collected in excavated pits and other areas due to rain water, ground water, springs etc. and maintain dry working conditions at all times until the excavation, placement of reinforcement, shuttering, concreting, backfilling is completed. The Concessionaire shall remove all slush/muck from the excavated areas to keep the work area dry. Sludge pumps, if required, shall be employed by the Concessionaire for this purpose.

The Concessionaire shall remove all materials arising from excavations from the vicinity of the

work either for direct filling, stacking and subsequent filling or for ultimate disposal as directed by the Project Engineer and Executing Agency. In no case shall the excavated soil be stacked within a distance of 1.5m from the edge of excavation or one third the depth of excavation whichever is more. Material to be used for filling shall be kept separately as directed by the Project Engineer and Executing Agency.

# Filling

* + 1. **Materials**
       1. Materials to be used for filling purposes shall be stone, sand or other inorganic materials and they shall be clean and free from shingle, salts, organic, large roots and excessive amount of sod. Lumps concrete or any other foreign substances which could harm or impair the strength of the substructure in any manner. All clods shall be suitably broken to small pieces. When the material is mostly rock boulders, these shall be broken into pieces not larger than 150 mm size. Sand used for filling shall be clean, medium grained and free from impurities. Fines less than 5 microns shall not be more than 20%. In any case, the materials to be used for filling purposes shall have the prior written approval of the Project Engineer and Executing Agency.
       2. If excavated materials are to be used for filling, then the Concessionaire shall select the materials from the stockpile, load and transport this material and execute the filling. This shall include excavation of earth which may become hard due to laying in stack yard for a long period of time.
       3. In case the materials have to be brought from pits/quarries, then it shall be the

for their use from concerned authorities, excavation/quarrying, loading and carriage of such material, unloading and filling at specified locations. The Concessionaire shall pay any fees, royalties etc. that may have to be paid for utilization of borrow areas.

# Filling procedure

* + - 1. After completion of foundation, footings, walls and other construction below the elevation of the final grades, and prior to filling, all temporary shoring, timber, etc. shall be sequentially removed and the excavation cleaned of all trash, debris and perishable materials. Filling shall begin only with the written approval of the Project Engineer and Executing Agency. Also, areas identified for filling shall be cleared of all soft pockets, vegetation, bushes, slush etc. In case of plinth and similar filling the ground shall be dressed and consolidated by ramming and light rolling.
      2. Fill materials shall not be dropped directly upon or against any structure or facility where there is danger of displacement or damage. Filling shall be started after the concrete / masonry has fully set and shall be carried out in such manner so as not to cause any undue lateral thrust on any part of the structure.
      3. All space between foundation (concrete or masonry) and the sides of excavation shall be filled to the original surface after making allowance for settlement. Fill shall be placed in horizontal layers not exceeding 200 mm loose thickness. Each layer shall be watered and compacted with proper moisture content and with such equipment as may be required to obtain a compaction/density as specified. Trucks or heavy equipment for depositing or compacting fill shall not be used within 1.5 metres of building walls, piers or other facilities which may be damaged by their weight or operations. The methods of compaction shall be subject to the approval of the Project Engineer and Executing Agency. Pushing of earth for filling shall not be adopted under any circumstances.
      4. Fill adjacent to pipes shall be free of stones, concrete, etc. and shall be hand placed and compacted uniformly on both sides of the pipe and where practicable up to a minimum depth of 300 mm over the top of pipes. While tamping around the pipes, care should be taken to avoid unequal pressure.
      5. Filling shall be accurately finished to line, slope, cross section and grade as shown on the drawings. Finished surface shall be free of irregularities and depressions and shall be within 20 mm of the specified level.
      6. Where filling with stone from excavated materials is required, as per design and functional requirements, it shall be from broken pieces of boulders. At first a 75mm thick cushion of selected earth shall be laid over which the 200 mm thick graded stones shall be laid in loose layers of 200 mm and then the interstices filled with properly graded fine materials consisting of selected earth brought from borrow areas. Each layer shall be watered and compacted to the required density as per design and functional requirements before the next layer is laid. However, no cushion shall be required where filling is over non-rocky surface.
      7. Where clean stone fill is required as per design and functional requirements it shall consist of clean selected stone metal of 40 mm nominal size. It shall be laid in layers not exceeding 150 mm (loose) and lightly tamped before the next layer is laid. No compaction shall be required for this type of stone filling.

# Compaction

* + - 1. Where compaction of 90% Standard Proctor Density is called for, such compaction shall be by mechanical means but the Concessionaire may be permitted to adopt manual means only

if the Project Engineer and Executing Agency finds that the desired compaction is achievable in the field.

* + - 1. Where compaction to 95% Standard Proctor Density is called for, it shall be by mechanical means only. Where access is possible, compaction shall be 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled and directed by the Project Engineer and Executing Agency. A smaller weight roller may be permitted by the Project Engineer and Executing Agency in special cases, but in any case not less than 10 passes of the roller will be accepted for each layer. Each layer shall be wetted or the material dried by aeration to a moisture content of 3-5% above the Optimum Moisture Content to be determined by Concessionaire. Each layer shall be watered, rammed and compacted to the density as specified in the Schedule of Quantities.
      2. For compacting each sand layer, water shall be sprayed over it to flood it and it shall be kept flooded for 24 hours to ensure maximum compaction. Vibro-compactors shall also be used if necessary to obtain the required degree of compaction. Any temporary works required to contain sand under flooded condition shall also be undertaken. The surface of the consolidated sand shall be dressed to required levels or slope.
      3. After the compacted fill has reached the desired level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement, at a later date. The compacted surface shall be properly shaped, trimmed and consolidated to an even gradient or level. All soft spots shall be excavated, filled and consolidated.
      4. The degree of compaction of compacted fill in place will be subject to tests in accordance with relevant Indian Standards as desired by the Project Engineer and Executing Agency. As the work progress, the Concessionaire shall provide the necessary facilities to make such tests. If any test indicates that the compaction achieved is less than the required as per design and functional requirements degree of compaction, the Project Engineer and Executing Agency may require all fill placed subsequent to the last successfully test to be removed and re-compacted by the Concessionaire. Compaction procedure shall be amended as necessary to obtain satisfactory results.
      5. When semi-compacted fill is required as per design and functional requirements by the Project Engineer and Executing Agency, the Concessionaire shall fill up such areas with available earth from stockpiles or borrow pits or directly from excavation without special compaction except that obtained by moving trucks, etc.

# Sampling testing and quality control

* + 1. **General**
       1. The Concessionaire shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Project Engineer and Executing Agency. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Project Engineer and Executing Agency. Tests shall be done in the field and at a laboratory approved by the Project Engineer and Executing Agency and the Concessionaire shall submit to the Project Engineer and Executing Agency, the test results in triplicate within three days after completion of a test. The Project Engineer and Executing Agency may, at his discretion, waive some of the stipulations given below, for small and unimportant operations.
       2. Work found unsuitable for acceptance shall be removed and replaced by the Concessionaire. The work shall be redone as per specification requirement and to the satisfaction of the Project Engineer and Executing Agency.
       3. Only as a very special case and that too in non-critical areas, the Project Engineer and Executing Agency may accept filling work which is marginally unacceptable as per the criteria laid down. For such accepted work, payment shall be made at a reduced rate prorate to the compaction obtained against that stipulated.

# Quality assurance programme

The Concessionaire shall submit and finalize a detailed field Quality Assurance Programme of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus / equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. On finalized field quality plan, the Executing Agency shall identify customer hold prints beyond which work shall not proceed without written approval from the Project Engineer and Executing Agency. Frequency of sampling and testing including the methods for conducting the tests are given in Table - 1. The testing frequencies set forth are the desirable minimum and the Project Engineer and Executing Agency shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

# Acceptance criteria

Following acceptance criteria shall be followed.

* + - 1. All individual samples collected and tested should pass without any deviation when only one set of sample is tested.
      2. For re-test of any sample two additional samples shall be collected and tested, and both should pass without any deviation.
      3. Where a large number of samples are tested for a particular test than 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.
      4. Tolerance on finished levels for important filling areas at approved intervals shall be + 20 mm. However, for an unimportant area, tolerance upto + 57 mm shall be acceptable at the discretion of the Project Engineer and Executing Agency. However, these tolerances shall be applicable for localized areas only.

# Table 1: Frequency of sampling and testing

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Nature of test/**  **characteristics** | | | **Methods of test** | **No. of samples &**  **frequency of test** | | **Remarks** |
| I. | **Suitability**  **materials** | **of** | **fill** |  |  | |  |
| (a) | Grain size analysis | | | IS:2720 (Part-IV) | One in every 2000 Cum. for each type and each source of fill material  subject to a minimum of | | Test for and sand |
| (b) | Liquid limit and plastic  limit | | | IS:2720 (Part-V) | two samples | | Test for soil |
| (c) | Shrinkage limit | | | IS:2720 (Part-VI) | One in every 5000 cum.  for each type | | The frequency of Test  shall be |
| (d) | Free sweel index | | | IS:2720 (Part-XL) | And each source of fill  materials. | | increased depending  on type of soil |
| (e) | Chemical Analysis | | | IS:2720 |  | |  |
|  | i. Organic matter | | | Part XXII | One in every 5000 Cum for each type and each  source of | | Test for sand and soil. |
|  | ii. Calcium carbonate | | | Part XXIII | Fill materials. | |  |
|  | iii. pH | | | Part XXVI |  | |  |
|  | iv. Total  sulphate |  | soluble | Part XXVII |  | |  |
| II. | **Standard proctor test** | | | IS:2720 (Part VII) | One in every 2000 cum. for each type and each source of fill materials | | Test for soil for determining optimum moisture content, Dry  Density etc. |
| III. | **Moisture content of fill**  **before compaction.** | | | IS:2720 (Part II) | -do- | | Test for soil |
| IV. | **Degree of compaction of fill** | | |  | (i) For foundation  filling, one for every ten foundations for each | | Test for soil |
| (a) | Dry density by core | | | IS:2720 (Part XXIX) | Compacted | layer. |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Nature of test/**  **characteristics** | **Methods of test** | **No. of samples &**  **frequency of test** | **Remarks** |
|  | cutter method |  | However, each layer for location of important and  heavily loaded |  |
|  | **or** |  |  |  |
|  | Dry density in place by sand displacement  method | IS:2720 (Part XXVIII) | Foundations resting on fill shall be tested. |  |
|  |  |  | (ii) For area filling one for every 1000 Sqm. Area for each compacted  layer. |  |
| (b) | Relative density index | IS:2720 (Part XIV) | -do- (i) & (ii) | Test for sand |
| (c) | Dry density by proctor needle penetration | Standard Practice | Random checks to be carried out for each compacted layer in addition to tests mentioned under IV (a)  above. | Test for soil |

**Sub section - C2**

# Technical specification for properties, storage and handling of common building materials

**Sub Section - C2**

**Technical specification for properties, storage and handling of common building materials**

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**Sub Section - C2: Technical specification for properties, storage and handling of common building materials**

* 1. **Scope**

The scope of this section of the specification is to specify the properties, storage and handling of common building materials namely, coarse aggregates, cement, water, sand masonry units, reinforcement and structural steel.

Properties of the materials in general have been discussed. Specific requirements of the materials have been stipulated separately under specification for relevant items of work.

# General requirements

The work shall include, providing of all necessary plants and equipment, providing adequate engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out the entire work as directed by the Project Engineer and Executing Agency to his complete satisfaction.

All materials proposed for use in the work shall conform to the requirements laid down in this section, and also subject to the approval of the Project Engineer and Executing Agency. After specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Project Engineer and Executing Agency.

Approval of any material by the Project Engineer and Executing Agency shall not relieve the Concessionaire of his responsibility, for the requisite quality and performance of the material used.

Any material considered to be sub-standard, or not upto satisfaction of the Project Engineer and Executing Agency, shall not be used by the Concessionaire and shall be removed from the site immediately.

Representative samples shall be procured by the Concessionaire and submitted to the Project Engineer and Executing Agency, for approval before bulk procurement. The representative samples shall be retained by the Project Engineer and Executing Agency for future comparison and reference.

# Codes and standards

In the event that state, city or other local governmental bodies have requirements more stringent than those set forth in this specification, the former shall govern.

All applicable standards, acts, specifications, codes of practice, hand books, referred to herein shall be the latest editions, including all official amendments and revisions.

In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decision of Project Engineer in such case shall be final and binding on the Concessionaire.

Any special materials used, but not covered here, shall conform to relevant Indian Standards, if any, or as specified by the Project Engineer and Executing Agency for any special purpose.

Some of the applicable Indian standards, codes are referred to here below: IS:226 Specification for structural steel (standard quality).

IS:269 Specification for ordinary Portland cement, 33 grade.

IS:383 Specification for coarse and fine aggregates from natural sources for concrete.

IS:432 Specification for mild steel and medium tensile steel bars and (Parts 1 & 2) hard-drawn steel wires for concrete reinforcement.

IS:455 Specification for Portland slag cement. IS:712 Specification for building limes.

IS:1077 Specification for common burnt clay building bricks. IS:1077 Specification for Burnt clay bricks/Fly ash bricks.

IS:1127 Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS:1129 Recommendation for dressing of natural building stones.

IS:1489 Specification for Portland pozzolana cement (Part-I) Fly ash based

(Part-II) Calcined clay based IS:1542 Specification of sand for plaster.

IS:1566 Specification hard-drawn steel wire fabric for concrete reinforcement.

IS:1597 Code of Practice for construction of stone masonry, rubble stone masonry. IS:1786 Specification for high strength deformed bars for concrete reinforcement. IS:2062 Specification for hot rolled medium and high tensile structural steel.

IS:2116 Specification for sand for masonry mortars. IS:2386 Testing of aggregates for concrete. (Part I to VIII)

IS:3495 Methods of test of Burnt clay bricks/Fly ash bricks (Part-I to IV) IS:4031 Methods of physical tests for hydraulic cement.

IS:4032 Methods of chemical analysis of hydraulic cement.

IS:4082 Recommendations on stacking and storage of construction materials at site.

IS:7969 Safety code for handling and storage of building materials. IS:8112 High strength ordinary portland cement.

IS:8500 Medium and high strength structural steel. IS:12269 43/53 grade ordinary Portland cement. IS:12330 Sulphate resisting Portland cement.

IS:12600 Portland cement, low heat. IS:12894 Fly Ash Lime Bricks - specification.

IS: 3812-2 Specification for pulverized fuel ash for use as admixture in cement mortar and concrete

# Burnt clay Bricks

Burnt clay bricks, for general masonry work, shall conform to IS:1077 and for face brick work, shall conform to IS:2691. Fly ash lime bricks shall conform to IS:12894.

Bricks for general masonry work shall be table moulded/machine made, well burnt without being vitrified, of uniform size, shape, having sharp edges and cherry red colour. These shall be free from cracks, flaws or nodules of free lime and shall emit clear ringing sound (metallic sound) when struck. These shall not show any signs of efflorescence either when dry or subsequent to soaking in water. Fractured surface shall show uniform texture free from girts, lumps, holes etc.

Unless otherwise specified, minimum compressive strength shall correspond to class designation 75 as per IS: 107 with a minimum crushing strength of 75 kg/sq.cm. for general masonry work. However, for non-load bearing walls, bricks pavements, etc. bricks of class designation 50 shall only be used, wherever specified or shown on the drawings. Water absorption after 24 hours immersion shall not exceed 20% by weight for common bricks and 15% for face bricks.

On the basis of finish and dimensional tolerance, the bricks shall be classified as sub class A and

B. Dimensional tolerance shall not exceed 3% and 8% of the size, of common bricks for sub-class A & B respectively and 3% for face bricks. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chip page for the face bricks shall be 6mm at the edges and 10mm for corners. The face bricks shall show no efflorescence after soaking in water and drying in the shade.

The size of the bricks used shall be either modular size as per IS:1077 or locally available conventional size as approved by the Project Engineer and Executing Agency.





colour and texture of face bricks shall be limited to the range of samples submitted. Any brick not found upto the satisfaction of the Project Engineer and Executing Agency shall be removed immediately from site by the Concessionaire.

# Fly Ash Bricks

Fly ash bricks (cement bonded) shall be locally made. Bricks shall have smooth rectangular faces with sharp and square corners. Bricks shall be hand or machine moulded and shall be made from the admixture of suitable good quality of fly ash, sand and cement as per the composition mentioned below:

|  |  |
| --- | --- |
| Fly ash : | 50-60% |
| Sand : | 32-40% |
| Cement : | 8-12% |

The fly ash bricks will be as per latest relevant IS code. The bricks will be of dimension as per standard clay brick, suitable for making 230 mm thick full brick wall, 115 mm thick half brick wall and 75 mm thick minor partition walls, as applicable, as per drawing/specification/BOQ. A maximum tolerance of (+/-) 2 mm shall be allowed as the manufacturing tolerance. The bricks shall have frog of 100 mm in length 40 mm in width and 10 to 20 mm deep of one of its flat sides.

The bricks when tested in accordance with the procedure laid down in IS 3495 (part 2): 1992 after immersion in cold water for 24 hrs. Water absorption shall be within 13-15% by weight. Similarly, the porosity of the fly ash bricks shall be within 12-20%. The bricks shall have a minimum crushing strength of 80 Kg/Sqcm.

Fly ash bricks, for general masonry work, shall conform to IS:2212-1991

Unless otherwise specified, minimum compressive strength shall correspond to class designation 80 as per IS: 107 with a minimum crushing strength of 80 kg/sq.cm. For general masonry work. However, for non-load bearing walls, bricks pavements, etc. bricks of class designation 50 shall only be used, wherever specified or shown on the drawings. Water absorption after 24 hours immersion shall not exceed 20% by weight for common bricks and 15% for face bricks.

On the basis of finish and dimensional tolerance, the bricks shall be classified as sub class A and

B. Dimensional tolerance shall not exceed 3% and 8% of the size, of common bricks for sub-class A & B respectively. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chip page for the face bricks shall be 6 mm at the edges and 10 mm for corners. The face bricks shall show no efflorescence after soaking in water and drying in the shade.

The size of the bricks used shall be either modular size as per IS:1077 or locally available conventional size as approved by the Project Engineer and Executing Agency.





colour and texture of face bricks shall be limited to the range of samples submitted. Any brick not found upto the satisfaction of the Project Engineer and Executing Agency shall be removed immediately from site by the Concessionaire.

# Stones

All stones shall be from approved quarries. These shall be hard, tough, and durable, compact grained, uniform the texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and hall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone with round surface shall not be used.

Stones showing mottled colours shall not be used for face work. A stone shall not absorb more than 5% of its weight of water after 24 hours immersion. The type of stone shall be as specified or shown on drawings and/or as instructed by the Project Engineer and Executing Agency. Stones used for masonry work shall conform to IS:1597 (Part I) No soft stone shall be used for masonry or for filling purpose.

Any stone not found up to the satisfaction of Project Engineer and Executing Agency shall be removed immediately from site by the Concessionaire.

# Lime

Lime shall be stone lime and it shall conform to IS:712. Hydrated lime shall be mixed with water to form a putty. This shall be stored with reasonable care to prevent evaporation of water for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream and then stored with reasonable care to prevent evaporation of water for at least seven days before use. Type of lime to be used for different purposes such as concreting, plastering, white washing etc. shall be according to the satisfaction made hereunder:

**Class A** Eminently hydraulic lime used for structural purposes.

**Class B** Semi-hydraulic lime used for masonry mortars, lime concrete and plaster undercoat

**Class C** Fat lime used for finishing coat in plastering, white washing, composite mortars, etc. and with addition of pozzolanic materials for masonry mortar.

**Class D** Magnesium/dolomite lime used for finishing coat in plastering, whitewashing, etc.

**Class E** Kankar lime used for masonry mortar.

**Class F** Siliceous dolomite lime used for undercoat and finishing coat of plaster

# Cement and fly ash

Cement shall be Portland pozzolana cement conforming to IS:1489 or Portland slag cement conforming to IS:455 or sulphate resistant cement confirming to IS 12330 as per the specific site condition and exposure. As per CPHEEO Maunal guideline, all civil works in contact with sewage/faecal sludge/septage shall be constructed with either brick work or RCC and in both cases sulphate resistant cement alone shall be used. However, any lower grade of OPC, PPC and PSC should never be mixed with higher grade cement.

Fly ash is generated by burning of coal in coal fired power plants. It has the characteristic of pozzolonic additive to cement. Continuous research studies by various engineering research laboratories revealed its varied usefulness as an additive for enhancing the various qualities of concrete including its workability, strength and durability if handled and cared properly. Partial replacement of cement with fly ash in concrete save much of the energy required for production of OPC and also facilitates the economical disposal of millions of tons of fly ash.

At present most of the fly ash blended cements commercially produced in India has 18 to 25% fly ash by weight and addition of fly ash to this extent has a beneficial effect on the workability and economy of concrete. It has been found that in order to improve the other qualities of concrete like resistance of sulfate attack and thermal cracking, larger percentage of fly ash is to be used in concrete.

Indian standard specification No. 3812-2003, Specification for Pulverized Fuel Ash, Part 2: For Use as Admixture in Cement Mortar and Concrete [CED 2: Cement and Concrete] covers the extraction and the physical and chemical requirements of pulverized fuel ash for use as admixture in cement mortar and concrete. Fly ash confirming to this standard shall be used in place of cement.

The chemical, physical requirements and testing of fly ash shall be in accordance with the IS 3812-2003

# Water

Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from injurious amount of oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and

concrete works, including curing. The Concessionaire shall carry out necessary tests in advance to prove the suitability of the water proposed to be used. As a guide, the following concentrations represent the maximum permissible values:

* + 1. To neutralize 200 ml sample of water, it should not require more than 2ml of 0.1 normal NaOH.
    2. To neutralize 200 ml sample of water, it should not require more than 10ml of 0.1 normal HCL.
    3. Percentage of solids shall not exceed the following :

|  |  |  |
| --- | --- | --- |
| 1. | Organic | 0.02 |
| 2. | Inorganic | 0.30 |
| 3. | Sulphates | 0.05 |
| 4. | Chlorides | 0.10 |
| 5. | Suspended matter | 0.20 |

# Aggregates

Aggregates mean both coarse and fine inert materials used in the preparation of concrete. Aggregates shall consist of natural sands, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, hard, strong, durable against weathering, of limited porosity and free from such quantities of deleterious materials as may cause corrosion of reinforcement or may impair the strength and / or durability of the concrete. Total percentage of all deleterious materials, including coal, lignite, clay lumps, and materials finer than 75 microns, soft fragments and shale but excluding mica shall not exceed 5%. However, for crushed fine aggregate, total percentage of coal and lignite and clay lumps, shall be limited to 2%. Both coarse and fine aggregates shall conform to IS:383 for concrete, shotcreting etc. unless otherwise mentioned.

Sample of aggregates for mix design and determination of their suitability shall be sent to the laboratory well in advance in scheduled placing of concrete. Sampling, testing, and interpretation of test results shall be subject to the approval of the Project Engineer and Executing Agency. Aggregates shall be properly graded.

# Sand

Sand shall be hard, durable, clean and free from adherent coatings of organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale, or other laminated materials, in such forms or quantities as to affect adversely the hardening, strength, durability or appearance on mortar, plaster, etc. or to cause corrosion of any metal in contact with such mortar, plaster etc. In no case, the cumulative percentage of Impurities in sand shall be more than 5% by weight. All sand shall be properly graded. Unless otherwise directed by the Project Engineer and Executing Agency, sand for masonry mortars shall conform to IS:2116 and sand for plaster shall conform to IS:1542. Sand,

when used as fine aggregate, in concrete, shall conform to IS:383. For filling, medium grained sand (having fines less than 75 microns not exceeding 20%) shall be used.

# Reinforcement steel, structural steel (including embedded steel) and wire mesh Billet: (Primary steel)

A semi-finished product obtained by forging or rolling, usually square and not exceeding 125 x

125 mm in cross section with rounded corners and is intended for further processing into suitable finished product by forging or re-rolling.

Steel shall be manufactured by open hearth, electric, duplex, basic oxygen or a combination of these processes. In case any other process is employed by the manufacturer, prior approval of the purchaser should be obtained.

The ladle analysis of the material when analyzed in accordance with the various parts of IS: 228, shall be confirmed with IS: 8056-1976- Table 1 (Chemical composition).

|  |  |
| --- | --- |
| **Table 1 Chemical Composition (As per IS: 8056-1976 clauses 3.1 & 6.1)** | |
| **Constituent** | **Percent** |
| Carbon | 0-45 to 0.80 |
| Silicon | 0.15 to 0.35 |
| Manganese | 0.40 to 1.00 |
| Sulphur, Max | 0.050 |
| Phosphorus, Max | 0.050 |

In case of continuous cast billets, the billet analysis shall be taken as ladle analysis.

Permissible variation in case of product analysis from the limits specified in IS: 8056-1976 clause-6.1 shall be as follows:

|  |  |
| --- | --- |
| **Constituent** | **Variation Over the Specified Maximum or**  **Under the Minimum Limits in %** |
| Carbon | 0.03 |
| Silicon | 0.03 |
| Manganese | 0.04 |
| Sulphur, Max | 0.005 |
| Phosphorus, Max | 0.005 |

***Note:*** *Variations shall not be applicable both over and under the specified limits in several determinations in a heat.*

# Sampling

At least one ladle sample analysis shall be taken per cast.

If required, the samples for product analysis shall be prepared by forging or rolling down to 30- mm round section.

In case of wire rods the test piece size shall be the size of wire rods.

Drilling shall be taken from the sample representing two-thirds, half and one-third of height from bottom of the billet separately.

In case of continuous cast billets and billets produced from ingots of masses 3 tonnes and more, the sample may be taken from anywhere from the billets.

# Freedom from defects

The billets and continuous cast billets shall be free from harmful defects, such as pipe, laminations, segregation, inclusions and cracks.

Subject to agreement between the purchaser and the manufacturer, the billets and continuous cast billets may be supplied with suitable surface dressing.

billets shall either be supplied free from harmful segregation, piping, cracks, inclusions, and blow-hole by appropriate top and bottom discard and dressing or supplied with suitable surface dressing only, without top and bottom discard if agreed to between the purchaser and the manufacturer, to ensure the requirements of freedom from defects specified in the relevant product specifications.

If agreed to between the purchaser and the manufacturer the following tests may be carried out from the samples prepared under IS: 8056-1976

# Dimensions

The size and tolerance of billets shall be subject to agreement between the purchaser and the manufacturer. However, the nominal sizes of billets generally supplied as per guidance given in IS: 8056-1976

The preferred sizes of billets shall be 50, 63, 71, 80, 90, 100 and 125 mm.

The sizes other than those specified may be supplied by agreement between the purchaser and the manufacturer.

A tolerance of the billets shall be confirmed with IS: 8056-1976

The ends of ingots and billets shall be painted with a suitable colour code conforming to IS: 2049-1963.

Each ingot and billet shall be legibly stamped or painted with the cast number, grade and the name or trade-mark of the manufacturer.

The material may also be marked with the IS1 Certification Mark.

All steel for reinforcement shall be clean and free from loose mill scales, dust, loose rust, oil, grease, paint or other harmful matters, which may affect its bond with concrete. Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement shall conform to grade-1 of IS:432 (Part-1). High strength deformed steel bars shall conform to grade Fe 415 of IS:1786. All steel bars shall be of tested quality. Actual grade and type steel, to be used, shall be as specified or shown on drawings.

Structural steel (including embedded steel) shall be straight, sound, free from twists, cracks, flaws, laminations and all other defects. Structural steel shall be of tested quality conforming to IS:226, IS:2062 or IS:8500. These shall be free from lamination defects. Grade and type of steel to be used shall be as specified.

Hard drawn steel wire fabric shall conform to IS:1566. Wire fabric shall be electrically cross welded.

# Storage and handling of materials

Generally, all materials shall be stacked and stored by the Concessionaire as described in IS:4082 unless otherwise mentioned and in a manner affording convenient access for identification and inspection at all times. The storage area and arrangements shall be subject to the approval of the Project Engineer and Executing Agency. Any material rendered unserviceable during the

the Project Engineer and Executing Agency.

All materials shall be as stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Project Engineer and Executing Agency, shall not be used and shall be removed.

Bricks shall not be dumped at site. These shall be stacked on dry firm ground in regular tiers even as they are unloaded to minimize breakage and defacement of bricks. Bricks of different class, selected for various categories of use in the work, shall be stacked separately. Each stack shall contain equal number of bricks, preferably not more than 3000.

Dressed stone for all facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

Lime shall be stored in weather-proof sheds. Lime which has been damaged by rain, moisture or air slaking, shall not be used. If the lime is supplied as hydrated lime, it shall be stored in the same manner as cement.

# Cement and fly ash

* + - 1. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery. Cement held in storage for more than ninety days shall invariably be tested, and only if test results are satisfactory, the Project Engineer and Executing Agency may consider permitting its use.
      2. Different consignments of different types of cement, i.e. OPC, PPC, PSC shall be stacked separately with clear identifiable stack number.
      3. The cement shall be stored in dry, leak proof and weather proof are closed sheds. Storage under tarpaulins shall not be permitted. The cement bags shall be stored well away from the walls and insulated from the floor, using
      4. Planks etc. to avoid contact with moisture. The cement shall be stacked in easily countable stacks and in a place of easy access so as to facilitate proper inspection and removal on a first in first out basis. Not more than 15 bags shall be stacked in any tier to prevent lumping up under pressure. However, in stacks more than 8 bags high, the cement bags shall be arranged alternately lengthwise and crosswise so as to tie the stacks together and minimize the danger of toppling over. The cement bags shall be gently kept to avoid leakage of cement from the bags. Substandard or partially set cement shall be immediately removed from the site as soon as it is detected.
      5. The Concessionaire shall make his own arrangements for the storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos which will provide adequate protection against dampness, contamination, etc. The bins or silos, shall be cleaned periodically.
      6. Pulverized fuel ash (Fly ash) shall be stored in accordance with the recommendation given in IS 4082. Additionally, during bulk storage, the fly ash should be suitably covered to avoid getting airborne.
      7. Supplies of pulverized fuel ash (Fly ash) may be made in bulk in suitable quantities or in bags (jute, jute-laminated, multiple paper or polyethylene lined) bearing the net mass (may be 15 kg, 30 kg, 300 kg, 600 kg as agreed by the Concessionaire)
      8. Pulverized fuel ash in bulk storage for more than 6 months or in bags for more than-3 months after completion of tests, may be re-tested before use and standard. May be rejected, if it fails to conform to any requirements of this standard.
      9. Pulverized fuel ash may be rejected if it does not comply with any of the requirements stipulated in IS 3812 Part 2 of 2003

# Coarse and fine aggregates/sand

* + - 1. Coarse and fine aggregates shall be stacked separately. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. Coarse aggregates shall be stacked in layers not exceeding 120 cm in height such that corning and segregation do not occur. Each layer shall cover the entire area of the stock pile before succeeding layers are placed. Segregated aggregates from stock-pile shall be rejected.
      2. Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substance, at any stage. For lifting aggregates from stock piles, rakers shall be used. Aggregates of different sizes shall be kept in separate and easily measurable stacks. If so desired by the Project Engineer and Executing Agency, aggregates from different source shall be stacked separately with proper care to prevent intermixing.

# Reinforcement and Structural Steel (including steel required for embedment)

* + - 1. Reinforcement and structural steel (including steel required for embedment) shall be stored consignment wise and size wise, off the ground by at least 150mm and protected by the suitable cover, or as desired by the Project Engineer and Executing Agency. The steel shall be protected from rusting, oil grese and distortions. The reinforcing steel shall be coated with cement wash before stacking to prevent scale and rust, in areas having accelerating corrosion effect like marine atmosphere. The stacks shall be easily measurable. Steel needed for immediate use only shall be removed from storage. Fabricated steel shall be carefully stored to prevent damage, distortion, corrosion and deterioration.
      2. Reinforcement shall be stored according to the diameter, grade and length in such a place as to permit easy approach for inspection and identification.
      3. The area shall be such that water does not accumulate and reinforcement does not get distorted or corroded. It shall not be stacked directly over ground or near any harmful materials. It shall be cleaned of excessive rust before use.
      4. Steel plates of different specifications shall be stacked separately. Steel of IS:2062 and IS:8500 quality shall be given a grade wise, distinctive identification mark. Passage and space between the stacks shall be sufficient for rigging operations.

# Testing

All materials provided by the Concessionaire shall be tested for conformity of the specification and the test results shall be submitted to the Project Engineer and Executing Agency for acceptance. In addition to above, the Concessionaire shall carry out the relevant tests at site as specified under different items of work.

# Sub-section - C3

**Technical specification for cast-in-situ concrete AND allied works**

# Sub Section - C3

**Technical specification for cast-in-situ concrete and allied works Contents**

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**Sub Section - C3: Technical specification for cast-in-situ concrete and allied works**

* 1. **Common requirement**

# Scope

The work shall include providing of materials, all necessary plant and equipment, providing adequate engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire work as indicated on the drawings and/or described herein subsequently and/or as directed by the Project Engineer and Executing Agency.

The Concessionaire shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein. All works shall be executed to the satisfaction of the Project Engineer and Executing Agency.

This specification is divided into 13 sections. The Section - 1 deals with common requirements and the other 12 sections deal with specifications for 12 different items/activities. The stipulations contained in Section- **Common Requirements** hall form a part of the specifications of 12 different items/activities described in section 2 to 13.

# All these eight sections are as follows:

Section - 1 Common requirement Section - 2 Cast-in-Situ Concrete Section - 3 Reinforcement Section - 4 Formwork and staging Section - 5 Embedded parts

Section - 6 Foundation bolt assembly Section - 7 Shotcreting

Section - 8 Grouting

Section - 9 Encasement of steel structures/elements Section - 10 Joints in Concrete

Section - 11 Water proofing / damp proofing of underground concrete structures. Section - 12 Dismantling / Demolishing works - RCC and PCC.

Section - 13 Cement Additives/Admixtures in concrete.

# General

Any approval, instructions, permission, checking, review, etc. whatsoever by the Project Engineer and Executing Agency, shall not relieve the Concessionaire of his responsibility and obligation regarding adequacy, correctness, completeness, safety strength, quality, workmanship, etc.

The Concessionaire shall make his own surveying arrangements for locating the coordinates and positions of all work and establishing the reduced levels (RLs) at these locations, based on two reference grid lines and one bench mark, which will be furnished by the Executing Agency. The Concessionaire has to provide at site, faction of the Engineer so that the work can be carried out accurately and according to the specifications and drawings.

# Codes and standards

All applicable standards, specifications, etc. and codes of practice shall generally be the latest editions, including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Concessionaire.

All work shall be carried out as per the stipulations contained in various sections of these specifications and the latest Indian Standards, Acts, Codes and best practices.

In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian Standards, Codes, etc. the requirements of stipulations contained in various sections of these specifications, shall prevail over that of Indian Standards, Codes, etc.

# Some of the applicable Indian Standards, Codes, etc. are referred to here below:

IS:73 - Specification for paving bitumen IS:2062 - Specification for structural steel

IS:269 - Specification for Ordinary Portland cement, 33 grade.

IS:280 - Specification of mild steel wire for general engineering purposes

IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.

IS:432 - Specification for mild steel and medium tensile steel (parts I & II) bars and hard drawn steel wire for concrete reinforcement.

IS:455 - Specification for Portland slag cement

IS:456 - Code of practice for plain and reinforced concrete.

IS:457 - Code of general construction of plain & reinforced concrete for dams & other massive structures.

IS:516 - Method of test for strength of concrete

IS:650 - Specification for standard sand for testing of cement IS:702 - Specification for industrial bitumen

IS:816 - Code of practice for use of metal arc welding for general construction in mild steel.

IS:1199 - Method of sampling and analysis of concrete

IS:1200 - Method of measurement of building (Part-II and civil engineering works. V, VIII, XVIII)

IS:1367 - Technical supply conditions for threaded steel fasteners.

IS:1489 - Specification for Portland-pozzolana cement (Part-I) Fly ash based (Part-II) Calcined clay based

IS:1566 - Specification for Hard-drawn steel wire fabric for concrete reinforcement. IS:1609 - Code of practice for laying damp proof treatment using bitumen felts.

S:1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement

IS:1791 - General requirements for batch type concrete mixers.

IS:1838 - (Part 1) Specification for preformed fillers for expansion joints in concrete pavements and structures (non extruding and resilient type)

IS:2204 - Code of practice for construction of reinforced concrete shell roof.

Criteria for the design of reinforced concrete shell structures and folded plates. Methods of test of aggregates for (Parts concrete I to VIII)

|  |  |
| --- | --- |
| IS:2210 | - |
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| IS:3150 | - |
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| IS:5121 | - |
| IS:5256 | - |
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| IS:5624 | - |
| IS:6461 | - |
| IS:6494 | - |
| IS:6509 | - |
| IS:7193 | - |

Specification for roller pan mixer

Code of practice for bending and fixing of bars for concrete reinforcement General requirements for concrete vibrators, immersion type.

General requirements for concrete vibrators, screed board type. Specification for concrete vibrating tables.

Code of practice for laying in-situ cement-concrete flooring. Specification for Integral cement water proofing compounds.

Specification for portable swing weigh batchers for concrete. (Single and double bucket type)

Specification for Steel scaffoldings

Code of practice for welding of mild steel plain and deformed bars for reinforced concrete structures.

Methods of sampling and test waste water.

Code of practice for general design details and preparatory work for damp proofing & water proofing of buildings.

Specification for hexagonal wire netting for general purposes. Specification for Pan vibrators.

Code of practice for concrete (Part I structures for the storage of to IV) liquids.) Specification for bitumen primer for use in water proofing & damp proofing.

Code of practice for design and installation of joints in buildings. Methods of test for routine control for water used in industry

Code of practice for use of immersion vibrators for consolidating concrete. Safety code for scaffolds (Part I ladders & II)

Specification for pulverized fuel ash for use as admixture in cement mortar and concrete

Code of practice for steel tubular scaffolding (Parts I & II) Methods for physical tests for hydraulic cement.

Safety Code for demolition of buildings.

Code of practice for earthquake resistant design and construction of buildings. Code of practice for joints in surface hydro-electric power stations.

Specification for form vibrators for concrete. Specification for batching and mixing plant. Specification for plywood for concrete shuttering work.

Criteria for design of reinforced concrete bins for the storage of granular and powdery materials. (Parts I & II)

Safety code for piling and other deep foundations.

Code or practice for sealing joints in concrete lining on canals. Recommendations for detailing of reinforcement in reinforced concrete work. Specification for foundation bolts.

Glossary of terms relating to cement concrete.

Code of practice for water proofing of underground water reservoirs and swimming pools.

Code of practice for installation of joints in concrete pavements. Specification for glass fiber base coal-tar pitch and bitumen felts.

IS:7293 - Safety code for working with construction machinery. IS:7861 - Code of practice for extreme weather concreting (Parts I&II) IS:9012 - Recommended practice for Shotcreting.

IS:9103 - Specification for admixtures for concrete.

IS:9417 - Recommendations for welding cold-worked steel bars for reinforced concrete construction.

IS:959 - Recommendations for metal-arc welding of carbon and carbon manganese steels.

IS:10262 - Recommended guidelines for concrete mix design.

IS:11384 - Code of practice for composite construction in structural steel and concrete. IS:12118 - Specification for two-parts poly sulphide.

IS:12200 - Code of practice for provision of water stops at transverse contraction joints in masonry and concrete dams.

IS:12269 - 43/53 Grade ordinary Portland cement. IS:12600 - Portland cement, low heat.

SP:23 - Handbook of concrete mixes

SP:24 - Explanatory Handbook on IS:456-1978

SP:34 - Handbook on concrete reinforcement and detailing

# Sampling, testing and quality assurance

Facilities required for sampling materials, concrete, reinforcement, formwork, etc. in the field and in the laboratory shall be provided by the Concessionaire. The Concessionaire shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and this specification. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Project Engineer and Executing Agency. Tests shall be done in the field in the presence of the Project Engineer and Executing Agency or his authorized representative and at a laboratory, approved by the Project Engineer and Executing Agency, and the Concessionaire shall submit to the Project Engineer and Executing Agency the test results in triplicate within three days after completion of any test.

The Concessionaire shall maintain records of all inspection and testing, which shall be made available to the Project Engineer and Executing Agency. The Project Engineer and Executing Agency at his discretion, may waive some of the stipulations for small and unimportant concreting operations and other works.

Work found unsuitable for acceptance shall be removed and replaced by the Concessionaire. The work shall be redone as per specification requirements and to the satisfaction of the Project Engineer and Executing Agency at no extra cost to the Executing Agency.

# Quality assurance programme

* + - 1. The Concessionaire shall submit and finalize a detailed field Quality Assurance Programme within 30 days from the date of award of the contract, before commencement of work at site, according to the requirements of the specification. This shall include setting up of a

testing laboratory, arrangement of testing apparatus / equipment, deployment of qualified/experienced manpower, preparation of format for record, field quality plan, etc. On finalized field quality plan, the Executing Agency shall identify, customer hold points, beyond which work shall not proceed without written approval from the Project Engineer. The testing apparatus/equipment installed in the field laboratory shall be calibrated

/corrected by the authorized persons as frequently as possible to give accurate testing results.

* + - 1. Frequency of sampling and testing, etc. and Acceptance Criteria are given in respective sections. However, the testing frequencies set forth are the desirable minimum and the Project Engineer and Executing Agency shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

# Cast-in-situ concrete

* + 1. **Scope**

This section of the specification deals with plain or reinforced cement concrete for general use and in structures and covers the requirements for concrete, materials, their properties, storage, handling, grading, mix design, strength and quality, pouring at all levels, testing, casting, protecting, curing, finishing, etc.

# General requirement

The provision of IS:456 shall be followed as general guidance, along with all other relevant Indian Standards, unless otherwise specifically mentioned.

Before starting a concrete pour, the Concessionaire shall obtain the approval of the Project Engineer and 



complete instructions about the materials and proportions, water cement ratio, etc. to be used, slump/workability, number of test cubes/samples to be taken, type of finishing to done, any admixture to be added, any limitation on size of pour and location for interruption of a pour in case of premature stopping of pour, etc.

The mixers and weigh-batchers, shall be maintained in clean and serviceable condition. Accuracy of all equipment shall be periodically checked. All concrete shall be mixed in mechanically operated batch mixers complying with IS:1791 and these shall be of approved make, with suitable provision for correctly controlling the water delivered to the drum. Weigh batchers shall conform to IS:2722 and shall be capable of controlling the weights to within one percent of the desired value.



or as identified by the Project Engineer and Executing Agency) shall take account of the release

of the heat of hydration, drying shrinkage behavior. The procedures shall be such that cracking or loss of strength of the concrete from these effects is prevented. At least one week before commencing the construction of any massive concrete section, the Concessionaire shall submit, for approval of the Project Engineer and Executing Agency, detailed proposals for placing the concrete together with supporting calculations to demonstrate the suitability of the methods.

# Materials

In general, all the materials used in the manufacture of concrete shall be in accordance with the Technical specification for properties, storage and handling of common building materials, (vide module C2) which shall be deemed to form a part of this specification.

The Project Engineer and Executing Agency shall have the right to inspect the sources of materials, method of procurement and storage of materials, method of procurement and storage of materials, quality control procedures, etc.

# Cement

The cement used shall be the Ordinary Portland cement conforming to IS:269 or Portland Pozzolana cement conforming to IS:1489 or Portland slag cement conforming to IS:455 or any other type of cement, specified in IS:456 with the prior approval of the Project Engineer and Executing Agency. However, any special type of cement such as High strength cement or sulphate resisting cement, may be used under special circumstances.

# Aggregates

* + - 1. For reinforced concrete work, aggregates conforming to IS:383 & IS:2386 having a maximum size of 20 mm shall be used. For certain reinforced concrete works, aggregates having a maximum size other than 20 mm size shall also be used as called for in the drawings. However, for lean concrete provided as mud mat below structural concrete, maximum size upto 40 mm shall be used.
      2. Aggregates (coarse or fine) with a specific gravity below 2.6 shall not be used without special permission of the Project Engineer and Executing Agency. Machine-made sand will be acceptable provided the constituent (rock/gravel) is sound, hard, dense and is acceptable to the Project Engineer and Executing Agency. Sand, natural gravel and crushed rock shall be prepared for use by such screening or washing, or both, as necessary to remove all objectionable foreign matter.
      3. **Type of aggregates:** Petro graphic examination shall be carried out to ascertain the structure and rock type of aggregate including presence of strained quartz and other reactive minerals. Moreover, in case the coarse aggregate sample is of composite nature, the proportions (by weight) of different rock types in the composite sample and petrographic evaluation of each rock should also be ascertained. While determining

different rock type is in the composite sample, special emphasis should be given on identification of known reactive rocks like chalcedony, opal etc. and procedure laid down in IS:2430 for sampling of aggregates may be followed. The sample should not contain weathered rock and reduced to required quantity by quartering and coning.

The results of petro graphic test shall be submitted to the Project Engineer and Executing Agency. The Project Engineer and Executing Agency shall review the results on consultation with some specialist agencies, if required, to determine potential activity of the aggregate (siliceous minerals) which may lead to reaction of silica in aggregate with the alkalis of cement. In additional, potential of some aggregate like lime stone to residual expansion due to repeated temperature cycle is also to be reviewed. Further, the Concessionaire shall submit the results of Alkali aggregates reactivity carried out as per IS:2386 (Pt. VII).

In case of any apprehension about the properties of the aggregate, the Project Engineer and Executing Agency shall ask the Concessionaire to send samples of coarse and fine aggregate to any of the established research laboratory including National Council for Cement and Building Materials (NCB).

In case, it is established from the tests that the aggregates contain reactive silica which would react with alkalis of the cement, the Concessionaire shall be asked to change the source of supply of the aggregate and take additional measures as suggested. In case aggregates indicate residual expansion, under repeated temperature cycle test, the material shall not be used for concreting of equipment foundations, which are likely to be subjected under repeated temperature cycle. The Concessionaire shall use different type of aggregate as approved by the Project Engineer and Executing Agency.

# Admixtures

Admixtures in concrete for promoting workability, improving strength, entraining air for similar purposes may be used only after the written permission from the Project Engineer and Executing Agency is obtained. These shall be free from injurious amount of chloride, etc. Addition of admixtures should not reduce the specified strength or durability of concrete and should not have detrimental effect on reinforcement. The admixtures shall conform to IS:9103 and shall be of proven make and from a reputed manufacturer. Calcium chloride as accelerating admixture is not permitted to be used other than in mass concrete works. The Concessionaire shall produce latest test results carried out at approved Government Test Houses for the approval of the Project Engineer and Executing Agency.

# Water

Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, sugar, organic materials or other substances that may be deleterious to concrete or steel. Potable water is generally considered satisfactory for mixing concrete. The maximum permissible values of impurities shall be as given in Clause no. 4.3 of IS:456-1978.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests specified in IS:456.

Average 28 days compressive strength of atleast three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. The cubes shall be prepared, cured and tested in accordance with IS:456.

The initial setting time of a concrete test block made with the appropriate cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by + 30 minutes from the initial setting time of control test block prepared with the same cement and distilled water. The test shall be carried out as per IS:4031.

Where concrete, made from water, proposed to be used does not satisfy the above requirements and/or contains an excess of acid, alkali, sugar, salt or other deleterious, substances, then the Project Engineer and Executing Agency may refuse to permit its use. Sea water shall not be used for curing besides mixing in concrete.

# Grades of concrete



such as 1:2:4, 1:3:6, 1:4:8 of 1:5:10 proportion is specified. The proportion referred to is by

  -15, M-20, etc. as specified in IS:456. (20% replacement ratio of cement with fly ash shall be considered):



# Nominal mix concrete

* + - 1. Nominal mix concrete shall be used only for plain Cement concrete works and where shown on drawings or specifically allowed by the Project Engineer and Executing Agency. Such concrete shall not require preparation of trial mixes and all such concrete shall be mixed in a mechanical mixer. Proportions for nominal mix concrete shall be according to Table-3 of IS:456-1978. In addition, standard proportion by volume shall be used wherever specified.
      2. In proportioning concrete, the cement & fly ash shall be measured by (mass) weight. The quantities of fine and coarse aggregates may be determined by volume (for corresponding weight) but preferably by weight. If fine aggregates are moist, the amount of surface water shall be determined. Also an allowance shall be made for bulking in case of volume batching, in accordance with IS:2386 (Part-III). Allowance shall also be made for surface water present in the aggregates, when computing the water requirement. All the above data shall be maintained properly, to the satisfaction of the Project Engineer and Executing Agency.
      3. The recommended maximum water cement ratios are specified in **Table 1.**

# Table 1: Recommended water - Cement ratio

|  |  |
| --- | --- |
| **Nominal mix concrete** | **Quantity of water per 50 Kg. of cement (max.)** |
| 1:5:10 | 60 litres |
| 1:4:8 | 45 litres |
| 1:3:6 | 34 litres |
| 1:2:4 | 32 litres |

* + - 1. Nominal mix concrete 1:5:10 shall correspond to grade M5, 1:4:8 shall correspond to grade M7.5, 1:3:6 to grade M10 and 1:2:4 to grade M15 of IS:456.
      2. If Nominal mix concrete made in accordance with specified proportions does not yield the specified strength of the corresponding grade and fails to satisfy the requirements of



the following manner:

* + - * 1. In case the Project Engineer and Executing Agency is satisfied that lower strength of concrete is attributed to material and workmanship of the Concessionaire, then such concrete shall be replaced by concrete of specified strength. The Project Engineer and Executing Agency may however, also accept such lower strength concrete but such lower strength concrete shall be classified as belonging to the appropriate lower grade proportion.
        2. In case the Project Engineer and Executing Agency is satisfied that lower strength of concrete is not attributable to the Concessionaire, he may direct in writing to increase the cement content to obtain specified strength. The use of richer mix shall be continued until the Project Engineer and Executing Agency instructs otherwise.
      1. Nominal mix proportion shall not be classified as higher grade proportion either on the ground that the test strengths are higher than the minimum specified or in the case where the Project Engineer and Executing Agency directs use of additional cement over the quantity specified for the particular mix proportion to achieve the minimum specified strength.

# Design mix concrete

1. Design mix concrete shall be used on all concrete works, except where specified otherwise or specially permitted by the Project Engineer and Executing Agency. The mix shall be designed for all grades of concrete (except those specified under Nominal Mix Concrete (20% replacement ratio of cement with fly ash):) such as to obtain for works cubes, the required workability and the characteristic strength not less than the appropriate values given in Table 2. Using Standard Deviation specified in IS:10262 corresponding to good

quality control, the Minimum value of target strength of design mix of various grades of concrete shall be as per Table 2.

However, the Project Engineer and Executing Agency may allow to change the target strength values based on adequate numbers of works test results.

# Table 2: Grades of concrete

**Compressive strength of a 15 cm cube at 28 days (N/Sq.mm)**

|  |  |  |
| --- | --- | --- |
| **Grade designation of**  **concrete** | **Preliminary test strength**  **(target of trial mix)** | **Characteristic strength on**  **strength works cubes** |
| M 15 | 20.8 | 15 |
| M 20 | 27.6 | 20 |
| M 25 | 33.7 | 25 |
| M 30 | 39.9 | 30 |
| M 35 | 45.4 | 35 |

1. In proportioning concrete, the quantity of cement, fly ash and aggregates shall be determined by mass. However, only in some exceptional cases including concreting in some isolated areas, the Project Engineer and Executing Agency may allow the quantity of aggregates to be determined by an equivalent volume basis after the relationship between weight and volume is well established by trials and the same shall be verified frequently. Water shall be either measured by volume in calibrated tanks or weighed. All measuring equipment at site, shall be maintained in a clean and serviceable condition, and their accuracy shall be periodically checked.
2. To keep the water-cement ratio to the designed value, allowance shall be made for the moisture contents in both fine and coarse aggregates and determination of the same in accordance with IS:2386 Part (III) shall be made as frequently as directed by the Project Engineer and Executing Agency.

In some of the structures, water-cement ratio shall be restricted even below 0.45. To increase the workability, plasticizer may have to be used in such cases. Trial mix shall be carried out accordingly.

1. With the permission of the Project Engineer and Executing Agency, for any of the above mentioned grades of concrete, if the water quantity has to be increased, proportionately cement quantity shall also be increased, to keep the ratio of water to cement same as adopted in Preliminary tests for the corresponding grade of concrete. The extra cement required on account of this shall also be considered for reconciliation purposes.

# Mix design

1. IS:10262 shall be followed as general guidance for mix design. Preliminary tests/trial mix, as specified or as required by the Project Engineer and Executing Agency, shall be carried out sufficiently ahead of the actual commencement of the work with different grades of concrete made from representative samples of aggregates and cement & fly ash expected to be used on the works. These tests are to be conducted to arrive at the grading of aggregates, water cement ratio, workability and the quantity of cement required to give Preliminary (target) compressive strengths as specified in Table - 2.
2. Minimum cement contents, from durability consideration, or different exposures and sulphate attack shall be as given in Table - 19 and 20 of IS:456. In case, higher value is obtained from trial mix from strength consideration, same shall be considered.
3. At least four trial mixes are to be made and minimum. Six test cubes taken for each trial mix noting the slump for each type of mix. The cubes shall then be properly cured and three cubes for each mix shall be tested in a laboratory (approved by the Project Engineer and Executing Agency) at 7 days and others at 28 days and others at 28 days for obtaining the compressive strength. The test reports shall be submitted to the Project Engineer and Executing Agency. The design mix particulars shall indicate, with the help of graphs and curves etc. the extent of variation in the grading of aggregates which can be allowed. While designing mixes, over wet mixes shall be avoided. For chimney, natural draft cooling tower, etc. where assessment of early strength is required, the concrete cubes shall also be tested for early age strength at 1 day and 3 days for establishing the values.
4. The Concessionaire shall submit the test reports of mix design to the Project Engineer and Executing Agency for his view, indicating design criteria, analysis and proportioning of materials, etc. On the basis of the above test reports, a mix proportion by mass and the water cement ratio, shall be determined by the Concessionaire such that concrete prepared with this mix yield the desired characteristic strength and shall have suitable workability. The mix design to be adopted on the works shall be subject to the approval of the Project Engineer and Executing Agency. The proportions, once decided for different grades of concrete, shall be adhered to, during all concreting operations as long as the quality of the materials does not change. If, however, at any time, the quality of materials being used has changed from those for Preliminary mix design, or there is a change either in the required strength of concrete, or water cement ratio or workability, the Concessionaire shall have to make similar trial mixes and Preliminary tests to ascertain the revised mix proportions and water cement ratio to be used for obtaining the desired strength and consistency.
5. In the situations, like casting of piles, where the compaction of concrete is not possible by vibration, the method of compacting concrete cubes of Preliminary / trial mixes and work tests shall be in the same manner as the method of compacting concrete at site is proposed.

# Workability of concrete

1. The workability of concrete shall be checked at frequent intervals. The workability of concrete measured in accordance with IS:1199 for every sample taken for testing shall be recorded with the corresponding cube test result.
2. The degree of workability necessary to allow the concrete to be well compacted and to be worked into the corners of formwork and round the reinforcement to give the required surface finish shall depend on the type and nature of the structure and shall be based on experience and tests. The suggested ranges of values of workability for concrete for some placing conditions, measured in accordance with IS:1199 as stipulated under Clause No.

6.0 of IS:456, are given below in Table - 3, for guidance only. In addition, in some special cases like casting of pile, very high degree of workability (up to 180 mm slump) shall be used.

# Table 3: Limits of workability

|  |  |  |
| --- | --- | --- |
| **Placing** | **Degree of workability** | **Value of workability** |
| Concreting of shallow sections with vibration factor | Very low | 20-10 seconds, Vee-bee time or  0.75-0.80 compacting. |
| Concreting of lightly reinforced section with vibration  Concreting of lightly reinforced section without vibration, or heavily reinforced sections with vibration | Low  Medium | 10-5 seconds, Vee-bee time or  0.80-0.85 compacting factor. 5-2 seconds, Vee-bee time or  0.85-0.92 compacting factor or  25-75mm, slump for 20 mm aggregate (for smaller aggregate the values will be lower). |
| Concreting of heavily reinforced sections without vibration | High | Above 0.92 compacting factor or  75-125 mm slump for 20 mm aggregate (for smaller aggregate  the values will be lower) |

***Note:*** *Notwithstanding the values given above, the slump to be maintained for work in progress shall be as per directions of the Project Engineer* and Executing Agency*.*

# Mixing of concrete

1. Concrete shall be mixed in a mechanical mixer conforming to IS:1791. However, mixing shall preferably be done at a single central batching plant, conforming to IS:4925, situated

as directed by the Project Engineer and Executing Agency. The plant shall have a mechanically operated mixer of an approved size and type, capable of ensuring a uniform distribution of the materials throughout the mass and the mass is uniform in colour and consistency.

1. Water shall not be added into the drum of the mixer, until all the cement and aggregates constituting the batch are already in the drum and dry mixed for at least one minute and are uniformly distributed. Water shall then be added and mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass but in no case shall mixing be done for less than two minutes and for atleast 40 revolutions after all the water and materials are in the drum. When absorbent aggregates are used or when the mix is very dry, the mixing time shall be extended as directed by the Project Engineer and Executing Agency. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.
2. The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used and it shall be immediately removed from site. Each time if the work stops for more than 30 minutes, the mixer shall be thoroughly cleaned and when the next mixing commences, the first batch shall have 10% additional cement.
3. In exceptional circumstances and/or work in remote areas, hand mixing may be allowed by the Project Engineer and Executing Agency, subject to adding 10% extra cement which shall be considered for reconciliation purposes. The mixing shall be carried out on watertight platform and mixing shall be continued till a uniform colour and consistency of the mix is achieved.

# Concrete conveying

1. Concrete shall be handled and conveyed as rapidly as practicable, from the place of mixing to the place of final laying, by approved means, before the initial setting of the cement starts. Concrete shall be conveyed in such a way that there is no segregation or loss of any of the ingredients and maintaining the required workability. If segregation does occur during transport, the concrete shall be remixed.

During very hot or cold weather, if directed by the Project Engineer and Executing Agency, concrete shall be transported in deep containers, which will reduce the rate of

water loss by evaporation in hot weather and heat loss in cold weather, at no extra cost to the Executing Agency.

1. Conveying equipment for concrete shall be mortar tight, well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipment shall be kept free from set concrete. Chutes shall not be used for transport of concrete without the written permission of the Project Engineer and Executing Agency. The chute in case permitted to be used shall be of such size and design as to ensure practically continuous flow. Slope of the chute shall be so adjusted that the concrete flow without the use of an excessive quantity of water and without segregation of its ingredients. The delivery end of the chute shall be as close as possible to the point of deposit.
2. Concrete may be conveyed and places by mechanically operated equipment, e.g. pumps or pneumatic placers only with the written permission of the Project Engineer and Executing Agency, who shall also review the entire scheme for which comprehensive details shall be furnished by the Concessionaire.

# Concrete placing

1. Concrete shall be placed and compacted in its final position before the cement reaches the initial set and normally concrete shall be compacted in its final position within minutes of leaving the mixer.
2. Where direct placement is not possible, the Concessionaire shall provide suitable arrangements such as chutes, tremie, elephant trunks, etc. to confine the movement of concrete as directed by the Project Engineer and Executing Agency. Concrete shall not be dropped from a height or handled in a manner which may cause segregation.
3. If concrete is placed by pumping, the consistency shall be the minimum necessary for such conveyance of concrete. Before commencement of regular pumping, the pipeline shall be lubricated by cement mortar (1:2), and once pumping commences, stoppages shall be avoided.
4. Concrete shall not be placed in foundations on soft areas or where there is standing water or debris. Such soft areas shall be removed and filled with 1:4:8/1:3:6 nominal mix concrete, as directed by the Project Engineer and Executing Agency.

For rock surfaces, it shall be ensured that the rock is not unsound. On sloping rock faces, rough steps or benches shall be formed and concrete shall not be placed on a sloping rock surface. Prior to pouring concrete, the rock surface shall be cleaned with a high pressure water and air jet and kept wet for three hours. Also, before placing concrete, water shall be removed from depressions, the rock surface shall be dried and a 10mm thick cement sand

mortar (1:6) layer shall be placed and worked into all crevices, cracks, depression, etc.

1. The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. Concrete shall be placed in continuous horizontal layers of 150 mm or higher thickness as directed by the Project Engineer and Executing Agency and thoroughly compacted before placing next layer. The thickness of each layer shall be such that it will be deposited before the previous layer has stiffened. When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregates.
2. Approval by the Project Engineer and Executing Agency of any of the materials and/or work as required herein shall not relieve the Concessionaire of his obligation to produce finished concrete in accordance with the drawings and specifications. Slots, openings, holes, pockets, etc. shall be provided in the concrete as directed by the Project Engineer and Executing Agency.
3. Slabs, beams and similar members shall normally be poured in one operation. In special circumstances, with the approval of the Project Engineer and Executing Agency, these can be poured in horizontal layers, but it must be ensured that the under layer is not already hardened. Bleeding of under layer, if any, shall be effectively removed. Molding, throating, drip course, etc. shall be poured as shown on the drawings or as desired by the Project Engineer and Executing Agency.
4. After the concrete has been placed, it shall be spaded and thoroughly compacted by approved mechanical vibrators to a maximum subsidence without segregation and thoroughly worked around reinforcement or other embedded fixtures into the correct form and shape. Hand tamping in some cases may be allowed subject to the approval of the Project Engineer and Executing Agency. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or disturbed during placing of concrete.
5. Whenever vibration has to be applied externally, the design of formwork and the disposition of vibrators shall receive special consideration to ensure efficient compaction and to avoid surface blemishes. Surface vibrators and form attached vibrator shall not be permitted under normal conditions. Their use shall require written approval of the Project Engineer and Executing Agency.
6. Vibrators shall penetrate both the layer poured and the under layer to ensure good bond homogeneity and to prevent the formation of cold joints. Immersion vibrators shall not be allowed to come in contact with steel reinforcement after start of initial set. Also, they shall not be allowed to come in contact with forms or finished surfaces.

k)   

IS:2505 depending upon the size of the vibrator. Immersion vibrators shall be operated by experienced men. These vibrators shall be immersed not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Such vibrators shall in no case be used to push concrete inside the forms and vibrators shall be withdrawn slowly.

1. No concrete shall be placed in wet weather or on a water covered surface. If there have been any signs of washing of cement or sand, the concrete shall be entirely removed immediately. Suitable precautions shall be taken in advance to guard against possible rains before leaving the fresh concrete unattended.
2. Mass concrete shall be poured in lifts not exceeding 1.0 m in height unless otherwise indicated on drawings or as directed by the Project Engineer and Executing Agency. Horizontal lift shall not be more than 150 cm in thickness, according to provision of IS:457.
3. Formwork and reinforcement shall be approved in writing by the Project Engineer and Executing Agency before concrete is placed. Concrete shall be placed only after all preparations for casting have been approved by the Project Engineer and Executing Agency and approval given to proceed with the casting in writing on pour card to be maintained by the Concessionaire for this purpose
4. Concrete, when deposited, shall have a temperature of not less than 5 degrees Centigrade and not more than 40 degree Centigrade. When depositing concrete in very hot weather, precautions shall be taken so that the temperature of wet concrete does not exceed 40 degrees Centigrade while placing. This shall be achieved by stacking aggregates under the shade and keeping them moist, starting curing before concrete dries out, etc. However, before mixing / placing concrete, when the above temperature conditions vary on either side, approval of the Project Engineer and Executing Agency shall be obtained for the method of execution.

# Protection and curing of concrete

1. Newly place concrete shall be protected by approved means from rain, sun and wind. Concrete placed below ground level, shall be protected from falling earth, during and after placing. Concrete placed in ground containing any deleterious substances, shall be kept free from contact with such ground or with water draining from such ground, during placing of concrete and for a period of atleast three days or as otherwise instructed by the Project Engineer and Executing Agency.
2. The ground water around newly poured concrete shall be kept down to an approved level by pumping or other approved means of drainage. Adequate steps shall be taken to prevent floatation or flooding. Steps, as approved by the Project Engineer and Executing Agency,

shall be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

1. As soon as the concrete had hardened sufficiently for the surface not to be marked, it shall be kept in a damp or wet condition by pounding or by covering with a layer of sacking, canvas, hessian or similar materials and kept continuously wet for atleast seven days after final setting. This period may be extended, at the discretion of the Project Engineer and Executing Agency, upto fourteen days. Curing of horizontal surfaces exposed to drying winds shall begin immediately after the concrete has hardened. Concrete slabs and floors shall be cured for the periods mentioned above by flooding with water of minimum 25mm depth.
2. Approved curing compounds may be used in lieu of moist curing with the permission of the Project Engineer and Executing Agency. However, such permission may be granted only in specific cases. Such compounds shall be applied to all exposed surfaces of the concrete, as soon as possible after the concrete has set.
3. Quantity of water applied shall be such as to prevent erosion of freshly placed concrete.

# Construction joints

1. When work has to be interrupted, the concrete shall be rebated and/or keyed at the joint to such shape and size as may be required by the Project Engineer and Executing Agency or as shown on the drawings. All vertical construction joints shall be made with stop boards, which are rigidly fixed and slotted to allow for the passage of the reinforcing steel. In the case of water retaining structures, basements, tunnels, etc. water stop of approved material shall be provided, if so specified on the drawings or as directed by the Project Engineer and Executing Agency.
2. Construction joints shall be located as shown or described on the drawings. Where it is not described, the joints shall be in accordance with the following guidelines.
   1. In a column, the joints shall be formed about 75 mm below the lowest soffit of the beams framing into it, including haunches, if any. In flat slab construction, the joint shall be 75 mm below the soffit of the column capital.
   2. Concrete in a beam shall be placed throughout without a joint. If unavoidable, the joint shall be vertical and within the middle-third of the span. When a beam intersects a girder, the joints in the girder shall be given an offset equal to a distance twice the width of the beam and additional reinforcement provided for shear. The joints shall

be vertical throughout the full thickness of the concrete member with suitable shear key wherever shown on the drawing.

* 1. A joint in a suspended floor slab shall be vertical at one quarter points of the span and at right angle of the principal reinforcement.
  2. Construction joints in equipment foundations shall not be provided without specific concurrence of the Project Engineer and Executing Agency.
  3. Vertical construction joints in water retaining structures shall not be permitted unless shown on the drawings.

However, if the Concessionaire desires any adjustments in the location of construction joints (to suit site conditions) from those shown on drawings or from those explained above, he shall obtain prior approval from the Project Engineer and Executing Agency.

1. Before fresh concrete is placed, the cement skin of the partially hardened concrete which was poured earlier shall be thoroughly removed and the surface made rough and aggregate exposed, by wire brushing, hacking, water jetting, air jetting or any other method as directed by the Project Engineer and Executing Agency. The rough surface shall be thoroughly wetted for about ½ hour and shall be dried and coated with 10 to 15 mm thick layer of 1:1 freshly mixed cement and sand slurry. Special care shall be taken to see that the first layer of concrete placed after a construction joint is thoroughly rammed against the existing layer.
2. In forming a joint, concrete shall not be allowed to slope away to a thin edge. The locations of construction joints shall be planned by the Concessionaire well in advance of pouring and they will have to be approved by the Project Engineer and Executing Agency. The

sequence of pouring, formwork details and their stripping times.

1. Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes. Care being taken to avoid dislodgement of particles of aggregates. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed shall be well rammed against old work, particular attention being to corners and close spots. Work thereafter, shall proceed in the normal way.
2. For multiple lift work a suitable gap shall be maintained between setting of the earlier placed concrete and the commencement of concrete pour. After depositing concrete in columns, piers or walked time gap of minimum 4 hours, preferably 24 hours shall be

maintained before depositing concrete in beams, girders or slabs, supported there in order to avoid cracking due to settlement.

# Work in extreme weather conditions

During hot weather (atmospheric temperature above 40 degree centigrade) of cold weather (atmospheric temp at 5 degree centigrade and below) the concreting shall be done as per the procedures and precautions set out in IS:7868 (Parts I and II).

# Cleaning and finishing of concrete

1. All concrete surfaces shall have an even and clean finish free from honeycombs, air bubbles, fins or other blemishes unmarred, reasonable smooth. The formwork joint marks on concrete work exposed to view shall be rubbed with carborandum stone and defects patched up with paste of cement sand mortar (1:2) and cured. The finish shall be made to the satisfaction of the Project Engineer and Executing Agency. Concrete surfaces to be subsequently plastered or where brickwork is to be built against them, shall be adequately hacked as soon as the form is stripped off so that proper bond can develop.
2. Immediately after removal of forms, the concrete shall be inspected and defective areas as pointed out by the Project Engineer and Executing Agency shall be removed partially or entirely as directed. Holes, left by form bolts, etc. shall be filled-up and made good with cement sand mortar of approved mix. All superficial defects such as honeycombing, rough patches, etc. shall be similarly made good. If the defective area is at a vulnerable location,

e.g. at the ends of beams & columns etc then it may be necessary to cut out the member completely or in part and reconstruct as directed by the Project Engineer and Executing Agency. If epoxies have to be used, the same shall be subject to the approval of the Project Engineer and Executing Agency. Poured concrete affected by faulty formwork shall be removed totally and replaced. If so directed, the Concessionaire shall have to resort to grouting / shotcreting.

1. A smooth finish shall be obtained with the use of forms having smooth and even surfaces and edges. Panels and form linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms, the joint marks shall be smoothened off and all blemishes, projections etc. removed leaving the surfaces reasonably smooth and unmarred.
2. Where integral cement concrete finish is called for, the surface shall be compacted and then floated and treated with a straight edge and any high and low spots eliminated. The work shall be carried out as per IS:2571

# Sampling, testing and quality assurance including construction tolerances

**General**

* + - 1. Concrete cubes for works tests shall be cured under laboratory conditions, except when in the opinion of the Project Engineer and Executing Agency, extreme weather conditions prevail at which time, these may require curing under job conditions.
      2. For the purposes of statistical analysis, any substandard cube result, which in the opinion of the Project Engineer and Executing Agency, is due to improper sampling, molding or testing shall be discarded and a dummy result shall be substituted. The value of a dummy result shall be equivalent to the average value of the cubes from the same grade of concrete tested immediately before and after the discarded result. The number of such substandard cubes shall not exceed 5%.

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falls below the compressive strength specified, the Project Engineer and Executing Agency shall have the right to order a change in the proportions or the water content for the remaining portion of the surface.

d) 

Engineer and Executing Agency shall have the right to require provisions for temperature and moisture control during the period of curing as necessary to secure the required strength, and may require retest in accordance with the standard method of securing, preparing and testing specimens from hardened concrete for compressive and flexural strengths, or load tests to be made on the portion of the building so affected. All such tests



1. Unacceptable concrete work shall be dismantled by the Concessionaire and replaced by fresh work, meeting the specification requirements. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, by the Concessionaire, to the satisfaction of the Project Engineer and Executing Agency, at no extra cost to the Executing Agency.
2. Only as a very special case and that too in non-critical areas, the Project Engineer and Executing Agency may accept concrete work which is marginally unacceptable as per the criteria laid down in IS:456.
3. Before placing concrete, the inside of forms shall be checked to ensure that they are clean and thoroughly wetted or adequately treated. So as to prevent absorption of water from the concrete.
4. Ultrasonic tests on the foundations of major equipment to ascertain the quality and grade of concreting shall be carried out. The Executing Agency shall arrange for the specialized

agency for conducting the test at his cost. The Concessionaire shall provide all the necessary facilities and arrangement for conducting the test at site in terms of access, scaffolding etc. In case of any defects, the Concessionaire shall rectify the same as directed by the Project Engineer and Executing Agency.

1. Rebound hammer test shall be carried out for ascertaining the quality of concrete work, as directed by the Project Engineer and Executing Agency.
2. Test shall be conducted for the water tightness of the liquid retaining structures as per IS:3370 and IS:6494. The details and sequence of tests shall be as given hereunder:
   1. All arrangements, including supply of water for testing purposes, shall be kept ready when the tank is nearing completion.
   2. Water supply to the tank shall be in stages of 300 to 450 mm height in order to check the water tightness of the tank and location of leakage of various levels.
   3. The permissible drop in level in 24 hours shall be 6 mm in case of covered reservoir/tank and 12 mm in the case of open reservoir/tank.
   4. The leakage points shall be marked and separately treated after dewatering.
   5. The reservoir / tank shall be retested for water tightness after rectification.
   6. For basement type structures like cable vault, track-hopper, tunnel, neutralizing pit, etc. the Concessionaire shall examine the water tightness against ingress of sub-soil water.

# Sampling of concrete

Samples from fresh concrete shall be taken according to IS:1199 and tested as per IS:516.

1. Normally only compressive test shall be performed but the Project Engineer and Executing Agency may require other tests to be performed in accordance with IS:516.

# i) Trial Mixes:

Atleast four trial mixes shall be made with; min. 6 test cubes for each mix.

# ii) Works Tests:

The min. frequency of sampling of concrete of each grade shall be according to clause

14.2.2 of IS:456-1978. However, after getting continuous satisfactory results and in the case of voluminous concrete works, the Project Engineer and Executing Agency, may at

his discretion reduce the frequency of sampling as follows.

For each grade of concrete, and for each 8 hours (shift) of work or part thereof, atleast one sample consisting of six specimens shall be taken from each 150 cum. of concrete or part thereof, 3 specimens shall be tested at 7 days and remaining 3 shall be tested at 28 days. However, in all cases, the 28 days compressive strength shall alone be the criterion for acceptance or rejection.

1. To control the consistency of concrete from every mixing, slump tests and compaction factor tests in accordance with IS:1199 shall be carried out by the Concessionaire every two hours or as directed by the Project Engineer and Executing Agency. Slumps corresponding to the test specimens shall be recorded for reference.
2. The strength of sample shall be the average of the strength of three specimens. The individual variation should not be more than 15% of the average.

# Unless otherwise specified, the tolerance in construction shall be as follows:

The dimensions of concrete as cast when compared with those on the drawings shall be within the tolerance given below:

|  |  |  |
| --- | --- | --- |
| **Description of item / structural element** | **Permissible deviation in mm** | |
| Faces of concrete in foundations and structural members  against which backfillis placed. | +25 | -10 |
| Location of footing (for RCC framed structures only). | +25 | -25 |
| Eccentricity of footing | 2% of footing width of direction of  misplacement but limiting to 50mm | |
| Top surface of slabs and of concrete to receive base plates  to be grouted. | +5 | -5 |
| Alignment of beams, lintels, columns, walls, slabs and  similar structural elements | +5 | -5 |
| Deviation from specified dimensions of cross-sections of  columns and beams | +12 | -6 |
| Alignment of holding down bolts without sleeves. | +1.5 | -1.5 |
| Alignment of holding down bolts with sleeves. | +5 | -5 |
| Level of holding down bolt assemblies. | +10 | -10 |
| Embedded parts (in any direction). | +5 | -5 |
| Centres of packets or holes with greatest lateral dimension  not exceeding 150 mm. Variation in steps: | +10 | -10 |
| Riser | +1.5 | -1.5 |
| Tread | +3.0 | -3.0 |
| Plumb | 3mm for every metre subject to a  maximum of 10mm. | |

# Acceptance criteria

The acceptance criteria of concrete shall be in accordance with Clause no.15 of IS:456. However, in exceptional circumstances, the Project Engineer and Executing Agency may, at his discretion, accept a concrete of lower strength than that specified at reduced rates. The concrete shall be deemed to comply with the strength requirements if:

1. Every sample has a test strength not less than the characteristic value or
2. The strength of one or more samples, though less than the characteristic value, in each case is not less than the greater of :
   1. The characteristic strength minus 1.35 times the Standard Deviation and
   2. 0.80 times the characteristic strength; average strength of all the samples, is not less than the characteristic strength + [1.65 - 1.65/ square root of (No. of samples)] times the standard deviation.

# Load test

If any work is found unacceptable whereupon the Project Engineer and Executing Agency requires its removal and reconstruction, the Concessionaire may request that it should be load tested in accordance with the provision of Clause no. 16.50 of IS:456-1978 as given below:

1. The test load shall be 125 percent of the maximum superimposed load for which the structure or element was designed. This load shall not be applied earlier than 28 days after the effective hardening of concrete. This test load shall be maintained for 24 hours and during the entire duration of the test, struts, strong enough to take the whole superimposed, dead and other loads shall be placed in position, leaving a small gap under the members.
2. The maximum deflection shall be measured after the test load is in position for 24 hours. Thereafter, the test load shall be removed.
3. If 24 hours after the removal of the load, the structure does not show a recovery of atleast 75 percent of the maximum deflection, registered as in (b) above, the test shall be repeated after a lapse of 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not atleast 80% of the maximum deflection during the second test.
4. If the maximum deflection in mm, shown during 24 hours under load, is less than 40 l sq / D, where I is the effective span in metres and D is overall depth of the section in mm, it is not necessary for the recovery to be measured and the recovery position of the above mentioned clause (c) will not apply.

# Reinforcement

* + 1. **Scope**

This section of the specification deals with reinforcement for all reinforced concrete works and covers the requirement of materials, their properties, storage, handling, furnishing of bar bending schedules and the cleaning, bending, binding and placing of reinforcement with suitable cover blocks. This shall also include the supply of reinforcement, wherever required.

# General requirements

The Concessionaire shall prepare and furnish to the Project Engineer and Executing Agency, bar bending schedules for all RCC works for his review and approval. No work shall commence without the approval of bar bending schedule by the Project Engineer and Executing Agency, in writing.

The Concessionaire shall have to obtain prior written approval from the Project Engineer and Executing Agency, if he desires any adjustments in diameter or spacing of reinforcement. However, the Concessionaire shall modify the bar bending schedule, when a particular type and size of reinforcement would not be available, with the approval of the Project Engineer and Executing Agency.

# Materials

All steel for reinforced concrete works shall be in accordance with Technical Specification for Properties, Storage and Handling of common Building Materials, (vide module C2) which shall be deemed to form the part of this Specification.

All bars shall be thoroughly cleaned before being fabricated. Pitted and defective bars shall not be used.

# Bending and placing

**Bending**

* + - 1. Reinforcing bars supplied bent or in coils, shall be straightened before these are cut to size. Straightening of bars shall be done in cold and without damaging the bars. This is to be considered as a part of reinforcement bending and fabrication work.
      2. Unless otherwise specified, reinforcing steel shall be bent in accordance with procedure specified in IS:2502 and/or as approved by the Project Engineer and Executing Agency. Bends and shapes shall comply strictly with the dimensions shown on the approved bar bending schedules and they shall be rechecked by the Concessionaire before bending and he shall be entirely responsible for their correctness. Bars correctly bent, shall only be used. Unless specified otherwise or directed by the Project Engineer and Executing Agency, the detailing of reinforcement shall be in accordance with IS:5525 and SP:34.
      3. No reinforcement shall be bent, when in position in the work without approval of the Project Engineer and Executing Agency, whether or not it is partially embedded in concrete. Where the reinforcement bars are bent aside, at construction taken to ensure that, at no time, the radius of the bend is less than 4 times the bar diameters for plain mild steel or 6 times the bar diameters for deformed bars. Care shall also be taken while bending back bars, to ensure that the concrete around the bar is not damaged.
      4. Welding of bars to obtain continually shall not be allowed, particularly for cold twisted bars, unless specifically approved by the Project Engineer and Executing Agency. If welding is approved, the work shall be carried out as per IS:2751 and IS:9417, according to the best practice and as directed by the Project Engineer and Executing Agency.

# Placing in position

1. All reinforcement shall be accurately fixed and maintained in position as shown on the drawings by such approved means as steel chairs, and/or concrete spacer blocks as per IS:2502. Bars intended to be in contact at crossing points by two numbers annealed steel wire of 0.9 mm to 1.6 mm size conforming to IS:280 in such a manner that they do not slip over each at the time of fixing & concreting. The tying of bars shall be in crisscross manner.
2. Binders shall tightly embrace the bars with which these are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of spacer bars. These shall be so spaced that the main bars do not sag perceptively between adjacent spacers.

Bundled bars shall be provided wherever shown on the drawing to facilitate concreting. Location of laps and development lengths, shall be as indicated on the drawings.

1. The placing of reinforcement shall be completed well in advance of concrete pouring. Just prior to concrete pouring, the reinforcement shall be checked by the Project Engineer and Executing Agency, for accuracy of placement and cleanliness. Necessary corrections, as directed by the Project Engineer and Executing Agency shall be carried out. Care shall be taken to ensure that projecting ends of ties and other embedded metal do not encroach into the concrete cover. Where concrete blocks are used for ensuring the cover and positioning of reinforcement, these shall be made of mortar 1:2 (1 cement : 2 sand) by volume and cured for at least seven days. The sizes and locations of the concrete blocks shall be approved by the Project Engineer and Executing Agency. The 28 days crushing strength of cover blocks shall be atleast equal to the specified strength of concrete in which the blocks will be embedded.
2. Laps and anchorage length of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller diameter will guide the lap length. Laps shall be staggered as far as practicable and as directed by the Project Engineer and Executing Agency and not more than 50% of bars shall be lapped at a particular section. Mechanical connections, for splicing reinforcement bars in congested locations may be used by the Concessionaire, only if approved by the Project Engineer and Executing Agency. Reinforcement bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

# Cover to reinforcement

* + - 1. Unless shown otherwise on the drawings, minimum clear concrete cover for reinforcement (exclusive of plaster or other finishes) shall be as follows:

At each end of a reinforcing bar, not less than 25 mm, nor less than twice the bar diameter.

For a longitudinal reinforcing bar in a column, 40 mm or bar diameter whichever is more. 25 mm cover may be adopted for columns of minimum dimension 200 mm or under and with longitudinal reinforcement diameter not exceeding 12 mm.

For longitudinal reinforcing bars in a beam, not less than 25 mm or less than the bar diameter.

For reinforcement in slabs and walls; not exposed to weather or ground not less than 15 mm nor less than the bar diameter.

For bottom reinforcement in footings: 75 mm, if concrete is laid against the ground or 40 mm if laid on a layer of lean concrete.

For retaining walls, grade beams, top and sides of footings and similar surfaces exposed to weather or ground; 50 mm for bars larger than 16 mm and 40 mm for bars upto 16 mm.

For concrete members exposed to the action of harmful chemicals, acids, alkalis, atmosphere, sulphurous smoke, seawater etc., the cover shall be as shown on the drawings.

For liquid retaining structures; 40 mm or diameter of main bars, whichever is larger. This shall be increased to 50 mm in case of seawater or corrosive environment.

* + - 1. Clean distance between reinforcing bars shall be in accordance with IS:456 or as shown on drawings.

# Sampling, testing and quality assurance

**General**

Sample bent bars shall be checked to ensure that they conform to the bar bending schedules.

Reinforcement in position shall be checked for proper positioning, and rigidity, cover, spacing of bars, placement of chairs and spacers, etc. Also it shall be checked that all bars at crossings are properly tied.

# Tolerance

Tolerance in construction, unless otherwise specified or as approved by the Project Engineer and Executing Agency shall be as follows:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Description of item / structural element** | | | | | **Permissible deviation in mm (Max.)** | | |
| **Placing of reinforcement** | | | | |  | | |
| For effective depth 200 mm or less | | | | | +10 | -5 |  |
| For effective depth more than 200 mm | | | | | +15 | -10 |  |
| Cover to reinforcement | | | | | -5 | | |
| **Cutting of reinforcement** | | | | |  | | |
| When minimum length specified | | | | | +75 |  | - |
| When maximum length specified | | | | | - |  | -50 |
| When maximum  specified | or | minimum | length | not | +75 |  | -25 |

# Formwork and staging

* + 1. **Scope**

This section of the specification deals with the requirements for the supply, erection, dismantling of formwork and staging required for cast-in-situ concrete works including for making pockets / block outs.

# General conditions

The Concessionaire shall supply, fabricate, erect, and dismantle (after use) all staging that is required for all activities covered under the specifications. He shall prepare the scheme and submit along with the supporting calculations for approval of the Project Engineer and Executing Agency.

# Materials

Formwork shall compose of steel, best quality wood or non-absorbent type plywood. Timber shall be free from significant knots and shall be of medium grain as far as possible and hard woods shall be used as caps and wedges under or over posts. Timber shall be well seasoned, free from sap, shakes, worm holes, warps or other surface defects and shall have smooth finish.

Staging, unless specified otherwise, shall generally be of mild steel tubes, steel beams and channels etc. or strong sal ballies 150 mm in diameter or above. Bamboos, small diameter ballies etc., shall not be used unless approved by the Project Engineer and Executing Agency in specific

cases.

# Classification of formwork

* + - 1. **Ordinary**

This shall be used in places where ordinary surface finish is required and shall compose of steel and/or approved good quality seasoned wood. Plywood shuttering can also be used by the Concessionaire.

# Plywood

This shall be used in exposed surfaces as shown on drawings or as directed by the Project Engineer and Executing Agency where a specially good finish is required. Such surfaces shall be formed using approved brand of heavy quality water resistant plywood to produce a perfectly leveled, uniform and smooth surface. Reuse of such forms may be permitted only after inspection and approval by the Project Engineer and Executing Agency, for each such reuse.

# Formwork for shell roofs

For this item, the detailed design of formwork shall be submitted by the Concessionaire to the Project Engineer and Executing Agency, well in advance, for his approval. Units of shell forms may be used repeatedly but prior approval shall be required for each repetition. Extra care shall be taken to keep correct levels and profiles.

# Quality of formwork and staging

Formwork shall consist of all materials required for forming the boxing to pour concrete, including steel / wood / plywood forms, ties, anchors, hangers, inserts, etc. Formwork shall be so constructed that vertical and horizontal adjustments can be made as required. The design and engineering of formwork including staging as well as its erection and dismantling shall be the responsibility of the Concessionaire.

The staging shall be true and rigid and thoroughly braced in both directions as well as cross braced, strutted and propped such that it will not deform unduly under weight of concrete and other loads due to men, equipment, etc. Vertical member or props should not be supported on an unpropped lower suspended floor or beam unless it is ensured by the Concessionaire that the lower floor or beam can safely carry the loads. No propping shall take place until the Project

submitted along with supporting calculations.

The forms and staging shall be sufficiently strong to carry without under deformation, the dead weight of the concrete as liquid as well as anticipated working loads. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration, without

appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of mortar. The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete, must be brought to the notice of the Project Engineer and Executing Agency immediately and rectified as directed.

To achieve the desired rigidity, ample studs, braces, bolts, spacer blocks, wires, clamps, ties, straps, shores, etc. Shall be used to hold the form in proper position without undue distortion. These shall be approved by the Project Engineer and Executing Agency but they must in no way impair the strength of concrete or leave stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Bolts passing completely through liquid and or earth retaining walls / slabs, basement walls etc. For the purpose of securing and aligning the formwork, shall not be permitted.

For exposed interior and exterior concrete surfaces of beams and columns, plywood or other approved forms thoroughly cleaned and tied together with approved corrosion resistant devices shall be used. Rigid care shall be exercised ensuring that all column forms are plumb and true and thoroughly cross-braced to keep them so.

Beveled strips 25x25 mm shall be provided to form angles and in corners of columns and beam boxes for chamfering of corners if shown on drawings or directed by the Project Engineer and Executing Agency. Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where these are necessary and as may be directed by the Project Engineer and Executing Agency. The temporary openings shall be so formed that they can be conveniently closed rigidly when required and must not leave any mark on the concrete.

If it is so desired by the Project Engineer and Executing Agency, the Concessionaire shall prepare, before commencement of the actual work, designs and drawings for formwork and staging and get them approved by the Project Engineer and Executing Agency. Formwork shall be so designed and positioned that it can be removed without damage to concrete.

The Concessionaire shall maintain necessary camber in centering for all floor slabs and beams in all spanning directions, so as to offset the deflection and assume correct shape. The camber shall have the crown of not less than 8 mm for every 5 metres span unless otherwise shown on the drawings. For cantilever, camber at free end shall be 1 in 100.

The Concessionaire shall provide the shuttering for complete stretch of work upto expansion joints for the structures like shell, folded plate etc. and/or as directed by the Project Engineer and Executing Agency.

# Cleaning and treatment of forms

All forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before these are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before

concrete is poured. Wire brushes, brooms, compressed air jet and/or water jet etc. shall be kept handy for cleaning, if directed by the Project Engineer and Executing Agency.

Before formwork is placed in position, the form surfaces that will be in contact with concrete shall be treated with approved non-staining oil or composition, which is insoluble in water and not injurious to concrete. Care shall be taken that the oil or composition does not come in contact with reinforcing steel or stain the concrete surfaces. Burnt oil shall not be allowed to be used specially where the concrete surface will require finishing and/or plaster.

# Removal of forms

The Concessionaire shall begin the removal of formwork only after the approval of the Project Engineer and Executing Agency. He shall place on record the dates on which the concrete is placed in different parts of the work and the dates of the removal of formwork therefrom. This record shall be checked and countersigned by the Project Engineer and Executing Agency. The Concessionaire shall be responsible for the safe removal of formwork but the Project Engineer and Executing Agency may delay the time of removal if he considers it necessary. Any work showing signs of damage through premature removal of formwork, shall be entirely removed and reconstructed by the Concessionaire at no extra cost to the Executing Agency.

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls may be removed first, leaving the beam bottoms and their supports in position. Re-propping of beams shall not be done except with the approval of the Project Engineer and Executing Agency. Formwork for columns and walls at each stage of concreting shall be erected only upto the particular lift of construction. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment of the formwork and to allow it to be removed gradually without jerking the concrete.

Forms of various types of structural components shall, under normal circumstances, not be removed before the minimum periods specified in Cl. 10.3 of IS:456-1978, which shall also be subject to the approval of the Project Engineer and Executing Agency. However, in any case formwork shall not be struck until the concrete has reached strength, atleast twice that of the stress to which the concrete may be subjected to at the time of removal of forms.

In normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods, according to clause no. 10.3 of IS:456-1978.

|  |  |  |
| --- | --- | --- |
| i. | Walls, columns and vertical faces of all structural members  as directed by the Project Engineer and Executing Agency. | 1 to 2 days |
| ii. | Slabs (Props left under) | 3 days |
| iii. | Beam soffits (props left under) | 7 days |
| iv. | **Removal of props under slabs** |  |
|  | Spanning up to 4.5 m | 7 days |
|  | Spanning up to 4.5 m | 14 days |
| v. | **Removal of props under beams** |  |

|  |  |  |
| --- | --- | --- |
|  | Spanning up to 6 m | 14 days |
|  | Spanning over 6 m | 21 days |
| vi. | Cantilever slabs | 14 days |

The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

Where the shape of the element is such that the formwork has reentrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

In case of cantilever slabs, the removal of forms shall begin from the outer edge and proceed towards the support, where as in the case of slabs supported on two/four sides, the removal of forms shall begin from centre to supports.

The formwork shall be so made as to produce a finished concrete, true to shape, lines, plumb and to dimensions as shown on the drawings. The Project Engineer and Executing Agency may call for finished work at any time to set standards of workmanship. Once approved, these will become the accepted Sample.

In case PPC/PSC is used instead of OPC, the removal of shuttering/support shall be after 50% more time from that being applied for OPC, unless otherwise permitted by the Project Engineer and Executing Agency. For concrete temperature above 40 C, stripping time shall be increased. In case of special structures, such as shells, folded plates, etc., the sequence of removal of forms shall be as per drawings or as directed by the Project Engineer and Executing Agency.

# Reuse of forms

Before reuse, all forms shall be thoroughly scraped, cleaned, all nails and adhering substances removed, holes and leaks satisfactorily plugged, joints examined and where necessary repaired and inside surfaces treated as specified herein before. Formwork shall not be used/re-used, if declared unfit or unserviceable by the Project Engineer and Executing Agency.

# Testing and quality assurance (including dimension tolerance)

**General**

Staging shall be checked for its soundness as a whole and for adequacy of the joints and its foundations. All joints shall be either vertical or horizontal and shall be such as to avoid loss of liquid through the formwork.

# Dimensional tolerance for formwork

Levels and heights 6 mm

Plumb 3 mm for every metre subject to a maximum of 10mm. Unevenness of any surfaces 3 mm

Length or breadth 12 mm

Diagonals 15 mm

In case of inclined surfaces like track hopper wall, folded plates etc., the deviation in the alignment of inclined surfaces, shall not exceed 3 mm with reference to the theoretical alignment, for a length of 1000 mm measured vertically, subject to a maximum of 10 mm.

In addition to above, requirement of clause no. 10.3 shall be complied with, which shall be the final acceptance criteria of concrete work.

# Embedded parts

* + 1. **Scope**

This section of specification deals with the supply, fabrication (where called for) and/or erection of embedded steel parts and PVC pipes

# General requirements

Embedded steel parts shall be furnished by the Executing Agency for transportation & erection by the Concessionaire or supplied, fabricated and erected by the Concessionaire as stipulated. If supplied by the Executing Agency, these parts shall be furnished anywhere within the project area and the Concessionaire shall transport the same to the work site.

* + - 1. Embedded steel parts supplied, fabricated and erected by the Concessionaire shall include items such as, but not limited to, foundation grillages, anchor bolts, pipe sleeves, equipment mounting plates, steel pieces properly welded with necessary lugs as shown on the drawings, auxiliary framing for equipment supports, pesty plugs for door and window frames, dowel bars for concrete work, miscellaneous frames, etc.
      2. Embedded steel parts supplied, fabricated/erected by the Concessionaire shall also include items such as, but not limited to plate inserts, edge protection angles, rolled sections with or without properly welded lugs.
      3. Cold work deformed steel bars shall not be used for lugs.

# Materials

The materials shall be in accordance with the relevant clauses of Technical Specification for

be deemed to form a part of this specification. Mild steel pipes shall conform to IS:1161. Unless otherwise specified, medium class pipes shall be provided/ PVC pipes shall conform to IS:4985. Minimum pressure rating shall be 2 Kgf/cm2.

# Fabrication, erection etc.

The Concessionaire shall fabricate, transport to site and erect accurately in position all embedded steel parts either by welding, bolting or any other means as approved by the Project Engineer and Executing Agency. Exposed surfaces of embedded parts other than holding down bolts, unless otherwise stated, are to be painted with two coats of approved anticorrosive paint (as per IS:2074) and/or bituminous paint as directed. The threads of holding down bolts shall be greased and protected with waterproof tape.

During erection, the Concessionaire shall provide necessary strong temporary bracings and supports to ensure proper installation of the embedded parts which shall be erected at the true locations as shown on the drawings and these shall be in plumb and level (unless otherwise shown on drawings). The Concessionaire shall furnish the Project Engineer and Executing Agency with fabrication and assembly drawings prepared for embedded steel parts showing the erection procedure, for major items, wherever necessary.

Fabrication & erection shall be carried out as per IS:800. Welding rods & site / field welding shall conform to IS:816 and IS:9595. IS:7634 (Part - III) shall be followed for PVC pipe works.

# Foundation bolt assembly

* + 1. **Scope**

This section of the specification deals with the requirements of supply, fabrication and erection of foundation bolt assembly etc.

# General requirements

Supply, fabrication, erection and installation of Foundation bolt assembly shall comprise of foundations bolts, stiffener plates, washers, nuts, lock nuts, pipe sleeves etc.

# Materials

Foundation bolts shall generally conform to IS:5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade-I of IS:432, IS:226, IS:2062 or any other material including high carbon/high tensile steel as specified.

Hexagonal nuts and lock nuts shall conform to IS:1363 & IS:1364 upto M 36 dia and IS:3138 and M 42 to M 150 dia.

Flat plain washers shall be of mild steel and punched/machined type conforming to IS:5369. Steel pipe sleeves shall conform, to Medium class of IS:1161.

# Fabrication, erection, etc

The fabrication and erection of bolt assemblies shall include threading, cutting, grinding, drilling, welding, etc., complete. All bolts, bolts assemblies, etc. shall be fabricated by the Concessionaire to the correct dimensions and shapes as shown on drawings, supplied by the Engineer. The bolts shall have coarse pitch screw thread in the diameter range, 8 to 64 and 6 mm pitch screw for diameter 64 mm as per IS: 4218.

For fabrication of any particular size of bolt indicated on the drawing, the diameter of the threaded portion of the bolt shall be considered as the diameter of the bolt.

Every bolt shall be provided with steel washer, under the nut. The washer shall be flat and min. outside circle have a diameter 2.50 times that of the bolt and of suitable thickness. All nuts shall be of steel with well formed hexagonal heads unless specified otherwise, forged from solid metal and shall be dipped in hot boiled linseed oil as soon as these are made. The nuts shall fit good on the bolts.

During erection, the Concessionaire shall provide necessary template, temporary bracings, supports, etc. to ensure proper positioning of the assemblies and holding them firmly until they are cast / grouted and the grouted has set. All materials shall be erected in plump and in level (unless otherwise specified) and at true locations as shown on the drawings. Threads shall be protected by using PVC taps.

Fabrication & erection shall be carried out as per IS:800. Welding shall conform to IS:816 and 9595.

# Shotcreting

* + 1. **Scope**

This section of the specification deals with the requirements of furnishing and placement of shotcreting.

# General requirements

Generally, shotcreting shall be done in accordance with IS:9012.

Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

* + - 1. Reinforcement in one direction consisting of 6 mm M.S. bars at 750 mm c/c shall be connected to the lugs of fastening of the wire fabric. This shall be used in case of 50 mm or above thick shotcreting.
      2. Wire fabric conforming to IS:1566 shall be used as reinforcement and shall consist of wire, 3 mm diameter, spaced 50 mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6 mm bars for 50 mm (min) thickness. Adjacent sheet of wire fabric shall be lapped at least 100 mm tied.
      3. Clear cover to reinforcement mesh shall not be less than 15 mm.

This work shall be executed only by experienced operators, approved by the Project Engineer and Executing Agency.

Minimum thickness shotcreting shall be 50 mm. for abrasion resistant and 25 mm for ordinary surface protection work.

# Materials

Generally, the materials shall be in accordance with the relevant clauses of Technical Specification for properties. Storage and Handling of common Building Material, which shall be deemed to form a part of this Specification.

* + - 1. Fine aggregates shall consist of natural sand or crushed stone from a known source and shall be strong, hard, coarse, sharp chemically inert, clean and free from any coating. It shall be free from clay, coal or coal residue, organic or any other impurities that may impair the strength or durability of the concrete and shall conform to IS:383.
      2. Fine aggregate (sand) shall be well graded and particles shall range in size within the following limits. The Project Engineer and Executing Agency, may approve the use of any other grading as per the requirements of IS:9012.

|  |  |
| --- | --- |
| **IS sieve designation** | **Percentage passing by weight** |
| 10 mm | 100 |
| 4.75 mm | 90 100 |
| 2.36 mm | 60 95 |
| 1.18 mm | 45 80 |
| 600 microns | 35 60 |
| 300 microns | 8 30 |
| 150 microns | 0 10 |

* + - 1. The fineness modules shall be preferably between 2.5 & 3.3. Any other value can be used, with prior approval of the Project Engineer and Executing Agency.

Water shall be clean & free deleterious matter and shall have same properties, stipulated for use in concrete work.

Set accelerating and water-proofing shotcreting admixtures of approved make shall be used wherever required.

# Application

After the placement of reinforcement and/or welded mesh and not more than six hours prior to the

application of shotcrete, the surface shall be thoroughly cleaned of all loose material and dirt. The Concessionaire shall properly prepare the surfaces, reinforcement and/or welded mesh to receive the shotcrete. Cleaned surfaces shall be wetted not more than one hour prior to shotcreting.

The mix as placed on surface shall one part cement to three parts approved sand by volume. Cement and sand shall be dry mixed; no water shall be added after mixing and before using in the gun. The quantity of water when added, shall be only that which is sufficient to hydrate the cement. For average atmospheric conditions, the water cement ratio for shotcrete in place shall be between 0.35 and 0.5. Suitable admixture shall be used wherever required.

A uniform pressure of not less than 2.5 Kgf/cm2 at the nozzle shall be maintained. Necessary adjustments shall be made to ensure this pressure, taking into account the length of hose and height of the place to be shotcreted.

The application shall proceed in an upward direction. Beams, stiffener and intermediate walls, if any, shall be wrapped with wire fabric and completely covered with shotcreting. All rebound shall be removed from the area of application as the work progresses and such rebound material shall not be reused.

# Curing

As soon as the freshly shotcreted surface shows the first dry patches, a fine spray of water shall be applied to keep it moist. After the surface has hardened, it shall be kept continuously moist for minimum seven days. If there is extreme heat, especially when accompanied by hot winds, the shotcreted surface, immediately upon completion, shall be covered with burlap of similar covering, which must be kept continuously moist for 14 days after shotcreting. The temperature of the lining shall not be permitted to exceed 38 Degrees Centigrade during placing and curing.

# Grouting

* + 1. **Scope**

This section of the specification deals with the requirements of furnishing and placement of grout in block outs and foundation bolt holes and underpinning of base plates In case special type of grouting is required for the machine base plate, the Concessionaire shall submit the details of the same and get it approved from the Project Engineer and Executing Agency.

# General requirements

The space between the top surface of the foundation and the underside of the base plate shall be filled with appropriate grout.

Crushing strength of grout shall be one grade higher than the foundation concrete. Minimum crushing strength shall be 25N/sq.mm. Unless otherwise specified.

The contact area between the grout and base plate shall not be less than 80%.

# Materials

Cement shall be Ordinary Portland Cement slag cement or Pozzolana Portland Cement conforming to IS:269, 455 and 1489 respectively.

Sand shall be clean and well graded conforming to IS 383. For flow able grout, sand conforming to Zone - 4 grade shall be used. Coarse aggregate wherever used shall also conform to IS:383.

Clean potable water as recommended for concrete mix shall be used.

# Admixtures

* + - 1. Non-shrink admixtures of approved make shall be used.
      2. Plasticizer conforming to IS:9103 shall be used to increase the workability, wherever required.

# Mixing and placing

**Type of mix**

There shall generally be following three types grout mix::

1. Ready mixed non-shrink cementations grout
2. Cement-Sand Grout: The proportion of cement to sand shall generally be 1:2, unless otherwise specified.
3. Cement Aggregate Grout: The approximate proportions of cement, sand and coarse aggregate shall be 1:1:25:2, with a maximum size of aggregate as 10 mm. This mix shall generally be used for grout thickness above 40 mm for dry pack application.

# Mixing

Depending upon the case of placement and method of application, there shall be following three grout consistencies.

1. **Fluid Mix:** Water cement ratio shall be 0.6 (max.) may be added to increase workability, wherever required. This grout mix shall be suitable for application with low pressure grouting equipment or self flowing and suitable for grouting of pockets/block outs, etc.
2. **Plastic Mix:** Water-Cement ratio shall be about 0.5. This grout mix shall be suitable for application with trowel or rod.
3. **Stiff Mix:** Water-cement ratio shall generally be 0.4. This grout mix shall be suitable for dry-pack application. The consistency should allow pressurizing into firm hardball without cracking.

# Placing

The block outs, bolts holes etc. Which have to be grouted, shall be cleaned thoroughly by use of compressed air just prior to taking up the grouting operations.

Cement, sand, aggregate, and non-shrink admixture of approved quality and proven make shall be



shall then be prepared by mixing this admixture with water. Any grout which has been mixed for a period longer than half an hour shall not be used on the work.

Immediately after preparation, a grout of suitable mix shall be poured into the block outs, pockets and bolt holes either from the sides or through the holes provided for this purpose in the base plate, by using special equipment for pressure grouting. It shall be ensured by Roding and by tapping of bolts that the block out is completely filled without leaving any voids. The pouring shall cease as soon as each hole is filled and any excess grout found on the surface of the concrete foundation shall be completely removed and the surface dried.

The space between the top surface of the foundation concrete and the underside of the base plate shall be filled with appropriate grout type. Grouting, once commenced, shall be done continuously. Grout shall be worked from one end to the other (to prevent air entrapment) and until the grout oozes out through the grout holes provided in the base plates.

In case of stiff mix, the space between the top surface of foundation concrete and the underside of the base plate shall be dry packed by firmly pressing or ramming into place against fixed supports.

When it is clear that the centre of base has been properly filled, the grout outside the base plate shall be briefly rammed to ensure compaction below the edges. Shims provided for the alignment of plant bases shall be positioned at the edges of the base to permit subsequent removal, which shall take place not less than 7 days after the grouting has been executed. The resulting cavities shall be made good with the same grade of grout as has been used for grouting under the rest of the base plate.

# Curing

The work shall be cured for a period of atleast 7 days commencing 24 hours after the completion of the grouting. The curing shall be done by covering the surfaces with wet gunny bags and flooding.

# Encasement of steel structures / elements

* + 1. **Scope**

This section of specification deals with the requirement for encasement of steel work in concrete

with necessary formwork, placing, finishing and curing, complete as per drawings and specifications.

# General requirements

All concrete work, reinforcement, formwork & staging work shall be done as per stipulations of section 2, 3 and 4 of this specification.

The reinforcement to be provided for encasement of steel elements shall be mild steel bars or in the form of wire netting. Such reinforcement shall be kept 20 mm away from the steel member and held securely to it.

The minimum grade of concrete to be used for encasing shall be M-20 unless specified. The aggregate to be used in concrete shall be 12.5 mm maximum size unless specified otherwise. In case of box type steel sections, encasement shall be done with cement, sand mortar (1:4) with thickness of 50mm over 0.9 mm size wire netting conforming to IS:3150, or as shown on the drawings.

In the case of encasement of beams with concrete, if the gap between the edge of the shuttering and flange is hardly sufficient for placing the concrete, the workability of the concrete shall be increased suitably by increasing the water-cement ratio.

Minimum cover for concrete encasement shall be 50 mm

# Materials

The materials shall be in accordance with the relevant clauses of Technical Specification for Properties, Storage and handling of common Building Materials which shall be deemed to form the part of this specification.

# Wire netting

Hexagonal wire netting shall be 0.9 mm dia and 19 mm aperture size, conforming to IS:3150.

# Joints in concrete

* + 1. **Scope**

This section of the specification deals with the requirement of furnishing and installing of joints including joint filler materials, water bars, resilient pads type vibration damping material in an around the side of concrete works etc.

# General requirements

Details of joints shall be as approved by Project Engineer and Executing Agency or as per approved drawings. Where necessary or / and specified, joints shall be made water tight by use of water stops.

# Classification of joints

From the point of view of utility, the joints as provided may be classified as below:

# Construction joints

Construction joints are produced by placing fresh concrete against surface of hardened concrete. Construction joints are generally, but not necessarily, vertical or horizontal. Requirements of construction joints shall be as per clause specified elsewhere.

# Contraction joints

These are provided to eliminate tensile stresses due to shrinkage and are commonly used where temperature variations are small and where there is no likelihood of expansion, such as spaces below water and earth levels and unexposed to atmosphere. At contraction joints, the reinforcement is discontinued and bond is not allowed to develop between the joint faces, thereby introducing a structural discontinuity. A contraction joint also serves as a construction joint so far as break in the pouring of concrete is concerned.

# Expansion joints

These are provided either to completely eliminate or to significantly reduce comprehensive stresses in concrete that would otherwise result from thermal expansion and might crush, buckle or crack part of the structure. Expansion joints serve the purpose of contraction and also construction joints.

# Control joints

At places where cracking is inevitable, places of weakness are introduced by the provision of control joints so that the cracking takes place along these joints instead of allowing it to develop in a haphazard manner.

# Separation joints

The places where the expansion of the structure is not expected but they are required to be kept structurally separate so that stresses, vibrations, etc. are not transferred, a separation joint should be provided. Like expansion joint, a gap is provided in separation joint also, but this is not expected to be used by the expansion of members. In case, no gap is required, the separation joint can be obtained by using an approved alkathene sheet stuck on the surface against which concrete shall be placed.

# Settlement joints

Structures, which are likely to settle with respect to the adjacent structures, shall be separated by a settlement joint so that the adverse effects of differential settlement are obviated. It is like an expansion joint but with a different sealing arrangement.

# Materials

**Joint filler**

# Bitumen board:

The bitumen impregnated fiber board; a preformed material shall be used as joint filler which shall fill space between the concrete surfaces at the joints. The minimum thickness of board shall be 12 mm and the material shall conform to IS:1838.

# Expanded polystyrene :

The expanded polystyrene slab shall be of fire retarding grade (type-2) conforming to IS:4671 Density of material shall not be less than 25 kg/cum.

# Water stops

1. Water stops shall be provided at the joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure.
2. The water stops shall be either metallic like Copper, or non-metallic like P.V.C. the material is to be procured from reputed manufacturers having proven records of satisfactory supply of Water Stops of similar make and shape of other jobs. Only PVC water stop shall be used, unless, otherwise, specifically approved by the Project Engineer and Executing Agency.

# Non-metallic Water Stop :

These will be normally in PVC and can be of shape having any combination of the following features:

* 1. Plain
  2. Central Bulb
  3. Dumb-bell or flattened ends
  4. Ribbed and Corrugated Wings
  5. V-shaped
  6. Kicker type (Externally placed)

Water bars shall generally meet the stipulations of IS:12200. The minimum thickness of PVC Water Stops shall be 5 mm and the minimum width 225 mm, unless otherwise specified in the schedule of items. However, for some non-critical areas 150 mm wide and

5 mm thick water stop can be used. The actual size and the shape will be as shown on drawings and/or as directed by the Project Engineer and Executing Agency. The material should be of good quality Polyvinyl Chloride, highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The performance requirements shall generally be as follows:

|  |  |  |
| --- | --- | --- |
| Sp. Gr | : | 1.3 to 1.4 |
| Shore hardness | : | 60A to 80A |
| Tensile strength | : | 116kgf / cm2 min. |
| Max. Safe continuous temp. | : | 70 degree C. |
| Ultimate elongation | : | Not less than 300% |
| Tear resistance | : | 45kgf / cm2 min. |
| Stiffness in flexure | : | 25kgf / cm2 min. |
|  |  |  |
| **Accelerated extraction** |  |  |
| i) Tensile strength | : | 110kgf / cm2 |
| ii) Ultimate elongation | : | 250% |
| iii) Water absorption in 7 days | : | 5% (max.) |
|  |  |  |
| **Effect of Alkali** | **:** | 7 days |
| 1. Weight increase | **:** | 0.25% max. |
| 2. Weight decrease | **:** | 0.10% max. |
| 3. Hardness change | **:** | + 5 % |
|  |  |  |
| **Effect of Alkali** | **:** | 28 days |
| a) Weight increase | **:** | 0.40% max. |
| b) Weight decrease | **:** | 0.30% max. |
| c) Dimension change | **:** | +1% |

# Sealing compound

1. **Bitumen sealing compound:**

The bitumen sealing compound shall be from approved manufacturer and shall conform to the requirements of IS:1834. For joints in concrete lining on canals/reservoirs, sealing compound conforming to IS:5256 shall be used.

# Polysulphide sealing compound:

This shall be two-part polysulphide sealant and shall be from approved manufacturer, conforming to IS:12118. Materials shall consist of polysulphide polymer and a curing agent. Gun grade material shall be used unless otherwise specified. The application of the

delines.

# Metal cover strips

Metal cover strips shall be made from aluminium or mild steel sections as shown on drawings. The min. thickness of aluminium strips shall be 3 mm and that of mild steel 6 mm. Aluminium alloy strip shall be corrosion resistant grade 31000 as per IS:737. Mild Steel shall conform to IS:226 or IS:2062.

# Resilient pads

1. The vibration damping material shall be resilient rubber pads made up of natural or synthetic rubber and shall have the following physical properties
   1. urometer hardness : 50 (+) / (-) 5
   2. Min. elongation : 450%
   3. Ultimate min. tensile strength : 145 kg/sq.cm
   4. Rubber pads shall not absorb more than 10% of weight of water in a 7 days test.
2. The minimum thickness of the resilient pads shall be 12 mm.

# Installation

**Bitumen board / Expand polystyrene**

The bitumen impregnated fiber board may be secured to vertical concrete by nails in the first placed concrete. The joint filler shall be coated on both faces with coal-tar pitch conforming to IS:216 or bitumen grade conforming to IS:73 or IS:702.

1. Water stops shall not have any longitudinal joints and shall be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacture

approved by the Project Engineer and Executing Agency. Suitable field splicing kit including heater shall be used for this purpose. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

1. As Non-metallic Water Stops can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Project Engineer and Executing Agency. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or approved by the Project Engineer and Executing Agency, taking particular care to match the centre and the edges accurately.
2. Particular care shall be taken for the correct positioning of the water stops to prevent any faulty installation, which may result in joint leakage.

Adequate provisions shall be made to support the water stops during the progress of work and to ensure their proper embedment in the concrete. The symmetrical halves of the water stops shall be equally divided between the concrete pours adjacent to the joints.

Max. Density and imperviousness of the concrete shall be ensured by thoroughly working in the vicinity of joints. However, particular care should be exercised in use of vibrators in the proximity of joints to avoid dislodging of the water stops.

# Splices

Splices in the continuity of intersections of runs of water stops shall be jointed as per

 of water stops used. In case of a cross section, overlapping must not be done but, instead factory made cross joint should be used. It is essential that the material is not damaged during the splicing operation and that the continuity of the entire water stops across the section be maintained.

# Inspection

All water stops installations shall be subject to inspection and approval by the Project Engineer and Executing Agency, before concreting operations, encasing water stops, are performed**.**

# Sealing compound

When directed, the gap in joints shall be thoroughly cleaned and sealing compound laid as per



For reservoir/canal lining, procedure as stipulated under clause 9.0 of IS:5256-1969 shall be followed.

# Metal cover strips

The metal cover strips shall be pinned (using stainless steel) at one end and slotted at the other end. Exposed surface of mild steel shall be painted with two coats of approved anti-corrosive paint (as per IS:2074) and/or bituminous paint. Welding of aluminium shall be in accordance with IS:2812.

# Resilient pads:

The resilient pads shall be installed around the foundation or at other locations as shown on the drawings. The pads shall be installed in position by sticking the same to the foundations by using approved glue.

# Waterproofing / damp proofing of underground concrete structures

* + 1. **Scope**

This section of specification deals with the retirements of all works for completing water proofing

/ damp proofing of underground concrete structure. This shall include water retaining and basement type structures.

# General requirements

As a general guidance, the provisions of IS: 6494 shall be followed unless otherwise mentioned.

The Concessionaire shall do the proper concreting so that concrete is water tight in itself without any waterproofing treatment. The waterproofing treatment shall be provided in exceptional cases, as additional precaution, as shown on the drawings or directed by the Project Engineer and Executing Agency.

The work of waterproofing / damp proofing of underground concrete structures by course of bitumen felt, blown bitumen or any other operations shall be entrusted by the Concessionaire to one of the well known expert agencies approved by the Project Engineer and Executing Agency. Actual type of waterproofing treatment to be provided for particular structure, shall be as shown on the drawings or directed by the Project Engineer and Executing Agency.

# Bitumen felt treatment

**Materials**

* + - 1. The materials shall be in accordance with the relevant clauses of Technical specification for properties, Storage and Handling of Common building materials
      2. The bitumen felt shall conform to IS: 1322 and the workmanship to IS:1609 and IS: 3067. The bitumen felt shall be hessian based. Bitumen primer shall conform to IS: 3384. The bonding materials shall consist of blown type bitumen conforming to IS: 702 or residual bitumen conforming to IS:73 or a mixture of the two, to withstand local conditions of prevailing temperature gradient of surface. The Concessionaire shall satisfy the Project Engineer and Executing Agency that the bonding materials proposed to be used are suitable for the particular job.

# Installation

1. Waterproofing / Damp proofing for horizontal surfaces, unless specified otherwise with two layers of felt on which subsequently concrete shall be placed, shall be provided with the following treatments :
   1. A minimum of 12mm thick plaster 1:4 (1 cement : 4 sand) with waterproofing admixture / additives over PCC
   2. One coat of bitumen primer @ 0.4 kg/Sqm min.
   3. One layer of hot applied bitumen @ 1.5kg/sq.m. min.
   4. One layer of self-finished felt (type - 3, grade II as per IS: 1322).
   5. One layer of hot applied bitumen @ 1.5 kg/Sqm min.
   6. One layer of self-finished felt (type - 3, grade - II as per IS: 1322).
   7. One layer of hot applied bitumen @ 1.5 kg/Sqm min.
   8. A minimum of 12mm thick plaster 1:4 (1 cement: 4 sand ).
2. Water proofing / Damp proofing for other surfaces (including vertical) unless specified otherwise, with two layers of felt shall be provided with following treatments:
   1. One coat of bitumen primer @ 0.4 kg/Sqm min.
   2. One layer of hot applied bitumen @ 1.5 kg/Sqm min.
   3. One layer of self-finished felt (type - 3, grade - II as per IS: 1322).
   4. One layer of hot applied bitumen @ 1.5 kg/Sqm min.
   5. One layer of self-finished felt (type - 3, grade II as per IS: 1322).
   6. One layer of hot applied bitumen @ 1.5 kg/Sqm min.
   7. A minimum 25mm thick plaster 1:4 (1cement: 4 stand).
   8. Half brick masonry work in cement mortar 1:4 (1 cement: 4 sand) using bricks of class designation 75, unless otherwise specified.

# Miscellaneous treatment

**Plastering treatment**

After the side walls are constructed and allowed to undergo the specified curing, the surface of the walls and the flooring should be made rough with a hacking tool, washed clean with water and wire brushed so as to remove all the loose material, and a waterproof cement plaster 1:3 mix, with suitable proportion of an integral waterproofing compound shall be applied in two coats, the first coat being 12mm thick and the next 10mm thick. The second coat shall be applied after allowing a time interval of at least 24 hrs for the first coat to harden. Hexagonal galvanized netting of 0.90mm dia, 19 mm aperture size shall be used in the plastering. The netting shall be fixed with the help of MS Screws, fixed with the help of fibrous plugs provided before application of first layer of plaster.

# Hot applied bitumen treatment

The external concrete of plastered surface shall be carefully cleaned, cured and allowed to dry for some time before the application of a coat of hot bitumen of the industrial grade 85/25 conforming to IS : 702 against ground water seepage. Rate of application of bitumen shall not be less than 1.7 kg/Sqm and it should be heated to about 120 C before application. Anti-stripping

compound shall be added. Anti-stripping and adhesion improving agent shall be 100% mixable in bitumen. The stripping and adhesion improving agent shall be 100% mixable in bitumen. The stripping value tested as per IS: 6241 should be nil when recommended quantity of anti-stripping compound is mixed. Nominal mix proportion of the compound shall be 1 percent by weight of bitumen. However, actual mix proportion shall be as per manufacturer's recommendation.

# Polymer modified cementitious coating treatment

* + - 1. **Materials**
         1. Modified liquid polymer blend shall be a dispersion containing 100% acrylic based polymer solids.
         2. Portland cement based dry powder
         3. Clean, fine specially prepared quartz sand approximately 0.6 mm size.

# Mixing

The liquid polymer shall be stirred well and cement base powder shall then be added slowly to make a slurry mix. For preparation of brush topping mix, quartz sand shall be added slowly and mixed well till a homogenous mixture is obtained. The mix shall be used within half an hour of the preparation. Addition of quartz sand may not be necessary, in case dry power contains the same.

# Properties of the coating

* + - * 1. It must adhere to the wet surface
        2. It should develop adequate bond strength with the concrete surface, not less than 2 N

/ Sqm

* + - * 1. Co-efficient of permeability shall be about 5 x 10 Cms
        2. Water absorption after continuous soaking shall not be more than 1%.
        3. The materials shall be permeable under water vapor.
        4. T  underground water with normal pH value between 4 and 14.
        5. The co-efficient of thermal expansion of the material shall be close to that of concrete.

# Application

The concrete surface shall be cleaned and made free from grease, oils or loosely adhered particles. The surface shall be damp without any free water.

* + - * 1. For slurry mix: a minimum of 2 coats shall be applied on the surface. The first coat being applied when the surface is still damp and left to harden for 4 to 6 hours. After

4 to 6 hours of the application of second coat, it shall be finished by rubbing down with a soft dry sponge. The coverage shall not be less than 1.1kg/sq.m in the 2 coats. A lap of 75mm shall be provided at the joints.

The coating shall be air dried for 4 to 6 hours and, thereafter, cured for 7 days after the application of last coat.

* + - * 1. For brush toping mix: This shall be applied in two coats. A primary coat of slurry mix can also be first applied on the surface as first coat. After the coating has dried up, a coat of brush toping mix shall be applied over it with a push broom or any other similar brush. It shall be left in broom finished condition. The nominal thickness shall be 1.5mm and minimum thickness shall be 1.0mm. A lap of 75mm shall be provided at the joints. It shall be ensured that no pinhole exists and re-brushing shall be done to cover the pinholes if any.

The coating shall be air dried for 4 to 6 hours and thereafter cured for 7 days after application of last coat.

# Chemical injection treatment

Wherever shown on the drawing or directed by the Project Engineer and Executing Agency, min 12mm dia (N.B.) threaded nozzle of suitable length, shall be provided over the surface ad along the construction joint line in a grid pattern at a spacing not exceeding 1.5m c/c before concreting operation. Adequate precaution shall be taken to keep the nozzles plugged at both ends to prevent them from getting closed by concrete.

For fixing of any nozzle in set concrete suitable size hole shall be drilled, preferably by using repercussive hammer drill electrically operated, in grid pattern and grouting nozzle shall be fixed in these holes.

After the nozzles are fully set, neat cement slurry admixed with water-soluble non-shrink polymer/monomer based chemical shall be injected through the network of nozzles with low pressure grout pumps at a pressure of about 2.0 kg/sq.cm. Water cement ratio of the slurry shall not be more than 1:2. The resultant solution shall not have viscosity greater than 1:2 centipoises. Plasticizing agent shall be added wherever required. The grouting shall be started at very low pressure and increased gradually to a required pressure. The grouting shall continue till the hole refuses to take any further grout, even at an increased pressure. Applied pressure shall not be more than the designed strength of the concrete. After completion of grouting operation, the nozzles shall be sealed properly to the satisfaction of the Project Engineer and Executing Agency.

# Dismantling / demolishing work - RCC and PCC

* + 1. **Scope**

This section of specification deals with the requirements of dismantling / demolishing RCC and / or PCC work.

# General requirements

The dismantling implies, carefully taking up or down and removing without damage, this shall consist of dismantling one or more parts of a structure. This includes chipping work, making holes/ opening etc in concrete members according to the required shape, size and profile at all elevations.

The term demolition implies, taking up or down or breaking up of a structure / member in part or full as specified or shown on drawings or as directed by the Project Engineer and Executing Agency.

In a structure / member, both dismantling and demolishing work may be involved. In such case, the portion of work treated as demolishing shall be as shown on the drawing or as decided by the Project Engineer and Executing Agency.

All materials obtained from the demolition/dismantling work shall be the property of the Executing Agency, unless otherwise specified.

All serviceable materials obtained, shall be separated out and stacked properly upto a lead of 500 metres and all unserviceable materials, rubbish etc shall be disposed off as directed by the Project Engineer and Executing Agency..

The dismantling / demolishing operations shall be carried out in proper sequence so that the serviceable material can be salvaged, without being damaged during the process of work.

Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property which is to be left intact, before dismantling / demolishing work

# Safety

All demolition work shall be carried out in conformity with the local safety regulations, extreme caution being exercised to avoid damage to the work and the equipment, which are to be left intact. Necessary precautions shall be taken to keep the dust nuisance down. Safety requirements in IS: 4130 shall also be followed.

As and where necessary, the dismantled / demolished materials shall be lowered to the ground and not thrown and then properly stacked as directed by the Project Engineer and Executing Agency. Wherever required, temporary enclosures shall be erected to minimize the dust or moisture infiltration.

# Cement additives / admixtures in concrete

* + 1. **Scope**

This section of specification deals with the requirements of furnishing, placing and mixing cement additives / admixtures, in all kinds of cement concrete, (plain or reinforced) for all kinds of structures at all levels.

# General requirements

The Concessionaire shall furnish all labour and equipment to place and mix waterproofing cement additive and cement plasticizer in concrete of any grade and cement mortar. Thereafter he shall carry out the work as specified earlier in relevant clauses of this specification for concrete and hence complete the work as indicated on the drawing and as per the specification listed hereunder.

Waterproofing additive and other types of admixtures shall be as far as possible, free from aggressive chemical like chloride, sulphide etc., which can cause corrosion of steel reinforcement in RCC.

The Concessionaire shall have the services of the manufacturer's supervisor, at no extra cost to the Executing Agency, to supervise the work, if directed by the Project Engineer and Executing Agency.

Admixtures in concrete for promoting workability, improving strength, entraining air or for similar purposes may be used only after the written permission from the Project Engineer and Executing Agency, is obtained. Addition to admixtures shall not reduce the specified strength or durability of concrete in any case. The admixtures shall conform to IS: 9103 and shall be of proven make and from a reputed manufacturer. Calcium chloride shall not be permitted to be used other than in mass (plain) concrete works.

# Materials

Waterproof cement additive shall conform to IS: 2645 and shall be of proven make and from a reputed manufacturer.

Admixtures in concrete shall conform to IS: 9103 and shall be of proven make and from a reputed manufacturer. In addition, for plasticizer cum waterproofing compound materials shall meet the permeability requirements as per IS: 2645. Similarly, for plasticizer cum retarder admixture material shall satisfy the setting time requirements of retarder and other properties of plasticizer as per IS: 9103.

# Mixing

Admixtures / waterproofing additive shall be used at the rate specified by the manufacturer or as indicated on the drawings and shall be mixed with water, as required by the Project Engineer and Executing Agency. Samples of concrete in which admixture and / or waterproofing cement additive is added shall be tested for water proofness, workability, compressive strength, water

absorption, density, setting time, etc., the results shall conform to relevant IS specifications.

# Table - 4: Frequency of sampling and testing

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Nature of test/**  **characteristics** | **Method of**  **test** | **No. of samples**  **& frequency of test** | **Remarks** |
| 1. | **Coarse aggregates** |  |  |  |
| a) | Particle size & shape | IS:2386(Pt.1) | One per 100 cum. or part thereof or change of source whichever is earliest | Result to be as per the requirement of design mix, subject to variations within the limits specified in  relevant Indian Standards. |
| b) | Moisture content | IS:2386(Pt.3) | Once for each stack of  100 cum. or part thereof except during monsoon when this has to be done every day before starting of the work. | Accordingly water content of the concrete shall be adjusted. |
| c) | Specific gravity,  density, voids, absorption. | IS:2386(Pt.3) | Once in 12 weeks or change of source whichever is earlier | These tests shall be carried out while establishing design mix and results to be  intimated. |
| d) | Mechanical properties, crushing value, abrasion value and  impact value. | IS:2386(Pt.4) | Once per source | Acceptance norms shall be as per IS:383 |
| e) | Soundness | IS:2386 (Pt.5) | Once per source | Acceptance norms shall be  as per IS:383. |
| f) | Reaction with alkali. | IS:2386 (Pt.7) | Once per source | These tests shall be carried out while establishing design mix and result to be intimated. Acceptance shall  be as per IS:2386 (Pt.7). |
| g) | Flakiness and petro- graphic examinations | IS:2386 | This is to be done once and should be repeated in case the source is  changed. | These tests shall be carried out while establishing design mix and results to be  intimated. |
| h) | Deleterious materials | IS:2386 (Pt.2) | Once per source | Results should be within the limit as specified in relevant Indian Standards  and in this Specification. |
| 2. | **Fine aggregates /**  **sand** |  |  |  |
| a) | Particle size and shape. | IS:2386 (Pt.1) | One per 100 cum. or part thereof or change of source, whichever is  earlier. | Should be as per the requirement of design mix, subject to variation within  the limit as specified in |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Nature of test/**  **characteristics** | **Method of**  **test** | **No. of samples**  **& frequency of test** | **Remarks** |
|  |  |  |  | relevant IS Codes. |
| b) | Specific gravity,  density, voids, adsorption and bulking. | IS:2386 (Pt.3) | Once in 12 weeks or  change of source whichever is earlier | These tests will be carried  out while establishing design mix and results to be intimated. |
| c) | Bulk age, moisture  content (Routine test) | IS:2386 (Pt.3) | To be done every day  before start of work. | Volume of sand and weight  of water shall be adjusted as per bulk age and moisture content. |
| d) | Silt, clay deleterious  materials, organic impurities. | IS:2386 (Pt.2) | Once per source and to  be repeated, if source is changed. | Volume of sand and weight  of water shall be adjusted as per bulk age & moisture content. |
| e) | Soundness and  Petrographic examination. | IS:2386 (Pt. 5  & 8) | Once per source. | Acceptance norms shall be  as per IS:383. |
| f) | Mortar making  properties. | IS:2386 (Pt.6) | -do- | Acceptance norms shall be  as per IS:383. |
| g) | Reaction with alkali. | IS:2386(Pt.7) | Once per source | Acceptance norms shall be  as per IS:383 and IS:2386 (Pt.7). |
| 3. | **Cement** |  |  |  |
| a) | Setting time | IS:4031 | One sample of each  received from stores. | Acceptance norms shall be  as per relevant Indian Standard |
| b) | Compressive Strength | IS:4031 | -do- | -do- |
| 4. | **Water** |  |  |  |
|  | Harmful substances,  pH value, initial setting time, compressive strength. | IS:3025,  IS:4031 & IS:516 | Once a month for each  source | Acceptance norms shall be  as per Cl.4.3 of IS:456- 1978. |
| 5. | **Concrete** |  |  |  |
| a) | Workability (Slump  and compaction factor) | IS:1199 | One sample every two  hours from every mixing plant. | Acceptance value shall be  as per Cl. 6.1 of IS:456- 1978. |
| b) | Crushing Strength | IS:516 | 1. As per Cl.14.2.2 of   IS:456-1978 for  initial period   1. One sample of six cubes per 150 cum or part thereof for mass concrete for   subsequent period. | Acceptance criteria shall be  as per Cl.15 of IS:456- 1978. A minimum of 3 (Part-7) specimens shall be tested for 28 days strength. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Nature of test/**  **characteristics** | **Method of**  **test** | **No. of samples**  **& frequency of test** | **Remarks** |
| c) | Water-cement ratio | IS:119 | At random at the time  of batching | According to mix design |
| d) | Cement Content | IS:1199 | -do- | -do- |
| e) | Finished dimensions | Physical  measurement | All structures | Acceptance as per  Specification |
| 6. | **Form work**  a) Staging (Durability strength &  soundness of staging, joints, adequacy of its foundation and  specific level) | Visual | Each member | Any staging intended for use shall be approved by the Project Engineer and Executing Agency for its durability and strength |
|  |  |  |  | After erection of staging, nominated representatives of Project Engineer and Executing Agency shall check the soundness of the staging as a whole, its joints, adequacy of its foundation and the specific  levels. |
|  | b) Shuttering |  |  |  |
|  | i) Materials | Visual | Random | Formwork materials shall be strictly as per specifications and approved of the Project Engineer and Executing Agency. Materials for formwork shall be unwrapped, thoroughly clean and without broken or damaged edges either due to repetitive use or otherwise. Oiling of for m work before concreting shall be resorted  to. |
|  | ii) Joints | Visual | Random | Joints shall be leak proof to  avoid loss of liquid |
|  | iii) Dimensions  and plumb | Physical measurement | Each member and before every lift. | Tolerance as per Specification |
| 7 | **Reinforcement** |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Nature of test/**  **characteristics** | **Method of**  **test** | **No. of samples**  **& frequency of test** | **Remarks** |
|  | a) Placement | Visual | each | The bar bending schedule  with the necessary hooks, laps, covers, spacers and chairs shall be 100% checked for all concreting works before start of the work. |
|  | b) Cutting tolerance | Physical  measurement | Random | Tolerance shall be as per  specification. |

* 1. **Slab on grade**

# Scope





duty industrial floors

# General requirements

The Concessionaire shall furnish all material/ labour and equipment. The specifications covered under section C-3, sub section 1 to 13 for cast in situ concrete and allied works shall generally be applicable unless otherwise specified here under.

The work includes right from preparation of sub grade to completing and curing slab on grade in all respects to the satisfaction of the Project Engineer and Executing Agency.

# Materials

1. Materials for filling shall be crushed stone dust, sand or other inorganic materials and they shall be clean and free from shingle, salts, organic matters, roots and excessive amount of sod, concrete or any other foreign substances which could harm or impair the strength of the substructure in any manner.
2. Stones for Granular sub base shall be broken stones to gauge not exceeding 63 mm and shall be free from dust, organic matters etc.
3. Maximum size of 40 mm stone aggregate shall be used for concrete.
4. Cement shall be ordinary Portland cement conforming to IS:269,Grade 43
5. Admixtures in concrete for improving workability, strength etc may be used only after the written permission from the Project Engineer and Executing Agency.
6. Water shall be clean, free from injurious matters. Potable water is generally considered satisfactory.
7. Reinforcing steel bars shall conform to grade 1 of IS:432 (part 1)
8. Polysulphide sealant shall conform to IS 12118 Gun Grade.
9. Concrete curing compound shall be CONCURE WB of M/s. Fosroc Chemicals (India) Ltd., or equivalent.

# Laying of slab on grade

1. Uneven (but fairly level) sub grade shall be dressed, leveled by necessary Excavation / Scraping / Filling, watered, rolled by 10T roller and consolidated to desired level.
2. On consolidated sub grade, two layers of granular sub base each of 75 mm thickness shall be laid Total consolidated thickness of sub base shall be 150 mm. Refer specification No.C-1.6.0 - Granular Sub Base (Hard core)
3. On consolidated sub base water proof paper shall be placed with minimum 150mm overlaps on all sides.
4. Concrete grade M20, 150 mm thick shall be poured in strips as per drawing and as directed by the Project Engineer and Executing Agency.

The strips shall be prepared by placing formwork in straight line and level. Each strip may be of size 4 metre wide x 20 metre long alternate strips shall be cast by leaving 24 hours interval in between.

Form work shall be strong enough to hold the screed vibrator.

The concrete shall be vibrated by screed vibrator / surface vibrator and when it becomes touch dry it shall be machine trowel led to smooth uniform level surface. Ramp surfaces

# Broom Finished

Under no circumstances dry cement or cement slurry shall be separately spread on concrete at any time.

Special care shall be taken to pour and vibrate the concrete along the form work to avoid any segregation of aggregate and honey combing.

1. 24 hours after concreting, the form work shall be removed and immediately the grooves of size 10mm x 50mm as shown on the drawing shall be cut in concrete at an interval of about

4.0 metres or as shown on the drawing.

The grooves shall be cleaned and concrete surface shall then be sprayed by water based concrete curing compound as specified. The grooves shall be filled up by poly sulphide sealant after fourteen days.

1. Dowels shall be provided along transverse and longitudinal construction joints as shown on the drawing.
2. Any expansion / contraction joints in slab on grade shall be provided at locations and as per the details indicated on the drawing.

# Acceptance criteria

All finished surface shall be smooth, uniform and at desired line and level within a tolerance of

3.0 mm. It shall be free from cracks and warping.

# Sub-section - C4

**Technical specification for masonry and allied works**

**Sub-Section - C4**

**Technical specification for masonry and allied works**

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**Section - C4: Technical specifications for masonry and allied works**

* 1. **Scope**

This section of the specification covers furnishing, installation including handling, transportation, batching, mixing, laying, scaffolding, centering, shuttering, finishing, curing, protection and repairing till handing over of brick masonry and allied works including DPC, plinth protection and dismantling.

# General requirements

The Concessionaire shall furnish all skilled and unskilled labour, plant, equipment, scaffolding, materials, etc. required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Project Engineer and Executing Agency.

All workmanship shall be in accordance with the latest standards and best possible practice. Masonry work shall be true to line & level as shown on drawings. All such masonry shall be tightly built against structural members and bonded with dowels, anchors, inserts, etc, as shown on the drawings.

The Concessionaire shall carry out all works for settling out the building lines, locating the co- mark, which shall be furnished by the Executing Agency, at one or more locations.

Any approval, instructions, permission, checking, review, etc. whatsoever by the Project Engineer and Executing Agency shall not relieve the Concessionaire of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

# Codes and standards

All applicable standards, acts and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Concessionaire.

In case of conflict between this specification and those (IS Standards, Codes etc.) more stingent shall prevail.

Some of the applicable Indian Standards, Codes, etc. are referred to here below:

|  |  |
| --- | --- |
| IS:1127 | Recommendations for Dimensions and Workmanship of Natural Building  Stones for Masonry Work. |
| IS:1597 | Code of practice for construction of Stone Masonry. |
| IS:1905 | Code of Practice for Structural Safety of Buildings - Masonry walls. |
| IS:2116 | Specification for sand for masonry mortars. |
| IS:2185 | Specification for Hollow cement concrete blocks |

|  |  |
| --- | --- |
| IS:2212 | Code of Practice for Brickwork. |
| IS:2250 | Code of Practice for preparation and use of masonry mortar. |
| IS:2572 | Code of Practice for construction of Hollow concrete block masonry |
| IS:3414 | Design and installation of joints in buildings. |
| IS:3696 | Safety code for scaffolds and ladders. |
| IS:4130 | Safety code during demolition of buildings. |
| IS:4326 | Code of practice for earthquake resistant design and construction of buildings |
| IS:12894 | Fly ash lime bricks specifications. |
| SP:20 | Explanatory hand book on masonry code. |

# Brick masonry

* + 1. **Materials**

Properties of common building materials for the construction of brick masonry, viz. burnt clay bricks, sand lime and cement shall be in accordance with the technical specification for



bricks, other type of bricks like, fly ash-lime bricks cured by autoclave process shall also be used, whenever specified, or shown on the drawing.

# Fly ash brick masonry

* + 1. **Materials**

Properties of common building materials for the construction of brick masonry, viz. fly ash bricks, sand lime and cement shall be in accordance with the technical specification for



ash bricks, other type of bricks like, fly ash-lime bricks cured by autoclave process shall also be used, whenever specified, or shown on the drawing.

# Mortar

IS: 2250 shall be followed as general guidance for preparation and use of mortar. Only cement & Fly ash-sand mortar shall be used. Lime shall be added for composite mortar with specific approval of the Project Engineer and Executing Agency.

Unless otherwise specified, mortar for brickwork having one or more brick thickness shall be 1 part cement & fly ash (20% replacement ratio of cement with fly ash): and 6 parts sand by volume. Mortar for half-brick thick walls shall be 1 part cement & fly ash (20% replacement ratio of cement with fly ash): and 4 parts sand by volume. Richer mix proportion shall be used, whenever specified or as per design requirement. Mortar shall meet the compressive strength requirement as per IS: 2250 and IS: 1905.

Sand shall conform to IS: 2116. Grading of sand when tested as per IS: 2386 shall be as specified in Table -1.

# Table 1: Grading of sand for use in masonry mortars

|  |  |  |
| --- | --- | --- |
| **IS sieve designation IS:460 (Part I)** | **Percentage passing by mass** | **Method of test** |
| 4.75mm | 100 | IS:2386 |
| 2.36mm | 90 to 100 | (Part-I) |
| 1.18mm | 70 to 100 |  |
| 600 micron | 40 to 100 |  |
| 300 micron | 5 to 70 |  |
| 150 micron | 0 to 15 |  |

Sand, whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, may be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of sand particles. Based on test results and in the light of practical experience with the use of local materials, deviation in grading of sand given in Table-1 may be considered by the Project Engineer and Executing Agency. The various sizes of particles of which the sand is composed, shall be uniformly distributed throughout the mass. The required grading may often be obtained by screening and/or by blending together either natural sands or crushed stone screenings, which are by themselves of unsuitable grading.

Cement, fly ash (20% replacement ratio of cement with fly ash): and sand shall be thoroughly mixed dry in a mechanical mixer and water shall then be added to obtain a mortar of the consistency of a stiff paste, care being taken to add just sufficient water for the purpose. Water shall be clean and free from injurious amount of deleterious matter such as oil, acid alkali, salt and vegetable growth. Hand mixing may be allowed by the Project Engineer and Executing Agency on clean approved platform in special cases only. Mortar shall be used as soon as possible after mixing, before it begins to set and preferably within 30 minutes after water is added to the dry mixture. Mortar unused for more than 30 minutes shall generally be rejected and removed from site of work. However, the Project Engineer and Executing Agency may allow the use of mortar upto 2 hours.

Surplus mortar droppings while laying masonry, if received on a surface from dirt, may be mixed with fresh mortar if permitted by the Project Engineer and Executing Agency, where direct for addition of extra cement and this shall be implemented.

# Laying

IS:2212 shall be followed as general guidance for construction of brick masonry Vat/tank of suitable size shall be provided by the Concessionaire for soaking of bricks. Bricks shall be soaked in water before use for a period generally not less than 6 hours so that the water just penetrates the whole depth of the bricks. Bricks shall be laid in by hand and not thrown inside the tank. Bricks shall be taken out sufficiently in advance so that these are skin dray at the time of laying.

Bricks shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond. Closers in such cases shall be cut to the required size and used near the ends of the walls, next to quoin headers.

Bricks shall be laid generally with frogs upwards. A layer of mortar shall be spread on the full width and over a suitable length of the lower course. Each brick shall be properly bedded and set home (in posi



face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of a course, all vertical joints shall be fully filled from the top with mortar. The thickness of joints shall be kept uniform and shall not exceed 10 mm. Bricks shall be so laid that all joints are full of mortar.

All face joints shall be raked to a minimum depth of 15 mm by raking tools during the progress of brickwork, when the mortar is still green, so as to provide proper key for the plaster or pointing to be done. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying.

Brickwork in walls shall be taken up truly plumb. All courses shall normally be laid truly horizontal unless indicated to be laid on slope and all vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. Brick wall shall be construed with atleast one plain face with proper alignment.

All connected brickwork shall be carried up simultaneously and no portion of work shall be left more than one metre below the rest of the work. Where this is not possible, in the opinion of the Project Engineer and Executing Agency, the work shall be raked back according to bond (and not toothed) at an angle not steeper than 45 deg. The work done per day should not be more than one metre height

All iron fixtures, pipes, water outlets, holdfasts for doors and windows, etc. which are required to be built into the brickwork shall be embedded in their correct position in mortar or cement concrete as the work proceeds as per directions of the Project Engineer and Executing Agency.

All brickwork shall be built tightly against columns, floor slabs or other structural parts and around door and window frames with proper distance to permit caulked joint. Where drawings indicate that structural steel columns and spandrel beams are to be partly or wholly covered with brickwork, the bricks shall be laid closely against all flanges and webs with all spaces between the steel and brickwork filled solid with mortar not less than 10mm in thickness.

The top courses of all plinth, parapet, steps and top wall below CRC shall be laid with brick on edge (other than modular size bricks) unless otherwise specified. Care shall be taken that the bricks forming the top courses and ends of walls are properly radiated and keyed into position as shown on the drawings.

Scaffolding shall be strong enough to withstand all the dead, live and impact loads which are likely to come upon it. It shall also be so designed as to ensure the safety of the workmen using them.

For all brick masonry except for exposed brickwork, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in header

course for the purpose. Only one header for each pose shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one metre in width. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

In case of joining old brickwork with new brick work, the old work shall be toothed to the full width of the new wall and to the dept of quarter of a brick in alternate courses. It shall be cleaned of all dust, loose mortar, etc., and thoroughly wetted before starting new brick work. Thickness of each course of new work shall be made equal to the thickness of the corresponding course of the old work by adjusting thickness of horizontal mortar joints.

The face of the brickwork shall be cleaned on the same day on which brickwork is laid and all mortar dropping removed promptly.

Template (bed-block) of plain or reinforced cement concrete shall generally be provided to support ends of RCC beams. Top surface of the wall shall be suitably treated as per direction of the Project Engineer and Executing Agency so as to minimise the friction to movement of the concrete slab over the bearing.

Brickwork shall be protected from rain by suitable covering when the mortar is green. Masonry work shall be cured by keeping it constantly moist on all faces for a minimum period of seven days. Brickwork carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

# Half brick masonry

The work shall be done in the same manner, as mentioned in 4.03 except that all course shall be laid with stretchers. In cases where reinforcement is considered necessary from structural consideration, 2 nos. 8 mm dia bars shall be provided generally at every 4th layer of bricks or as specified on the drawings. Before laying reinforcement, it shall be cleaned of rust and loose flakes with a wire brush. They shall be securely anchored at their ends where the partitions bond. Half the mortar thickness for the bedding joint shall be laid first and then 8mm dia bars laid straight out near each face of the brickwork maintaining a side cover of 12mm mortar. Subsequently the other half of the mortar thickness shall be laid covering the reinforcement fully.

# Exposed brickwork

Exposed brickwork i.e. brickwork is superstructure which is not covered by plaster shall be as shown on the drawings and shall be done by specially skilled masons. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. Thickness of brick courses shall be kept uniform and for this purpose wooden straight edge with graduations indicating thickness of each course including joint shall be used. The height of window sills, bottom of lintels and other such important points in the height of the wall shall be marked on the graduated straight edge. Masons must check workmanship frequently with plumb, spirit level, rule and string.

For all exposed brick work, double scaffolding having two sets of vertical supports shall be

provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

If face bricks are specified on the drawings, the brickwork shall be in composite work with face bricks on the exposed face and balance in standard bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from available stack of bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used, carborundum stone shall be used for rubbing down.

# Reinforcing anchorage

For external walls, the anchorage in the form of flats or rods from spandrel beams and columns and any other anchoring and reinforcement as shown on the drawing shall be adequately embedded in the masonry.

# Stone masonry

Rubble stone masonry which is commonly used in stone work has been covered under this specification. Details of construction for Random Stone Masonry (uncoursed) and Coursed Rubble Masonry (first and second sorts) are given in the following clauses. IS: 1597 shall be followed as general guidance for construction of stone masonry

# Stone masonry

The stone shall be of the type specified, such as granite, sand stone, quartzite and /or best locally available stone which shall be subject to approval of the Project Engineer and Executing Agency. It shall be obtained only from an approved quarry. Colour of the stone shall be as shown on the drawings or approved by the Project Engineer and Executing Agency. It shall be hard, sound, durable and free from decay, weathering. It shall also be free from defects like cavities, cracks, sand holdes, flaws, veins, patches of soft and loose materials, etc. Stones with round surface shall not be more than 5 percent when tested in accordance with IS: 1124. The minimum crushing strength of stone shall be 200 kg/sq cm unless otherwise specified.

# Size of stone

Normally, stones used should be small enough to be lifted and placed by hand. The length of stone, shall not exceed three times the height and the breadth on base shall not be greater than three fourth of the thickness of wall not more than 15 cm. The height of stone may be upto 30 cm.

# Mortar

Unless otherwise specified, mortar for stone masonry shall be 1 part of cement & fly ash (20% replacement ratio of cement with fly ash): and 6 parts sand by volume. Properties, preparation and use of mortar shall be same as specified for brick masonry work.

# Dressing of stone

The dressing of stone shall be as specified below for individual types of masonry work and it shall also conform to the general requirements for stone covered in IS:1129.

* + - 1. For Random Rubble Stone Masonry, stone shall be hammered the face, the sides and

the beds to enable it to come into close with the neighbouring stone. the bushing on the face shall be than 4 cm on an exposed face, and 1 cm on a face, to

* + - 1. For coursed Rubble Masonry (First sort) Face stones, shall dressed on all beds, and joints, so as to give them approx. angular shape.

# Laying

* + - 1. **Random rubble masonry**

All stones shall be wetted before use. The wall shall be carried up truly plumb or to the specified batter. Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Stones may be brought to level courses at plinth, window sills and roof level. Levelling up shall be done with concrete comprising of one part of mortar (used for the masonry) and two parts of graded stone aggregate of 20 mm nominal size. The bond shall be obtained by fitting in closely, the adjacent stones and by using bond stones.

Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints, the hearting or interior filling of the wall shall consist of rubble stones which may be of any shape but shall not pass through a circular ring of 15 cm inner diameter. Thickness of these stones in any direction shall not be less than 10 cm. These shall be carefully laid, hammered down with a wooden mallet into the position and solidly bedded in mortar. Clips and spells of stone shall be used where necessary to avoid thick mortar beds or joints and at the same time ensuring that no hollow spaces are left any where in the masonry. The hearting shall be laid nearly level with facing and backing except that at about one metre intervals, vertical

successive courses. The chips shall not be used below the hearting stone to bring these upto the level of face-stones. The use of chips shall be restricted to the fillings of interstices between the adjacent stones in hearting and these shall not exceed 20% of the quantity of stone masonry. The masonry in a structure shall be carried regularly. Where the masonry of one part has to be delayed, the work shall be raked back at an angle not steeper than 45 deg. Toothing in masonry shall not be permitted.

Bond or through stones running right through the thickness of walls shall be provided in walls upto 60 cm thick and in case of walls above 60 cm thickness, a set of two or more bond stones overlapping each other by atleast 15 cm shall be provided in a line from back to back.

In case of highly absorbent type of stones (porous lime stone and sand stone etc.) the bond stone shall extend about two third into the wall. Through stones in such cases may give rise to damp penetration and therefore, for all thickness of such walls, a set of two or more bond stones overlapping each other by atleast 15 cm shall be provided.

Where bond stones of suitable length are not available, cement concrete block of mix 1:3:6 (with 20mm nominal size graded stone aggregate) shall be used. Atleast one bond stone or a set of bond stones shall be provided for every 0.5 sq m of the wall surface. All bond stones in stone masonry shall be marked suitably as directed by the Project Engineer and Executing Agency.

The quoins shall be selected stones, neatly dressed with the hammer or chisel to form the required angle, and laid header and stretcher in the alternate layers. Volume of these stones shall not be less than 0.03 cu m.

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more that 20mm think. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

Single scaffolding having one set of vertical support shall be allowed. Masonry work shall be kept constantly moist on all faces for a minimum period of seven days. Green work shall be protected from damage, mortar dropping and rain during construction.

# Coursed rubble masonry (First Sort)

All stones shall be wetted before use. The walls shall be built up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 150 mm nor more than 300 mm. Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Face stones shall be laid in alternate header and stretcher fashion. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height. These shall be so arranged as to break joints by 7 atleast 75 mm. Each face stone shall be of the same height in any given course. The bond shall be obtained by fitting in closely the adjacent stones and by using bond stones.

Stones shall be laid with grains horizontal so that the load is transmitted along the direction of the maximum crushing strength.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar; chips and spalls of stone being used where necessary to avoid thick beds or joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these upto the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the

total volume of stone masonry. All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar. Face joints shall not be more than 10 mm thick. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20mm by raking took during the progress of work, when the mortar is still green.

Stone may be brought to level courses at plinth, window sills and roof level. Levelling up at plinth level, window sills and roof level shall be done with concrete comprising of one part of the mortar (use for the masonry) and two parts of graded stone aggregate of 20mm nominal size.

The masonry in a structure shall be raised up uniformly and regularly but where breaks are unavoidable, the work shall be raked back at angle not steeper than 45 deg. Too things shall not be allowed. Masonry on any day should not be raised by more than 1 metre in height.

Bond or through stones running right through the thickness of walls shall be provided in walls upto 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by atleast 150mm shall be provided in a line from face to back.

In case of highly absorbent types of stones (porous limestone and sand stone etc.) the bond stone shall extend about two-third into the wall. Through stones in such cases may give rise to damp penetration. Therefore, for all the thickness of such walls, a set of two or more bond stones overlapping each other by atleast 150mm shall be provided.

Where bond stones of suitable lengths are not available, cement concrete blocks of 1;3:6 mix (1cement : 3 sand : 6 graded stone aggregate 20mm nominal size) shall be used.

A bond stone or a set of bond stones shall be inserted 1.5 to 1.8 metres apart, in every course. All bond stones shall be suitably marked during construction for subsequent verification and shall be staggered in subsequent layers. The quoins shall be of selected stones, neatly dressed with the hammer or chisel to form the required angle. These shall be of the same height in which these occur. These shall be atleast 450 mm long and shall be laid stretchers and headers alternately. These shall be laid square on the beds, which shall be rough chisel dressed to a depth of atleast 100 mm. In case of exposed work, these stones shall have a minimum 25mm wide chisel drafts at four edges, all the edges being in the same plane. Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars less than one metre in width. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement : 3 sand : 6 stone aggregate 20 mm nominal size)

Masonry work shall be kept constantly moist on all faces for a minimum period of seven days. Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

# Coursed rubble masonry (second sort)

Laying of this type of masonry shall be in the same manner as First Sort masonry described above except for the following:

The use of chips for filling of interstices of adjacent stones in hearting shall not exceed 15% of the total volume of stone masonry, and stone in each course need not be of the same height, but more than two stones shall not be used in the height of a course. Face joints shall not be more than 20mm thick.

# Mouldings and cornices

The bricks or stones shall be cut and dressed to the required shape as shown on architectural drawings. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborundum stone.

# Plinth protection

Plinth of buildings shall be protected with brick on edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall consist of laying bricks conforming to class 50 (min.) of IS:1077 in cement mortar 1:6 (1 cement & fly ash (20% replacement ratio of cement with fly ash): : 6 sand) over a 75 mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. the top shall be finished with 1:3 cement mortar pointing (1 cement & fly ash (20% replacement ratio of cement with fly ash):: 3 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly over burnt and dense brick bats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required, slope around and building. The high portions of the ground should be cut down, hollows and depressions filled upto the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed and heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50 m or as directed by the Project Engineer and Executing Agency.

Over this, 75mm thick bed of dry brick aggregate of 40mm nominal size shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.06 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the sub grade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement & fly ash (20% replacement ratio of cement with fly ash): 6 sand) shall be laid. The soaking of bricks shall be done as per the relevant standard. The bricks shall be laid on edge in Diagonal / herring Bone Bond or other pattern as specified or as directed by the Project Engineer

and Executing Agency. Bricks shall be laid on 12mm thick mortar bed and each brick shall be prope  



inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The point shall be done in cement mortar 1:3 (1cement & fly ash (20% replacement ratio of cement with fly ash): 3 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge the mortar shall not spread over surface of the masonry.

Brick flooring and pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

# Damp Proof Course (DPC)

All walls in a building shall be provided with a damp proof course generally immediately below the underside of the ground floor or as shown on the drawings. This shall run without break throughout the length of the wall, even under door or other openings.

Damp proof course shall be 50 mm thick (unless, otherwise specified) consisting of cement concrete in proportion 1:1.5:3 (1 cement: 1.5 sand: 3 graded stone aggregate 10mm nominal size) mixed with water proofing cement additive as approved by the Project Engineer and Executing Agency. The additive shall be used in proportion recommended by the manufacturer.

The surface of masonry work shall be levelled and prepared before laying the cement concrete. Edges of DPC shall be straight and even. The side shuttering shall consist of wooden forms and shall be strong and properly fixed so that it does not get disturbed during compaction and mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the side shuttering are removed the surface should be smooth without any honeycombing. The top surface shall be double chequered and cured by pounding for atleast 7 days. The cement concrete shall be allowed to dry for atleast 24 hours after curing and hot bitumen of grade 85/25 conforming to IS:702 at the rate of 1.7 kg/sq metre shall be applied over the dried up surface of cement concrete after being properly cleaned with brushes and finally with a cloth soaked in kerosene oil. The bitumen shall be applied uniformly so that no blank spaces are left anywhere.

# Dismantling and demolition



consist of dismantling one or more part of the building as specified or shown on the drawings.

 up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on the drawings.

# General requirements

1. All materials obtained from dismantling or demolition shall be the property of the Executing Agency, unless otherwise specified and shall be kept in safe custody until

profile shown on the drawings or as directed by the Project Engineer and Executing Agency.

1. The dismantling or demolition shall always be planned before hand and shall be done in reverse order of the one in which the structure was constructed. The scheme shall be got approved from the Project Engineer and Executing Agency before starting the work.

# Precautions

1. Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property before dismantling or demolition is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions shall also be provided.
2. All demolition work shall be carried out in conformance with the local safety regulations, ensuring the safety of men and materials.
3. Necessary precautions shall be taken to keep down the dust nuisance.
4. All materials which are likely to be damaged during the operation shall be carefully removed first.
5. Dismantling shall be done in a systematic manner. The dismantled articles shall be passed by hand, where necessary, lowered to the ground (and not thrown) and then properly stacked as directed by the Project Engineer and Executing Agency.
6. Where fixing is done by nails, screws, bolts, rivets, etc. dismantling shall be done by taking out the fixing with proper tools and not be tearing or ripping off.
7. All serviceable materials obtained shall be separated out and stacked properly as directed by the Project Engineer and Executing Agency, upto a lead of 500m or handed over at

 rviceable materials, rubbish etc. shall be disposed off, as directed by the Project Engineer and Executing Agency.



# Sampling testing and quality control

* + 1. **General**

1. The Concessionaire shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Project Engineer and Executing Agency. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Project Engineer and Executing Agency. Tests shall be done in the field and at a laboratory approved by the Project Engineer and Executing Agency and the Concessionaire shall submit to the Project Engineer and Executing Agency, the test results in triplicate within three days after completion of a test. The Project Engineer and Executing Agency may at his discretion, waive off some of the stipulations given below, for small and unimportant operations.
2. Material / work found unsuitable for acceptance shall be removed and replaced by the Concessionaire. The works shall be redone as per specification requirements and to the satisfaction of the Project Engineer and Executing Agency.

# Quality assurance programme

The Concessionaire shall submit and finalise a detailed field Quality Assurance Programme according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus / equipment, deployment of qualified / experienced manpower, preparation of format for record, field quality plan etc. On finalised field quality plan, the Executing Agency shall identify, customer hold points beyond which work shall not proceed without written approval from the Project Engineer and Executing Agency.

Frequency of sampling and testing including the methods for conducting the tests are given in Table - 2. The testing shall be done at site. The testing frequencies set forth are the desirable minimum and the Project Engineer and Executing Agency shall have the full authority to carry out or all for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. Some of the type tests and performance tests

independent Government approved laboratory.

All masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the pretends properly aligned.

* + - 1. Deviation in vertically in total height of any wall of a building more than one storey in height shall not exceed +/- 12.5 mm.
      2. Deviation from vertical within a storey shall not exceed +/- 6mm per 3 m height.
      3. Deviation from the position shown on the plan of any brickwork more than one storey in height shall not exceed 12.5 mm.
      4. Relative displacement between load bearing walls in adjacent storeys intended to be in a vertical alignment shall not exceed 6 mm.
      5. Deviation of bed joint from horizontal in any length upto 12 m shall not exceed 6 mm, and in any length over 12m it shall not exceed 12.5mm total.
      6. Deviation from the specified thickness of bed-joints, cross joints or pretends shall not exceed +/- 3 mm.

# Table 2: Frequency of sampling and testing

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Type of material/**  **work** | **Nature of test / characteristics of test** | **Method of test** | **No. of samples and frequency** | **Remarks/ acceptance norms** |
| **1** | **2** | **3** | **4** | **5** | **6** |
| 1. | Burnt clay bricks/Fly ash bricks | (a) Dimensions | Clause No.5.2.1 of IS:1077 |  | Max. 8% deviation for non-modular bricks. For modular bricks as per Clause no.5.2 of IS: 1077.  For face bricks as  per IS: 2691. |
|  |  |  |  |  |  |
|  |  | (b) Compressive  strength | IS:3495 (Part-1) |  | As specified |
|  |  |  |  |  |  |
|  |  | (c) Water absorption | IS:3495  (Part-2) | A set of 20 bricks (min.) for each lot of 50,000 or part thereof for all tests  (a to c) | Max. 20%.  However, 15% for face bricks only. |
|  |  |  |  |  |  |
|  |  | (d) Efflorescence | IS:3495  (Part-3) |  | Moderate.  However for face brick nil. |
|  |  |  |  |  |  |
|  |  | (e) War page | IS:3495 |  | For face brick 2.5  mm (max.) |
|  |  |  |  |  |  |
| II. | Stone | a) Type of stone by  petro graphic examination | IS:1123 | One set of stones of each type and from each source. | As specified. |
|  |  |  |  |  |  |
|  |  | b) Shape & size | Physical  measurement | Random | As specified |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Type of**  **material/ work** | **Nature of test / characteristics of test** | **Method of test** | **No. of samples and frequency** | **Remarks/ acceptance norms** |
| **1** | **2** | **3** | **4** | **5** | **6** |
|  |  |  |  |  |  |
|  |  | c) Crushing strength | IS:1121  (Part-I) | One set of stones of  each type and from each source. | As specified |
|  |  |  |  |  |  |
|  |  | d) Water  absorption | IS:1124 | One set of stones of each type and from  each source. | As specified |
|  |  |  |  |  |  |
|  |  | e) Durability | IS:1126 | One set of stones of each type and from  each source. | As specified |
|  |  |  |  |  |  |
| III. | Sand | a) General quality | Visual | One set of samples  from each source of material per 100 Cum. or part thereof. | As specified |
|  |  |  |  |  |  |
|  |  | b) Deleterious material | IS:2386 (Parts-I  & 2) | One set of samples  from each source of material per 100 cum. or part  thereof. | Clause 3.3 of  IS:2116 |
|  |  |  |  |  |  |
|  |  | c) Grading | Sieve analysis as per IS:2386 (Part-I) | One set of samples from each source of material per 100 cum. or part  thereof. | Table-1 of IS:2116 |
|  |  |  |  |  |  |
| IV. | Cement | a) Setting time | IS:4031 | One set of sample for each lot of material received | No separate testing is required in case cement is tested for preparation of  concrete mix |
|  |  |  |  |  |  |
|  |  | b) Compressive strength | IS:4031 | One set of sample for each lot of material received | No separate testing is required in case cement is tested for  preparation of |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sl.**  **No.** | **Type of**  **material/ work** | **Nature of test / characteristics of test** | **Method of test** | **No. of samples and frequency** | **Remarks/ acceptance norms** |
| **1** | **2** | **3** | **4** | **5** | **6** |
|  |  |  |  |  | concrete mix |
|  |  |  |  |  |  |
| V. | Water | a) Harmful substances, pH value | IS:3025 | Once a month for each source | No separate testing is required in case water is tested for  concrete mix |
|  |  |  |  |  |  |
|  |  | b) Initial setting time | IS:4031 | Once a month for each source | No separate testing is required in case water is tested for  concrete mix |
|  |  |  |  |  |  |
|  |  | c) Compressive strength | IS:516 | Once a month for  each source | No separate testing  is required in case water is tested for concrete mix |
|  |  |  |  |  |  |
| VI. | Mortar | a) Compressive strength | Appendix-A of  IS:2250 | One sample  (consisting of min 3 specimens) | Table-1 of IS:2250 |
|  |  |  |  |  |  |
|  |  | b) Consistency | Appendix-B of  IS:2250 | One sample for  each type of mix | Clause 7.2 of  IS:2250 |
|  |  |  |  |  |  |
|  |  | c) Water  retentively | Appendix-C of IS:2250 | One sample for each type of mix | Clause 7.3 of IS:2250 |
|  |  |  |  |  |  |
| VII. | Masonry construction | a) Workmanship | Visual & Physical measurement | All work | As per specification and Cl. No.11.0 of IS:2212 for  brickwork |
|  |  |  |  |  |  |
|  |  | b) Verticality and alignment | Physical measurement | All work | As per specification  and Cl.No.6.3.4 of IS:1905 |

**Section - C5**

# Technical specification for plastering and allied works

**Section - C5**

# Technical specification for plastering and allied works

|  |  |  |  |
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**Section - C5: Technical specification for plastering and allied works**

# Scope

This part of the specification covers the requirements for plastering and allied works for all types of masonry and concrete surfaces.

# General requirements

The Concessionaire shall furnish all skilled and unskilled labour, plant, equipment, scaffolding, materials, etc. required for complete execution ofthe work in accordance with the drawings and as described herein and/or as directed by the Project Engineer and Executing Agency.

The Concessionaire shall follow all safety requirements/rules during execution of the work. I.S:1661 shall be followed as a general guidance for plastering work.

# Codes and standards

All applicable standards, acts and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at Site with the Concessionaire.

In case of any conflict between this specification and those (IS Standards, Codes etc.) more stringent shall prevail.

Some of the applicable Indian Standards, Codes, etc. are referred to here below:

|  |  |  |
| --- | --- | --- |
| IS:383 | - | Coarse and fine aggregates from natural sources for concrete. |
| IS:712 | - | Building limes. |
| IS:1542 | - | Specification for sand for plaster |
| IS:1635 | - | Code of practice for field slaking of Building lime and preparation of  putty |
| IS:2250 | - | Code of practice for preparation and use of masonry mortar. |
| IS:2333 | - | Plaster-of-paris |
| IS:2402 | - | Code of practice for external rendered finishes |
| IS:2547 | - | Gypsum building plaster |
| IS:3150 | - | Hexagonal wire netting for general purpose |

# Materials

Materials namely, cement, sand, water, Coarse aggregate, shall be in accordance with Technical Specifications for properties, storage and handling of common building materials.

Lime for preparation of putty or neeru for punning work shall be according to class B& C of IS:

712.

For rough cast plaster, coarse aggregate of size 6 to 12 mm shall be used in the finishing coat. Coarse aggregate shall be as per IS: 383.

Gypsum, for use in plaster-of-paris punning work shall be according to IS:2333.

For lath plastering, galvanised hexagonal wire netting with wire 0.9mm dia and 12.5 mm mesh conforming to IS:3150 shall be used.

# Mortar

Unless otherwise specified cement & Fly ash (20% replacement ratio of cement with fly ash): - sand mortar shall be used. Cement mortar shall be prepared by mixing cement & fly ash (20% replacement ratio of cement with fly ash): and sand in specified proportions by volume. Sand shall be measured on the basis of its dry volume using gauge boxes. Suitable allowance in quantity shall be made to cater for the bulkage. Cement and fly ash shall preferably be measured by weight. For the purpose of determining the corresponding volume, one cubic metre of cement shall be taken to weigh 1440 Kg and one cubic metre of fly ash shall be taken to weigh 641 Kg (i.e. coal ash)

The mixing of mortars shall be done in mechanical mixer. However, depending on nature, magnitude and location of the work, the Project Engineer and Executing Agency may relax the condition of use of mechanical mixer and allow hand mixing.

Cement, fly ash and sand in the specified proportions shall be fed into the mixer and mixed dry thoroughly in the mixer. Water shall then be added gradually and the wet mixing continued for at least 3 minutes. Hand mixing shall be carried out on a clean, water tight platform. Only that quantity of mortar, which can be used within 30 minutes of its mixing, shall generally be prepared at a time. Care shall be taken, not to add more water than that which shall bring the mortar to the consistency of a stiff paste. IS: 2250 and IS:1661 shall be referred for ascertaining the quantity of water.

In case of cement mortar, the mortar that has stiffened because of evaporation of water from the mortar may be retempered under special circumstances, with the approval of the Project Engineer and Executing Agency, by adding water as frequently as needed to restore the requirements of consistency but this retempering shall be permitted only upto one hour from the time of addition of cement.

Cement mortar shall be used as soon as possible after mixing and before it begins to set, preferably within half an hour from the time water is added to cement during mixing and in any case within one hour thereof.

Sweep mortar shall not be used.

# Plastering

* + 1. **Mix proportion and plaster thickness**

The mix proportion and thickness of plaster for various surfaces shall be as specified or shown in the drawings. Unless otherwise specified the following shall be adopted.

|  |  |  |
| --- | --- | --- |
| i. | Ceiling plaster | minimum 6mm thick cement mortar (1:4) |
| ii. | Plaster on external / rough face of masonry  work or concrete surface | 18mm thick, cement mortar\* (1:6) |
| iii. | Plaster on plain face of masonry work or  concrete surface. | 12mm thick, cement mortar\*(1:6) |

\*In case of special application like water proofing surface, base course of decorative finish etc., richer mix proportion not leaner than 1:4 shall be used.

# Preparation of surface

The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surfaces shall be roughened by wire brushing, if it is not hard and by hecking when it is hard. In case of concrete surface, if a chemical retarder has been applied to the framework, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

Trimming of projections, wherever necessary shall be done to achieve an even surface. Ranking of joints in case of brickwork where necessary shall be done. The masonry shall be allowed to dry out for sufficient period before plastering.

For ceiling plaster, the concrete surface shall be pock marked with a pointed tool to ensure a proper key for the plaster.

The wall shall be dampened evenly and not soaked before application of plaster. If the surface becomes dry in spots, such areas shall be moistened again.

# Sequence of plastering operations

For external plaster, the plastering operations shall be started from the top and carried downwards. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied horizontally and vertically, at not more than 2m intervals over the entire surface to serve as gauges. The surfaces of those gauged areas shall be truly in the plane of the finished plastered surface. For internal plaster, the plastering operations may be started wherever the building frame and cladding work are ready; the temporary supports of the ceiling resting on the wall have been

removed.

The first undercoat shall then be applied to ceilings. After the ceiling plaster is completed and scaffolding for the same removed, the first undercoat on walls shall then be applied.

After a suitable time interval as detailed under application of plaster, the second coat (finishing coat) shall be applied, first to the ceiling and then to the walls.

Where corners and edges have to be rounded off, such rounding off shall be completed alongwith the finishing coat to prevent any joint marks.

# Application of plaster

**Wall / vertical surface plaster**

Unless otherwise stated, the plastering above 12mm thick shall be carried out in two coats only.

# The backing or first coat

The backing coat shall be 10 to 12 mm thick and carried to the full length of the all or to natural breaking points like doors and windows. Before the rendering coat hardens, it shall be roughened to provide mechanical key for the second coat.

Masonry walls on which plaster is to be applied directly, shall be properly set and cured with the joints raked to a depth of at least 10 mm. The rendering coat shall be troweled hard and tight, forcing it into surface depressions to obtain a permanent bond.

On smooth concrete walls, the surface shall be roughened and the rendering coat shall be dashed on to ensure adequate bond. The dashing of the rendering coat shall be done using a strong whipping motion at right angles to the face of the wall, or it may be applied with a plaster machine or cement gun.

# Finishing coat

Before starting to apply the finishing coat, the surface of the backing coat shall be dampened evenly. The final plastered surface shall be cured and kept continuously damp for minimum 7 days.

# Ceiling plaster

Stage scaffolding shall be provided for ceiling plaster. This shall be independent of the walls. Projecting burrs of mortar formed due to gaps at the joints is shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition, the concrete surfaces shall be pock marked with a pointed tool at a spacing of not more than 50 mm centres, the pocks being made not less than 3 mm deep, to ensure a proper key for the plaster. The mortar shall be washed off and all surface cleaned of all oil, grease, etc. and well wetted before the plaster is applied.

Ceiling plaster shall not be commenced until the slab above has been furnished and centering has been removed. The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

The Surface shall be cured atleast twice a day for a minimum period of seven days.

# Grooves in plaster

Where specified in drawings, rectangular grooves 12 to 20 mm wide and 8 to 10 mm deep shall be provided in external plaster by means of timber battens or metal strips, fixed on plaster when plaster is still green. Battens or strips shall be carefully removed after initial set of plaster and broken edges and corners made good. All grooves shall be uniform in width and depth and shall be truly plumb and correctly aligned.

# Drip course

Drip course wherever indicated in the drawings shall be provided at the time of plastering to prevent travelling of water drops from the projections. Unless otherwise, specified, projected strip form drip course shall be provided.

# Metal lathing

The lathing shall be tightly stretched with the long way of the mesh across the supports before nailing. This shall be secured with 25 mm galvanised steel staples or nails at 200 mm centres, if the studding is of wood and with 0.90 mm iron tying wire, if the studding is of steel. Edges of lathing shall be lapped not less than 25 mm at the sides and ends and wired together with galvanised wire of diameter not less than 1.25 mm, every 100 mm between supports.

Before plastering, the surface of metal lathing shall be brushed over with thin cement slurry or given a protective coat of bitumen oil paint.

# Plastering to lathing

It shall be carried out in two coats. Mortars for the first coat shall be of stiff consistency and applied as evenly as possible to give a uniform good cover to the lathing. It shall be allowed to dry until all shrinkage movement has ceased before the second coat is applied. Too much pressure shall not be used in applying plaster to lathing to guard against its deflection.

# Rough cast finish

The plaster base over which the rough cast finish is to be applied shall be done in general as per Clause no. 5.6.2 under sub head "Application of Plaster".

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. Coarse aggregate of size 6 to 12 mm shall be used in the finishing coat. The grading and size shall vary according to the texture required.

The rough cast mix shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix gets well pitched into the plaster base. The mix shall again be dashed over the vacant spaces, if any, so that the finished surface represents a homogeneous surface of sand mixed with grovel. The surface shall be cured for a minimum period of 7 days.

# Punning work

**Lime punning or Neeru finish Materials**

**Lime putty:** It shall be obtained by slaking lime with fresh water and sifting it. The slaking shall

be done in accordance with IS: 1635.

**Neeru:** It shall be obtained by mixing lime putty and sand in equal proportion and chopped jute @ 4 Kg. per cu.m. of mortar. The mixture shall be properly ground to a fine paste between two stones.

# Application of punning

Lime punning consists in finishing the interior with a thin coat (3 mm) of fat lime putty mixed with an equal amount of sand. Before actual use, putty shall be matured for 2 to 3 days.

The mortar for punning shall be applied in 3 mm thick layer just after the undercoat has hardened. It shall be finished to a smooth surface by means of a plaster's trowel.

The curing shall be started as soon as the punning has hardened but in any case not earlier than 24 hours after the punning has been completed. The punning shall be kept wet for a period of seven days.

# Plaster of paris punning

The plaster of paris (gypsum Anhydrous) conforming to IS: 2547 shall be used for plaster of paris punning. The plaster of paris shall be mixed with water to a workable consistency and shall be applied on the plastered surface and finished to a smooth surface by steel float. The finished surface shall be smooth and true to plane, slopes or curves as required. The nominal thickness of the punning shall be 2 mm.

# Neat cement punning

The plastered surface over which neat cement punning is to be done, shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied shall be 1 kg. per sq. metre. Smooth finishing shall be completed with a float immediately and in no case later than half an hour of adding water to the cement.

# Trueness of plastering system

The finished plastered surface shall not show any deviation more than 4 mm when checked with a straight edge of 2 metre length placed against the surface.

# Thickness of plaster

The thickness of the plaster shall be measured exclusive of the thickness of key i.e. grooves or open joints in brickwork. The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm for plaster thickness above 12 mm and 1 mm for ceiling plaster. Extra thickness required in dubbing behind rounding of the corners at junctions of wall or in plastering of masonry cornices etc. shall be ignored.

# Inspection and testing

1. The plastered surface shall be checked for following defects and the remedial measures for the same shall be adopted as per IS: 1661.
   1. Blistering
   2. Bound failure or loss of adhesion
   3. Cracking
   4. Crazing
   5. Efflorescence
   6. Grinning
   7. Irregularity of surface texture
   8. Popping or blowing
   9. Recurrent surface dampness
   10. Softness or chalkiness
2. Trueness of the plaster shall be checked as per Clause no. 5.6.6
3. Thickness of the plaster shall be checked as per Clause no. 5.6.7

# Pointing

The materials, preparation of mortar etc. shall be same as specified for cement plaster works. The mix proportion shall not be leaner than 1:3, unless otherwise specified. For all exposed brickwork or stone masonry work, self supporting double scaffolding, having two sets of vertical supports shall be provided so as to avoid openings in the wall.

# Preparation of surface

The joints shall be raked out properly to such a depth that the minimum depth of the new mortar measured from either the sunken surfaces of the finished pointing or from the edge of the brick shall not be less than 10 mm. Dust and loose mortar shall be brushed out. Efflorescence, if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before commencement of pointing.

# Application of mortar and finishing

The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raked, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool according to the type of pointing required.

# Type of pointing

**Ruled pointing**

Unless otherwise specified ruled pointing shall be adopted for all exposed brick/block masonry work However, for rubble masonry works, recessed pointing shall be adopted.

The mortar shall be pressed into the raked out joints and shall be finished off flush and then while the mortar is still green, a groove of shape and size as shown in drawings shall be formed by running a forming tool straight along the centre line of joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical joints shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same. For recessed pointing in rubble masonry recess shall be provided along the centre line of the joint profile.

# Flush pointing

The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the brick, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge. Unless otherwise specified, flush pointing shall be adopted for drains and brick on edge paving.

# Raised and cut pointing

Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm raised and width 10 mm or more as directed. The superfluous mortar shall be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. Unless otherwise specified, raised and cut pointing shall be adopted for stone masonry pointing, and shall be provided along the Centre line of the joint profile.

# Curing

The pointing shall be kept wet for 7 days.

# Sub section - C6

**Technical specification for flooring and other allied works**

# Sub section - C6

**Technical specification for flooring and other allied works Contents**

# Clause no. Description Page nos.

1. 6.1 Scope

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1. 6.2 Installation

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**Sub section - C6: Technical specification for flooring and other allied works**

* 1. **Scope**

This specification cover the supplying, installation, finishing, curing, testing, protecting, maintaining until handling over of various types of floor finishes and allied items of works as listed below :

# In situ finishes

Integral finishes to concrete base. Terrazzo finish.

h.

# Tile finishes

Terrazzo tile Glazed tile

Rubber based vinyl tiles

# Base

The base to receive the finish is covered under other relevant specifications.

# Sequence

The commencement, scheduling and sequence of the finishing works shall be planned in details and must be specifically approved by the Project Engineer and Executing Agency, keeping in view the activities of other agencies working in the area. However, the Concessionaire shall remain fully responsible for all normal precautions and vigilance to prevent and damage whatsoever till handling over to the Executing Agency.

# Installation

* + 1. **Special materials**

Materials required for individual finishing items are specified under respective items. In general, all such materials shall be in accordance with the relevant IS Codes (Latest edition) where applicable. In all cases these materials shall be of the best indigenous quality unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialized manufactures and on the basis of approval of samples by the Project Engineer and Executing Agency. The materials shall be ordered, procured and stored well in advance to avoid possible delays to the construction programme.

# Workmanship

Workers specially experienced in particular items of finishing work shall carry out the work. Where such workers are not readily available, experienced supervisors recommended by the manufacturer shall be engaged with the prior permission of the Project Engineer and Executing Agency. In particular cases, Project Engineer and Executing Agency may desire the installation of finishing items by the manufacturer. This arrangement shall be made by the Concessionaire.

# Preparation of the base surface

The surface to be treated shall be thoroughly examined by the Concessionaire. Any rectification necessary shall be brought to the notice of the Project Engineer and Executing Agency and his approval shall be obtained regarding the method and extent of such rectification required. For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking of joints and thoroughly cleaning of all dirts, grease etc., using water hard brushes and detergent as required, unless otherwise directed by the manufacturer of any special finishing materials, or specifically indicated in this specification under the individual item. To prevent absorption of water from any wet finishing treatment, the base shall be thoroughly soaked with water and all excess water mopped up. However, the surface shall be dry where adhesive are used for fixing the finishes. The actual finishing work shall not commence until the Project Engineer and Executing Agency has approved the surface.

# In-situ-finishes

**Integral finishing to concrete base**





made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set, it shall be pressed with iron floats, to achieve a firm, compact and smooth surface without any trowel marks or undulations. The finish shall be as thin as possible by using 2.2 kg.

of cement per sq.m. of area. The surface shall not be subjected to any loads or abrasion for at least 21 days after laying.



be intended by pressing strings. The markings shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

# Terrazzo finish: In-situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

# Thickness

Unless otherwise specified, the total thickness of the finish shall be a minimum of 40 mm for horizontal surfaces and 25 mm for vertical surfaces of which the topping shall be not less than 10 mm. The topping shall be of uniform thickness but the underbed shall vary in thickness as necessary to provide any slopes. The finished vertical surface shall project 6 mm from the adjacent plaster or other finishes. The surface receiving the finish shall be cut back as necessary to accommodate the specified thickness. All junctions between vertical and horizontal surfaces shall be rounded neatly to a uniform radius of 25 mm.

# Mix

* + - * 1. **Underbed**

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1 part sand and 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water shall be added to provide a mortar of workable consistency.

# Topping

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. The proportions of the ingredients shall be such as to produce the terrazzo of the colour, texture and pattern approved by the Project Engineer and Executing Agency. The cement shall be white or grey or a mixture of the two in which the pigment shall be added to achieve the desired colour. To 3 parts of these mixture, 1 part marble powder by volume shall be added and thoroughly mixed dry to 1 part of this mix, 1 to 1.5 parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and non-fading. It must be very finely ground. The marble powder shall l be from white marble and shall be finer than I.S. Sieve No. 30. The size of marble chips may be between 1 mm to 20 mm but at least 5 mm smaller than the topping thickness.

Sufficient quantity to cover each visible area shall be prepared in on lot to ensure uniform colour. Water to make it just workable shall be added to a batch immediately before it is laid. The size of batch shall be such that it can be laid before it starts setting.

# Laying

The underbed shall be laid in panels. The panels shall not the more than 5 sq.m. in area of which no side shall be more than 2.5 m long. For locations exposed to the sun, the maximum ate of a panel shall be 2.0 sq.m. The panels shall be laid in alternate bays or chequered board pattern. No panel shall be in contact with any other already laid until the later has contracted to the full extent.

Dividing strips made of aluminium 40 mm wide and 2 mm thick (min) shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After laying, the underbed shall be levelled, compacted and brought to proper grade with a screed or float. The topping shall be laid after about 24 hours while the underbed is still

pigment already made shall be spread evenly and brushed in just before laying and topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas of extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing at least 75% exposure of marble chips in an even pattern of distribution over the area covered.

# Curing

The surface shall be left for curing for 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

# Grinding and polishing

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (No. 60) grit blocks till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout already prepared from a mixture of cement and pigment shall be applied to fill up all pinholes. This surface shall be cured for 7 days by keeping it moist and then ground with fine grit block (No. 120). It shall again be cleaned with water, the grout reapplied to fill up any more pinholes that might have appeared and allowed be cured again for 5 days. Finally the surface shall be ground a third time with very fine grid blocks (No. 320) to achieve a smooth surface free from pinholes. Where a grinding machine cannot be used, hand grinding may be allowed where the first rubbing shall be with carborundum stone of coarse grade No. 60, the second rubbing with medium grade NO. 80 and the final rubbing and polishing with fine grade (No. 120). The surface shall be cleaned with water, dried and covered with oil free clean saw dust if directed by the Project Engineer and Executing Agency.

Just before handing over to the Executing Agency, the surface shall be dusted with oxalic acid at the rate of 0.33 gm per sq.m., water sprinkled on to it and finished by buffing with felt or hessian mops. The floor shall be cleaned with soft moist rag and dried, if desired by the Project Engineer and Executing Agency, wax polish shall be applied. However, all excess wax polish has to be wiped off and the surface left glossy but not slippery.



It shall consist of an underbed and a topping (incorporating iron particles) laid over an already laid and matured concrete base.

# Thickness

Unless otherwise specified the total thickness of the finish shall be minimum of 52 mm for horizontal surfaces of which topping shall not be less than 12 mm. The topping shall be of uniform thickness, but the underbed shall vary in thickness to provide and slopes. Vertical surfaces shall project 6 mm from adjacent plaster or other finishes. The surface receiving the finish shall be cut back as necessary to accommodate the specified thickness.

# Material

The hardening compound shall be uniformly graded iron particles, free from non-ferrous metal impurities, oil, grease, sand, soluble alkaline compounds or other injurious materials. When desired by the Project Engineer and Executing Agency, actual samples shall be tested for impurities.

# Mix

* 1. The underbed for floors and similar horizontal surfaces and for vertical surfaces shall be prepared in accordance with Clause 6.2.4(b).
  2. The Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. A minimum quantity of water shall be added to make it workable.

# Laying

The concrete floor shall be laid in panels of 1m x 1m or as directed by the Project Engineer and Executing Agency. Alternate panels shall be laid on the same day followed by the

other group of alternate panels the next day. The edges of the panels shall be supported either by wooden strips or flat angle iron pieces fixed securely in position. The underbed shall be laid to the required grade. The forms, if any, shall remain sufficiently projecting to take the topping. The surface of the underbed shall be roughened by wire brush as soon as possible.

The junction of floor and walls, floors and dado or skirting shall be rounded off as directed.

The Wooden strips or flat iron pieces shall be removed from their places before the succeeding alternate layers are laid.

  out 3 hours after laying of the later. The topping shall be of uniform thickness and even dense surface without trowel marks, pinholes, etc. The topping layer shall be pressed firmly, worked vigorously and quickly to secure full bond with the underbed. Immediately after the initial setting starts, the surface shall be finished smooth with a steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

# Tile finishes

These shall included tiles, stone slabs and similar manufactured or natural items over an already, laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

# Terrazzo tiles

This tiles finish shall consist of precast terrazzo tiles laid over an underbed.

# Thickness

The total thickness including the underbed shall be a minimum of 40 mm for floors and 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project 6 mm uniformly from the adjacent plaster or other wall finishes. The surface receiving the finish shall be cut back as necessary to accommodate the specified thickness.

# Tiles

The tiles shall be composed of an underbed and topping. The topping shall be of uniform thickness not less than 10 mm. The total thickness including the topping shall be as specified but not less than 20 mm. The underbed shall be composed of 1 part ordinary grey cement and 3 parts of stone ships by weight, mixed with water.

# Topping

The tiles for the topping shall be as specified under Clause 6.2.4 (b).

The tiles shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles in the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be stored carefully to prevent staining by damp, rust, oil, grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that the colour of each area of the floor shall be uniform. The manufacturer of the tiles shall also supply the grout mix containing cement and pigment in the exact proportions as used in finishing the tiles. The containers for the grout mix shall be suitably marked to ensure that they can be related to the particular type and batch of tiles.

# Mix-underbed

The underbed for floors and similar horizontal surfaces shall be 1 part lime putty; 1 part surkhi; 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dados and all vertical surfaces it shall be about 10 mm thick and composed of 1 part cement and 3 parts sand by weight.

# Laying

The underbed mortar shall be evenly spread and brought to the appropriate grade and consolidated to a smooth surface. The surface shall be roughened for better bond with the tiles. While the underbed is still fairly moist but firm, cement shall be hand dusted over it or cement slurry applied. The tiles shall immediately be placed in position and firmly pressed by wooden mallet on to the underbed so that the tile surface achieves the desired level. The tiles shall be soaked in water for about 10 minutes just before laying. The joints between tiles shall be as narrow as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level, the surface and the lines of the joints frequently so that these are perfect.

When tiles are required to be cut to match the dimensions, they shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approved by the Project Engineer and Executing Agency.

At the junction of horizontal surface with vertical surfaces the tiles on the former shall enter at least 12 mm under the later.

After fixing, the floor shall be kept moist sand allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired, diving strips as specified under Clause 6.2.4 (c) may be used for dividing the work into suitable panels.

# Grinding and polishing

The procedure shall be the same as specified in Clause 6.2.4 (e) but grinding shall not commence until 14 days have elapsed after laying of tiles.

# Glazed tiles

This finish shall be composed of glazed, earthen, coarse tiles with an underbed laid over a concrete or masonry base.

# Thickness

The total thickness shall be between 20 mm and 25 mm including the underbed.

The tile finish on vertical surface shall project 6 mm uniformly from the adjacent plaster or other wall finishes. The surfaces receiving the finish shall be cut as necessity to accommodate the specified thickness.

# Tiles glazed

The tiles shall be earthenware, covered with glazed, white or coloured, plain or with designs, of this size approved by the Project Engineer and Executing Agency and 6 mm thick. The tolerance shall be +/-1.5 mm for length and breadth and +/-0.5 mm for thickness. Specials like internal and external angles, beads, covers, cornices, corner pieces etc., shall match. The top surface of the tiles shall be glazed with an unfading stable gloss finish as desired by the Project Engineer and Executing Agency. The tiles shall be flat and to shape. The colour shall be uniform and a fractured section shall be fine grained in texture, dense and homogenous. The tiles shall be strong and free from flaws like cracks, chips craze, spacks, crawlings etc., and other imperfections. The edges and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

# Mix-underbed

This mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

# Laying

The under and tiling shall be laid as specified in Clause 6.2.4 (e).

# Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping

it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching immediately before handing over to the Executing Agency.

# PVC tiles and rolls as per IS-3462-1986

This covers PVC based vinyl Tiles and Rolls set with adhesive on to a concrete or masonry base. An underbed may be required to secure a desirable surface and grade.

# Tiles

Unless otherwise mentioned the tiles shall be squares of approved dimensions. The tolerance of dimensions shall be +/-1.5 mm.

The tiles should be clandered laminated solid resilient unbreakable and flexible PVC Vinyl tiles in sizes of 305 mm x 305 mm x 3 mm thick. This shall have properties of a high wear resistance and resilience, designed to withstand high traffic and abrasion. All edges shall be cut true and square. The colour shall be non-fading and uniform in appearance, insoluble in water and resistant to alkalies cleaning agents and usual floor polishes.

Rubber based adhesive to be used for fixing tiles shall be Dunlop S-758 or Fevicol SR-998 or equivalent or a recommended by the manufacture. The adhesive shall have a short drying time and long life. Each container shall show the shelf life, date of manufacture and over age container shall be immediately removed from the site.

# Rolls

It should be clandered laminated solid resilient unbreakable and flexible PVC Vinyl Flooring of size 1.5 mtrs. (Width) x 20 mtrs (Length) x 3 mm thick with inherent characteristics of wear resistance, dimensional stability, elegance etc.



mark, thickness, size batch number and date of manufacture.

Tiles shall be delivered securely packed and store in clean, dry, well ventilated places.

# Joint welding

This can be provided where ever the PVC Rolls are installed in order to avoid dust accumulation leakage of water and prevention from wear and tear in joints. In this, a PVC cord is put into the joint after making groves with machine and is welded with hot thermo welding machine.

# Mix Underbed

The underbed, where required to make up the specified thickness or to achieve the required grade of the right type of surface shall be composed of 1 part cement, 2 parts sand and 4 parts stone

chips mixed with just sufficient water to make the mix workable.

# Laying

The tiles shall be stored in the room to be tied for atleast 24 hours to bring them to the same temperature as the room. In air conditioning spaces, the air conditioned space, the tiles shall be stored in the room to be tiled for at least 24 air conditioning shall be fully operational before the tiling is laid.

The surface to receive this finish shall be firm, even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid, the same shall be cured for at least 7 days by keeping it moist and then is shall be fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease, if any shall be removed completely by the use of detergent.

The adhesive shall be applied uniformly to the fully dry surface in the desired thickness. The adhesive shall also be applied to the backs and edges of the tiles and surface shall be allowed to dry. The tiles shall then be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl up, weights are to be applied to keep the edges down. Special care shall be taken to avoid the formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

# Finishing

Any adhesive marks on the surface shall be removed by wiping with a soft cloth soaked in solvent. The surface shall be cleaned with soft soap dried and then polished with approved type of polish just before handling over to the Executing Agency.

# Ground floor with earth subgrade

For ground floors having an earthen subgrade, the floor finish shall consist of the following:

# Compacted Earth

1. 150 mm thick dry rubble soling on rammed earth. Rubble shall be hand packed as directed by the Project Engineer and Executing Agency. This shall be laid closely in position on the subgrade. All interstices between the stones shall be wedged in with smaller stones of suitable size well driven to ensure tight packing and complete filling of the interstices. The filling shall be carried out simultaneously with the placing in position of the rubble stone and shall not lag behind. The small interstices shall be filled with hard clean sand well watered and rammed.
2. 100 mm thick sand cushion.
3. PVC sub-base 75 mm thick, 1:4:8 mix.
4. Floor finish with underbed as specified elsewhere.

# Acceptance criteria

The finish shall be checked specially for:

1. Level, slope, plumb as the case may be (The surface of the finish shall be smooth and within

+/-5 mm of the specified level or position. Local irregularities shall be within +/-3 mm when measured against a 3 metre straight edge. Abrupt changes of alignment shall not exceed 2 mm).

1. Pattern and symmetry
2. Alignment of joints, dividing strips, etc.
3. Color, texture
4. Surface finish
5. Thickness of joints
6. Details of edges, junctions, etc.
7. Performance
8. Precautions specified for durability

# External wall treatment

**Madrasi danna, vineratex, granotex, etc.**

Madrasi Danna, Vineratex, or Granotex finishes, where indicated shall be applied with materials as manufactured by the approved agencies. Stone finish, unless otherwise specifically mentioned, shall be used.

Samples of materials shall be submitted to the Project Engineer and Executing Agency to approval before the bulk purchase is made. The Concessionaire shall prepare test panels 1m x 1m in size and obtain approval from the Project Engineer and Executing Agency before commencing actual application of each type of finish.

The thickness of the finish shall not be less than 3 mm.

All surfaces to be finished shall be smooth and level and shall be thoroughly cleaned to remove any grease, dirt or loose particles and shall be free from surface water.

Extremely porous surfaces shall be pre-sealed with a thin coat of suitable primer. Previously painted surfaces shall be prepared by scrapping off all loose paints, washing with a suitable detergent and rinsing thoroughly with clean water. The finish shall be applied strictly in



After application, the Concessionaire shall protect the surfaces against rain & sun until complete hardness of the finish is achieved without any extra cost to the Executing Agency. This type of work shall be carried out by specialized agencies only.

# I.S. codes

Some of the important applicable Indian Codes for this section are listed below. Latest editions of these codes shall be follows:

IS : 777 - Glazed earthenware tiles

IS : 1237 - Cement concrete flooring tiles

IS : 1433 - Code of practice for laying and finishing of cement concrete flooring tiles. IS : 2114 - Code of practice for laying in situ terrazzo floor and finishes.

# Sub section - C7

**Technical specification for roof waterproofing insulation and allied works**

# Sub section - C7

**Technical specification for roof waterproofing insulation and allied works Contents**

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**Sub section - C7: Technical specification for roof waterproofing insulation and allied works**

* 1. **Scope**

This specification covers furnishing, installing, finishing, curing, testing, protecting, maintaining till handing over of roof waterproofing, thermal insulation and allied works for buildings.

# General requirements

The Concessionaire shall furnish all skilled and unskilled labour, plant, equipment, scaffolding, materials etc., required for complete execution of the work in accordance with the drawings and as described herein and / or as directed by the Project Engineer and Executing Agency.

The Concessionaire shall follow all safety requirements / rules during execution of the work.

The Concessionaire should have adequate experience in execution of such works. Alternatively, he should engage specialized agency for executing the work after obtaining approval from the Project Engineer and Executing Agency.

# Codes and standards

All applicable standards, acts and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Concessionaire.

In case of any conflict between this specification and those (IS Standards, Codes etc.) more stringent shall prevail.

Some of the applicable Indian Standards, Codes, etc are referred to here below:

|  |  |  |
| --- | --- | --- |
| IS : 702 | - | Specification for industrial bitumen |
| IS : 1203 | - | Methods of testing tar and bitumen |
| IS : 1237 | - | Specification for cement concrete flooring tiles |
| IS : 1322 | - | Specification for bitumen felts for water proofing and damp  proofing |
| IS : 1346 | - | Code of practice for water proofing of roofs with bitumen  felts |
| IS : 1580 | - | Specification for bituminous compound for waterproofing  and caulking purposes |
| IS : 3067 | - | Code of practice for general design details and preparatory  work for damp- proofing and water proofing of buildings |
| IS : 3384 | - | Specification for bitumen primer for use in water proofing  and damp- proofing |
| IS : 5916 | - | Safety code for construction involving use of hot  bituminous materials |

|  |  |  |
| --- | --- | --- |
| IS : 6598 | - | Specification for cellular concrete for thermal insulation |

# Materials

Bitumen felt for waterproofing treatment shall be Hessian base self - finished felts of specified type and grade conforming to IS: 1322

Bitumen primer shall conform to IS: 3384

The bonding material between the felt and the roof surface and between the successive felts shall be industrial blown type bitumen of specified grade (s) conforming to IS: 702

Cellular concrete (foam concrete) for insulation of roof shall be cast - in - situ of specified type conforming to IS: 6598

Materials for cement mortar under bedding and cement sand plaster over cellular concrete shall be as specified for plastering and allied works

Materials for cement concrete under bedding work shall be as specified for concrete and allied works

# Layers of treatments

Various layers of treatment required for roof waterproofing and insulation work shall be as given below

However different layers which are to be actually provided for various areas shall be as shown in the drawings and directed by the Project Engineer and Executing Agency.

* + 1. Grading underbed
    2. Insulation (Cellular concrete)
    3. Cement plaster and
    4. Waterproofing treatment

# Grading underbed

The underbed shall be laid to provide an ultimate run-off gradient not less than 1 in 100 or as specified in the drawing and as directed by the Project Engineer and Executing Agency. Upto an average thickness of 25mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete. However actual thickness and other details shall be as per approved drawings well defined cracks other than hair cracks in the roof structure shall be cut to 'V' section, cleaned and filled up flush with cement - sand slurry or with cold applied bituminous caulking compound conforming to IS: 1580. The roof surface shall be cured prior to the application of underbed.

The surface of roof and that part of the parapet, gutters, drain mouths etc., over which the underbed is to be applied shall be roughened and thoroughly cleaned of all foreign matter namely fungus, moss and dust, with wire brushing and dusting. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct sunlight and shall be kept in shade immediately after laying, so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water twice a day for at least 7 days.

The underbed shall be finished to receive the waterproofing treatment directly or insulation as the case may be.

# Cement mortar underbed

The grading plaster shall have an average thickness of 25mm. It shall consist of cement and sand in the ration of 1:4 by volume. The sand and cement shall be thoroughly mixed dry before water is added. Each batch of mix shall be consumed before the initial set starts.

The plaster shall be laid to proper grade in continuous operation and fully compacted. The surface shall be even and reasonably smooth. For detailed specification of plastering work Section -C5 shall be followed.

# Cement concrete underbed

The concrete shall be used where the underbed is more than 25mm (average) thick. It shall consist of cement concrete 1:2:4 mix by volume (1 cement: 2 sand: 4 graded stone aggregate.

12.5 mm down stone nominal size). The aggregate shall be thoroughly mixed dry and minimum quantity of water shall be added to make the mix workable.

The mix shall be laid to proper grade in continuous operation and full consolidated. The surface shall be even and smooth. For detailed specification of concrete work Section C3 shall be followed.

# Insulation

Insulation shall consist of cast-in-situ cellular concrete conforming to IS: 6598.

The cellular concrete of thickness 40 mm (minimum) shall be laid over the grading underbed over precast/cast-in-situ RCC roofs. The cellular concrete shall be laid directly over the surface of the roof without separate under bedding and the slope be provided by cellular concrete, wherever shown in the drawings and / or as directed by the Project Engineer and Executing Agency.

# Cellular concrete

It shall consist of cast - in - situ light weight concrete formed by producing gas or air bubbles in cement slurry or a cement - sand slurry. The cement slurry or cement - sand slurry. The material shall be cured under natural conditions i.e., under ambient pressure and temperature by water. The material shall have a density of 320 kg/cu.m. crushing strength of minimum 2.5 kg/sq.m. value of thermal conductivity of maximum 0.7 mW/cm deg at 50 degree Centigrade mean temperature i.e., Type A.

Before start of the laying of the cellular concrete, samples shall be prepared at site got tested. The approval of the Project Engineer and Executing Agency shall necessarily be obtained.

Cellular concrete laid shall be sufficiently strong to take the usual workloads and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith.

While laying the cellular concrete, samples from each batch of the mix shall be kept for test, if so

desired by the Project Engineer and Executing Agency.

The approval of the Project Engineer and Executing Agency shall be taken before laying the layer of cement plaster over the cellular concrete.

# Cement plaster

After laying the insulation (cellular concrete), the surface shall be regarded with cement plaster and made ready as required to receive the waterproofing treatment.

The top surface of insulation shall be finished, with 12mm (minimum) thick, or as specified in the item 1:4 cement - sand plaster by volume to get an even and smooth surface. The sand and cement shall be thoroughly mixed dry before water is added to it. Each batch of the mix shall be consumed before the initial set starts. It shall be cured twice a day for at least seven days before laying the waterproofing course. For detailed specification of plastering work MODULE / shall be followed.

# Waterproofing treatment

* + 1. **Preparatory work**

IS: 3067 shall be followed as a general guidance for preparatory work.

Waterproofing treatment shall be carried out into the drain pipe or outlets by at least 100mm. The waterproofing treatment laid on the surface shall overlap the upper age of the waterproofing treatment in the drain outlets by at least 100 mm.

Drain outlets shall be suitably placed with respect to the roof gradient to ensure rapid drainage and prevent local accumulation of water on the roof surface. Masonry drain mouths shall be widened two and a half times the diameter of the drain and rounded with cement mortar.

Forecast iron outlets a groove shall be cut all round to tuck the treatment.

When a pipe passes through a roof on which waterproofing treatment is to be laid, a cement concrete angle - fillet shall be built round it and the waterproofing treatment taken over the fillet.

In case of parapet walls above 450mm in height, for tucking in the waterproofing treatment a horizontal groove at a minimum height of 150mm above roof level shall be left in the vertical face at the time of construction. This groove shall be 75mm wide and 65mm deep. The horizontal face of the groove shall be shaped with cement mortar 1:4.

In case of low parapets, where the height does not exceed 450mm, no groove shall be provided and the waterproofing treatment shall be carried right over the top.

In the case of existing RCC and stone walls, cutting the chase for tucking in the waterproofing treatment is not recommended.

At the junction between the roof and the vertical face of the parapet wall, a fillet 75mm (min) in radius shall be constructed.

At the drain mouths, the fillet shall be suitably cut back and rounded off for easy application of the waterproofing treatment and easy flow of water.

Outlets at every low dividing wall, about less than 300mm in height, shall be cut open to full depth and the bottom and sides shall be rendered smooth and corners rounded off for easy application of waterproofing treatment.

The surface to be coated with bitumen primer shall be cleaned with wire brushes and cotton or gunny cloth. All loose materials shall be removed and surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil. The surface shall be painted when it is completely dry.

Bitumen primer (priming coat) shall be used prior to the application of the first mopping coat of hot molten bitumen to promote the bonding of the bitumen with the surface. The bitumen primer shall be liquid bitumen of low viscosity which shall penetrate into the prepared surface upon application. It shall be free from water and it shall conform to IS: 3384. It shall preferably be made from the same grade of bitumen as used in bonding.

The bitumen primer shall be brushed over the surfaces and allowed to dry. Generally, a quantity of 0.27 litres per sq.m. (Minimum) is recommended.

The bonding material between the felt and the roof surface and between the successive felts shall be industrial blown type bitumen of Grade 85/25 or 90/15 conforming to IS: 702 to withstand local conditions of prevailing temperature and gradient of roof surface. For top dressing bitumen used shall be industrial blown type of allowable penetration not more than 40 when tested in accordance with IS : 1203.

For vertical surface upto 1 meter height blown type bitumen of grade 85/25 or 90/15 and above 1 metre height grade 115/25 shall be used.

Bitumen tar felt of type 3, grade 1 conforming to IS: 1322 shall be used for roof waterproofing and the treatment shall be done as per IS: 1346.

The Concessionaire shall state the source from where he proposes to procure the materials. The Concessionaire shall satisfy the Project Engineer and Executing Agency that the bonding material proposed to be used is suitable for the particular job. Test certificates for the bonding material shall also be submitted and samples, if desired by the Project Engineer and Executing Agency shall be provided for confirmatory tests. Sample of the self - finished felt shall be submitted in advance to the Project Engineer and Executing Agency along with test certificates for his review. Samples of stone grit shall be submitted if instructed by the Project Engineer and Executing Agency. The stone grit shall be 6mm and down size and shall be devoid of fine sand. Test certificates shall be furnished with each batch of bulk supply for Project Engineer and Executing Agency 's approval.

# Course of treatment

The waterproofing treatment shall consist of a seven course treatment. Each layer of bonding materials, self - finished bitumen felt or stone grit is counted as one course.

Brief description of various courses of treatment shall be as follows: Heavy treatment - seven courses for severe conditions:

* + - 1. Primer conforming to IS : 3384 at the rate of 0.27 litre / sq.m minimum
      2. Hot applied bitumen at the rate of 1.2 kg/sq.m minimum
      3. Hessian - base self finished felt, Type - 3, Grade 1
      4. Hot applied bitumen at the rate of 1.2 kg/sq.m minimum
      5. Hessian - base self finished felt, Type 3, Grade 1
      6. Hot applied bitumen at the rate of 1.2 kg/sq.m, minimum and
      7. Grit, devoid of fine sand, at the rate of 0.006 cu.m/sq.m

# Surface finish

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of cement concrete flooring tiles conforming to IS: 1237 shall be provided in place of stone grit and cement painted. The tiles shall be laid as per IS: 1443. Alternatively, a screening of proportion of 1:4 of cement and sand 45mm thick can be laid over the roof treatment wherever shown in the drawing and marked off into square of 600mm made with expansion joints provided at a distance of 3 metre which shall be properly caulked with bituminous sealing compound conforming to grade A of IS: 1834.

Waterproofing treatment shall be carefully carried out from the time the surface is prepared to receive the felt to the finishing of the treated surface. Special attention and strict supervision shall be necessarily paid to overlapping of joints in felts, treatment around drainage openings in the roof and treatment of the parapet walls. The sticking of the felt to the roof by means of hot bitumen also requires skill. In order to achieve this, the waterproofing treatment shall be laid by a specialist firm with long experience in this particular line. The surface to receive the waterproofing treatment must be cleaned of all foreign matter, namely fungus, moss, dust etc by wire brushing and dusting and dried satisfactorily and the approval of the Project Engineer and Executing Agency taken before starting the work. If any existing top course shall be completely removed and all damaged felts or other defects repaired. The Project Engineer and Executing Agency may instruct the Concessionaire to lay part of the stipulated course at the first instant to be followed later on with the balance courses. This interim finish shall be done with a course of hot applied bitumen. While doing the balance, hot bitumen shall be applied again to start with after repair of all damages to the already laid courses.

The bitumen bonding material of specified grade shall be prepared by heating to the correct working temperature specified by the manufacturer and maintained at that temperature. It shall

then be conveyed to the point of work in a bucket or pouring can, poured and spread on the surface in a uniform continuous coating at the specified rate. For very large roofs, use of a spray machine is recommended to secure even spreading. The surface shall be carefully examined for gaps or pin holes, which on location shall be carefully filled up with the bitumen. Bitumen shall be applied carefully so that the exposed faces are not disfigured by splashing or spattering the bitumen all over.

The coat of bitumen shall be continued at least 15cm along the vertical surfaces joining the roof. In case of parapet walls, it shall be continued upto the drip course.

The self finished felt shall be cut to the required lengths, brushed clean of dusting material and laid out flat on the roof and allowed to soften, to eliminate curls and subsequent stretching. The felt shall normally be laid in lengths at right angles to the direction of run-off gradient, commencing at the lowest level and working upto the crest so that the over-laps of the adjacent layers of felt shall offer minimum obstruction to the flow off of water. The felt shall not be laid in single piece of very long lengths as they are likely to shrink. Six to eight metres are suitable lengths. Each length of felt prepared for laying as described above shall be laid in position and rolled up for a distance of half its length. The hot bonding material heated to correct working temperature as specified by the manufacturer, shall be poured on to the roof across the full width of the rolled felt as the latter is steadily unrolled and pressed down. The excess bonding material which squeezes out at the ends shall be removed as the laying proceeds. The pouring shall be so regulated that the correct weight of bonding, material per unit area is spread uniformly over. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on to the hot bonding material in the same way. Subsequently strips shall also be laid in the same manner. Each strip shall overlap the preceeding one by at least 75mm at the sides of strip of felt and at least 100mm at the ends. All overlaps shall be firmly bonded with hot bitumen. Streaks and trailings of bitumen near edges of laps shall be levelled by heating the overlaps with a blow lamp and leveling down unevenness.

In a seven course treatment the fourth and sixth layers of bonding material and the fifth layer of self-finished felt shall be laid in the manner already described, taking care that the joints are staggered with those in the layer beneath it i.e., third layer. The sixth layer shall be carried out after the flashing is done.

Immediately after application of top layer of bitumen stone grit shall be evenly spread and levelled over the surface when the bitumen is still hot.

After completion, the surface shall be cleaned taking care that loose gravels, felt cuttings, etc. do not find their way into rain down corners.

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

For heat reflecting surface or for aesthetic reasons bitumen based aluminium paints or coloured bituminous emulsions may be used as directed by the Project Engineer and Executing Agency.

# Flashing

Felt shall be laid as flashings in widths wherever junctions of vertical and horizontal structures (i.e., roof surface and parapet wall or any other vertical structure) occur with minimum overlap of 100mm. The lower layer of flashing felt in seven course treatment shall overlap the roof waterproofing by not less than 200mm while upper layer shall overlap the roofing felt by 100mm. On the vertical and sloping faces last course of flashing should not be of stone grit or pea-sized gravel, but it shall be replaced by providing two coats of bituminous paint at the minimum rate of

0.1 litres/sq.m per coat or a single coat of bituminous emulsion at the rate of 0.5 litre/sq.m may be applied.

The lower edge of flashing shall overlap the felt laid on flat portion of the roof and the upper edge of the flashing shall be tucked into the horizontal groove 75mm thick wide 65mm deep, provided at a minimum height of 150mm from top of the roof surface. The flashing treatment shall be firmly held in place in the grooves with wooden wedges at intervals and the grooves shall be filled with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 6 mm nominal size) and surface of flashing.

After the top flashing felt layer has been laid, the penultimate layer of bonding material shall be applied over the roofing felt and horizontal overlaps and vertical and sloping surfaces of flashing at the specified rate. Then grit or gravel shall be spread uniformly over the hot bonding material on the horizontal surface and pressed into it with a wooden roller.

Where waterproofing treatment is required to be isolated from the roof structure, bitumen saturated felt shall be spread over the roof surface and tucked into the flashing grooves. To keep these felts free from the structure, no bonding material shall be used below these felts.

# Fillets

All along the junction of the roof surfaces and vertical walls cement mortar (1:4) fillet shall be provided. The fillets shall be 150mm x 150mm in size unless otherwise shown on drawing or instructed by the Project Engineer and Executing Agency. The shape of the fillet shall slightly be concave.

Cast-in-situ cement concrete (1:2:4 with 12.5mm down aggregate) or cement mortar 1:4 shall be used to provide fillet.

# Expansion joints

Expansion joints shall be designed to suit the requirements of each roof. Expansion joint coverings shall be of bitumen felt. In this case, a minimum of two layers of bitumen felt, Type 2, Grade 2 as specified in IS: 1322 shall be used with top dressing gravel or other suitable finish.

# 7.11 Acceptance criteria

The surface level shall be such as to allow quick draining of rains without leaving any pool

anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or crushed or squeezed insulation or underbed.

# Sub section - C8

**Technical specification for painting, white washing, etc.**

# Sub section - C8

**Technical specification for painting, white washing, etc.**

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**Sub section - C8: Technical specification for painting, white washing, etc.**

* 1. **Scope**

This specification covers painting, white washing, etc. of both interior and exterior surfaces of masonry, concrete, plastering, plaster of Paris, rain water down comers, floor and roof drains, waste and service water pipes and other items, as directed by the Project Engineer and Executing Agency.

If the surface to be finished cannot be put in a suitable condition for painting by customary preparatory method, the Concessionaire shall notify the Project Engineer and Executing Agency in writing and assume responsibility for any rectification and unsatisfactory finishing that might result.

Before commencing painting, the Concessionaire shall obtain the approval of the Project Engineer and Executing Agency in writing regarding the scheduling of work to minimise damage, disfiguration or staining by other trades. He shall also undertake necessary precautions to prevent damage, disfiguration or staining of other trades or other installations.

# Materials

Materials shall be the highest grade products of well known approved manufacturers and shall be

colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection and approval by the Project Engineer and Executing Agency. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade be obtained from the same manufacturing batch. All paints shall be subjected to analysis from random samples taken at

All primer coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Project Engineer and Executing Agency.

All colours shall be as per the painting schedule and tinting and matching shall be done to the satisfaction of the Project Engineer and Executing Agency. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Project Engineer and Executing Agency.

# Synthetic enamel paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with ageing, The paint shall conform to IS:2932 and IS:2933.

# Waterproof cement paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS:5410.

# Dry distemper

Dry distemper of required colour conforming to IS: 427 of approved brand and manufacturer shall be used. The primer where used shall be cement primer or distemper primer. These shall be of same manufacturer as that of distemper.

# White washing

White washing shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the Project Engineer and Executing Agency and shall conform to IS:712 (latest edition) Samples of lime shall be submitted to the Project Engineer and Executing Agency for approval and lime as per the approved samples shall be brought to site in an unslaked condition. After slaking, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

# Colour wash

Shall be done with mineral colours not affected by lime added to white wash. No colour wash shall be done until a sample of the colour wash to the required tint or shade has been approved by the Project Engineer and Executing Agency. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the Concessionaire at his own cost.

# Acrylic emulsion paint

Shall be water based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigment and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without pelling or blistering the paint. After it is dried, the paint should be able to withstand washing with mild soap and water without any deterioration in colour or without showing flaking, blistering or peeling.

# Oil bound distemper

Oil bound distemper (IS:428-1969) of approved brand and manufacture shall be used. The primer where used be cement primer or distemper primer. These shall be of same manufacturer as that of distemper. The distemper shall be diluted with prescribed thinner in a manner recommended by

the manufacturer. Onl    prepared.



# Chemical resistant paint

Chemical resistant paint as per IS:157 of approved brand and manufacture shall be used. Primer

ications.

# Fire resistant paint

Fire resisting paint (silicate type) shall be as per IS:162 and of approved brand and manufacture.



# Oil resistant paint

Oil resistant paint shall be as per IS:161 and of approved brand and manufacturer. Primer coat



# Storage

The Concessionaire shall arrange for safe and proper storage of all materials and tools. Paints shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the Concessionaire to prevent fire.

# Preparation of surface

Before starting the work, the Concessionaire shall obtain the approval of the Project Engineer and Executing Agency regarding the soundness and readiness of the surface to be painted on.

# Masonry, concrete and plastered surface

The surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaced area shall be treated with a minimum of one coat of cement primer and should be continued to the surrounding area for a distance of atleast 100mm.

# Surfaces with mildew or efflorescence shall be treated as below:

* + - 1. **Mildew**

All mildewed surfaces shall be treated with an approved fungicide such as ammonical wash consisting of 7 gm. of copper carbonate dissolved in 80 ml liquor and diluted to 1 liter with water or 2.5 percent magnesium silica fluoride solution and allowed to dry thoroughly before paint is applied.

# Efflorescence:

All efflorescence shall be removed by scrubbing the affected surface with a solution of mariatic acid and in water (1:6 to 1:8) and then washed fully with clear water and allowed to dry thoroughly.

# Metal

All metal surfaces shall be absolutely clean, dry and free from wax, grease and soap films. All steel and iron surfaces in addition shall be free from rust. All galvanised iron surfaces shall be



shop coat shall be touched up with the same quality of paint as the original coat.

# Application

* + 1. **General**

The method of application shall be as recommended by the manufacturer. In case of selection of a special shade and colour (not available in standard shades) the Concessionaire shall prepare test panels in different shades of minimum size 1 metre square as instructed by the Project Engineer and Executing Agency and obtain his approval prior to applications of the finishing paints.

Proper tools and implements shall be used. Scaffolding if used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor holes. Painting shall be done by skilled labour in a workman like manner. All materials shall be evenly applied, so as to be free of sags, runs, crawls or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of the paint.

All priming undercoats for painting shall be applied by brush only. Roller and spray equipment, etc., shall not be used.

No work shall be done under conditions that are unsuitable for the production of good results. No painting shall be done when plastering is in progress or is drying. Paint which seals the surfaces to moisture shall be applied only after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before being sand papered or before the succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Concessionaire when so directed by the Project Engineer and Executing Agency.

All primers and under coats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true

to finish.

# Synthetic enamel paint

Shall be applied on properly primed surface. Subsequent coat shall not be applied till the previous coat is dry. The previous coat shall be lightly sand papered for better adhesion of subsequent coats.

# Waterproof cement paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first, coat has dried (24 to 48 hours), the second coat shall be applied.

In a similar manner the finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

# Dry distemper

New plastered surface shall be allowed to dry for atleast two months. New lime or lime plastered surface shall be washed with a solution of 1 part of vinegar to 12 parts water or 1:50 sulphuric acid solution and left for 24 hours after which the wall shall be thoroughly washed with clean water. For cement plastered surface, the surface shall be washed with a solution of 100 gms of zinc sulphate to 1 litre of water and then allowed to dry.



brush should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long as otherwise brush marks may result.

# White washing

The surface where white washing is to be applied shall be cleaned of all loose material and dirt. All holes and irregularities of the surfaces shall be filled up with lime putty and shall be allowed to dry out before application of the lime solution.

One coat of white wash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right and right to left before the vertical stroke dries out. A second coat shall be applied and similarly a third coat shall be applied whenever the Project Engineer and Executing Agency feels that more than two coats are required and the Concessionaire shall do so without any extra cost to the Executing Agency. No brush marks shall show on the finished surface.

# Colour wash

For new work, the priming coat shall be of white wash with lime or with whiting. Two or more coats shall then be applied on the entire surface till it represents a smooth and uniform finish. The finished dry surface shall not be powdery and shall not readily come off on hand when rubbed. Indigo or synthetic ultramarine blue shall, however, not be added.

# Acrylic emulsion paint

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. All sample patch shall be painted to check alkali reaction if so desired by the Project



# Oil bound distemper

Any unevenness in surface shall be made good by applying putty. The patched surface shall be allowed to dry thoroughly before the coat of distemper is applied. One coat of distemper properly diluted with thinner as specified by the manufacturer shall be applied by brush in horizontal strokes followed immediately by vertical ones which together will constitute one coat. Two or more coats of distemper as found necessary shall be applied to obtain even shade.

# Chemical resistant, fire resistant and oil resistant paints



specification.

# Painting of iron work

Paint to use for various items of work shall be of best quality and shall be obtained ready mixed in sealed containers from approved manufacturer. The Concessionaire shall obtain the Project

use.

All surfaces shall be thoroughly cleaned of all dirt, loose particles and rust and approved prior to application of paint. Workmanship shall conform to IS:1477 (Part I & II)

Specified number of coats shall be applied and atleast 24 hours shall elapse between the application of successive coats. No painting shall be carried out on exterior work in wet weather or on surfaces which are not entirely dry.

Painting rate shall include all necessary scaffolding, cradles and plant.

# Protection

Furniture and other movable objects, equipments, fittings and accessories shall be moved,

protected and replaced upon completion of the painting work. All stationary items of equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protection shall be as per instruction of the Project Engineer and Executing Agency.

# Cleaning up

The Concessionaire shall upon completion of painting etc. remove all marks and make good surfaces, where paint has spilled, splashed or splattered, including all equipments, fixtures, glass furniture, fittings, etc. to the satisfaction of the Project Engineer and Executing Agency.

# Acceptance criteria

All painted surfaces shall be uniform and pleasing the appearance. The colour, texture etc. shall match exactly with approved samples.

All stains, splashes and splatters of paint shall be removed from surrounding surfaces.

# Painting of structural steel / miscellaneous steel

* + 1. **Scope**

The specification covers painting of the structural/ miscellaneous steel supplied and erected either by other agencies or by the Concessionaire for work under the scope of this contract. One shop coat of red oxide zinc chromate primer including necessary touching up has already been completed by the concerned agency. One coat of red oxide zinc chromate primer followed by a coat of undercoating and two or more finishing coats of synthetic enamel paint as described hereunder are only required to be provided under the item for painting structural / miscellaneous steel.

# Type of structures to be painted

Painting shall be done on all exposed surfaces (including undersides wherever exposed) of various structural steel members like columns, trusses, beams, roof girders, oil tanks, trestles, bracings, crane girders, chequered plates, gratings, brackets, base plates etc. in the plant as directed by the Project Engineer and Executing Agency. It should be clearly noted that all structures are already erected / placed in position or are under erection, hence the quoted rate by Concessionaire shall account for all aspects involved in painting keeping in view the heights, available access to members etc. It is advised that the Concessionaire should visit the site and get himself acquainted with the nature of work completely including the extent and type of scaffoldings etc, required, before quoting his rate.

# Material

Paint shall be synthetic enamel paint conforming to IS:2932 of approved colour and brand.

# Painting

In general, painting work shall be in accordance with IS:1477 (Part I & II).

Surface of steel work to be painted shall be thoroughly cleaned of all grease, oil dirt, rust, foreign matter like cement splashings, etc. by suitable solvent and mild rubbing with abrasive paper/ hand scrapping to the full satisfaction of the Project Engineer and Executing Agency. Clearing with solvents/ scraping shall be limited to the affected areas only.

In cases where the existing primer is removed while cleaning the surface as detailed in 12.4.2, damaged portions shall be provided with a coat of wash or etching primer on suitable chemical pretreatment solutions and another coat of red oxide Zinc chromate primer. The payment for red oxide primer will be made as per relevant item of Schedule of items.

After the surface is prepared in a manner described above, the primer coat shall be dry cut without scratching or in any way damaging the primer coats and clean the surfaces from dust.

Over this dry surface apply an optimum coat of undercoating (synthetic enamel paint) by brush or spray with minimum brush marks. Allow the film to dry hard, wet rub, cutting down to a smooth finish (ensuring that at no place the undercoat is completely removed) Allow the water to evaporate.

The total dry film thickness of each coat shall be not less than 25 microns.

The paint shall be applied by brushing / spraying. Spraying shall be adopted with prior approval of Project Engineer and Executing Agency generally on large surface areas. Paints shall be stirred frequently to keep the pigment in suspension. Paint shall be ready mixed in original sealed containers as packed by the paint manufacturers and no thinners shall be permitted. No painting shall be done in frosty/ foggy / rainy weather or when humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is 5 deg or lower.

Concessionaire shall provide and use sufficient number of drop clothes, covers, tarpaulins and other screens to protect adjacent surfaces and shall remove all splatter and stains from such surfaces. The Concessionaire shall also protect his own work.

Any and all damage to adjacent work or any part of the premises due to painting carelessness or accidental performance of the Concessionaire shall be repaired or made good at the se.

Painting shall be discontinued when exposed to rain and dust storm and shall not commence until the surfaces are perfectly dry and clean. Wherever practicable. Surfaces shall be painted when in shade or when temperature is falling.

# Cleaning up

The Concessionaire upon completion of painting etc. shall remove all marks and make surfaces good, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings, etc. to the satisfaction of the Project Engineer and Executing Agency.

# Acceptance criteria

* + - 1. All painted surfaces shall be uniform and pleasing in appearance.
      2. The colour, texture, etc. shall match exactly with the approved samples.
      3. All stains, splashes and splatters of paints shall be removed from surrounding surfaces.

# Sub section - C9

**Technical specification for fabrication and erection of structural steel works**

# Sub section - C9

**Technical specification for fabrication and erection of structural steel works Contents**

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**Sub section - C9: Technical specification for fabrication and erection of structural steel works**

* 1. **Scope**

This section of specification deals with the technical specifications needed for the fabrication and erection of structural steel works coming under the scope of this contract. All connections shall be of welded type unless specifically approved by the Project Engineer and Executing Agency otherwise.

The specification cover providing, fabrication, erection, alignment etc. complete including preparation of fabrication drawings of structural steel work involving rolled sections, pipes and built up sections fabricated out of plates, rolled section and or combination of plates and rolled sections in columns, beams, gantry girders, roof trusses, portals, purlins, space frames, shear connector, monorails, galleries, wall beams, brackets, stub columns bracings, trestles, base plates, chequered plate floorings, gratings with binders, walk way platform, ladders, stairs complete with stringers, treads, landings, hand rails posts, erection bolts and nuts, permanent bolts and nuts, dismantling, modification and re-erection of fabricated/erected steel, etc. including all sampling and testing as given in Annexure-B for the areas of work as specified above.

# General requirements

The Concessionaire shall furnish all structural steel material, labour, plant, equipment, consumables, scaffolding, tools, tackles, materials and everything that is required for complete executions of the work on schedule in accordance with the drawings and as described herein and/or as directed by the Project Engineer and Executing Agency.

# Reference points and bench marks

The Concessionaire shall make his own arrangements for locating the coordinates and positions of all work and reduced level (RL) at these locations based on two reference grid lines and one bench mark which shall be furnished by the Executing Agency. The Concessionaire has to provide at site all the required survey instruments to the satisfaction of the Project Engineer and Executing Agency so that the work can be carried out accurately according to the specifications and drawings.

# Safe working

The Concessionaire shall strictly follow, at all stages of fabrication, transportation and erection of steel structures, the stipulations contained in the Indian standard safety code for erection of structural steel work IS:7205 and the provisions of the safety rules as specified in the general conditions of the contract for ensuring safety of men and materials. This shall include proper approach and working platform during erection of the structures.

# Drawings

The fabrication drawings are to be prepared and furnished by the Concessionaire. These shall be based on the design drawings. These drawings shall indicate complete details of fabrication and erection including all splicing details, lacing details, weld sizes of lengths, detailing of all joints, and bill of materials in the proforma approved by the Project Engineer and Executing Agency, and all other customary details in accordance with standard structural engineering practice whether or not given by the Executing Agency. He shall furnish along with the fabrication drawings, necessary calculations regarding design of joints viz. Size and length of welds, dia and number of bolts, and calculations justifying other fabrication details as well as design of erection and fabrication splices in accordance with IS:800 and other relevant standards. He shall also furnish scheme of erection.

The fabrication drawings shall indicate identification (erection) marks for purposes of despatch and erection etc.

In addition, the total quantity as well as abstract of quantities is indicated in the fabrication drawings. The Concessionaire shall prepare a consolidated schedule of permanent bolts and nuts, showing the length, size, weight and numbers required for each fabricated member.

Three copies of the detailed fabrication drawings including bolts and nuts schedule shall be submitted by the Concessionaire for approval in the first instance along with Bill of materials showing the description of members, their erection marks, quantity, etc. (Proforma to be approved by the Project Engineer and Executing Agency). In case the approval accorded to the fabrication drawings is subject to any modifications, additions, and alterations, the Concessionaire shall submit two sets of the revised drawings for final approval after incorporating these changes.

In case the drawings are approved as submitted, he shall submit thirteen additional prints of such approved fabrication drawings. In addition, the Concessionaire shall also be required to furnish one reproducible copy of final fabrication drawings (as actually fabricated).

The design drawings may require revision either before or after the preparation and approval of fabrication drawings. Such revision shall be duly incorporated in the fabrication drawings and nothing extra shall be payable on this account for preparation / revision of fabrication drawings. The Concessionaire is expected to make his own assumptions regarding the quantum of such revisions involving preparation/revision of fabrication drawings, while quoting.

The fabrication work shall start only after the approval to the fabrication drawings is accorded by the Project Engineer and Executing Agency.

Such approval shall, however, not relieve the Concessionaire of his responsibility for the safety of the structure, good connections, erectability, etc.

# Samples

Samples for checking the quality of materials procured by the Concessionaire and workmanship in the execution of the works may be called for at any time by the Project Engineer and Executing Agency. In case such samples are found to be of sub standard/unacceptable quality, the

Concessionaire shall immediately discontinue use of such materials and workmanship and get fresh samples approved by the Project Engineer and Executing Agency. Nothing shall affect the liberty of the Project Engineer and Executing Agency to reject whole or portions of structures where such defective materials and workmanship has already been used before detection.

# Test at works

The Concessionaire shall arrange for all materials procured by him to be tested as and when required and in the presence of the representative of Project Engineer and Executing Agency.

For structural steel test samples shall be cut out of the materials from the locations indicated by the Project Engineer and Executing Agency and samples shall be prepared in accordance with the requirements of Indian Standards Specifications for conducting such tests. For each set of tests three samples shall be taken for tensile strength test and bend test. One set of tests will include test of three individual specimens of samples.

# Fabrication shop at project site

Fabrication shop of the Concessionaire at project site shall have all facilities required for carrying out the work. The Concessionaire shall get the details of the shop approved by the Project Engineer and Executing Agency.

# Applicable standard and codes

Except where otherwise specified herein or authorized by the Project Engineer and Executing Agency, all items of work shall conform to the requirements of relevant latest Indian standards. Any item of work, for which there is no Indian Standard available, shall conform to the latest British standard (B.S.). The item of work shall be best of its kind and subject to approval of the Project Engineer and Executing Agency. In case of conflict between this specification and those referred to in the standard, the former shall prevail.

List of certain important codes and standards applicable to this work is given below. However the applicable standards and codes shall be as per but not limited to the list given below.

# Materials

IS : 808 Rolled steel, beam, channel and angle sections IS : 2062 Structural steel (fusion welding quality)

IS : 1363 Hexagon head bolts, screws and nuts of production grade C.

IS : 1364 Hexagon head bolts, screws, and nuts of production grade A & B. IS : 1367 Technical supply conditions for threaded fasteners.

IS : 1161 Specification of steel tubes for structural purposes. IS : 2016 Specification for plain washers.

IS : 814 Specification for covered electrodes for metal arc welding for weld steel.

IS : 1852 Specification for rolling and cutting tolerances for hot rolled steel products.

IS :2074 Ready mixed paints, red oxide zinc chromate primer. IS : 3502 Specifications for chequered plate.

IS : 383 Specification for coarse and fine aggregates from natural sources for concrete.

IS : 1566 Specification for hard-drawn steel wire fabric for concrete reinforcement. IS : 3757 Specification for high strength structural bolts.

# Codes of Practice

IS : 800 Code of practice for construction in steel.

IS : 816 Code of practice for use of metal arc welding for general construction.

IS : 9595 Code of procedure of manual metal arc welding of mild steel. IS : 817 Code of practice for training and testing of metal arc welders

IS : 1811 Qualifying tests for metal arc welders (engaged in welding structures other than pipes).

IS : 1182 Recommended practice for radiographic examination of fusion-welded butt joints in plates.

IS : 1477 Code of practice for painting of ferrous metal in buildings and allied finishes.

IS : 3696 Safety code of scaffolds and ladders.

IS : 7293 Safety code for working with construction machinery.

IS : 7205 Indian Standard safety code for erection of structural steel. IS : 7215 Tolerances for fabrication steel structures.

IS : 12843 Tolerance for erection of structural steel.

IS : 4353 Recommendation for submerged arc welding of mild steel and low alloy steels.

SP : 6 ISI Hand book for structural engineers. (Part 1 to 7)

# Standards for testing

IS: 1608 Method of tensile testing of steel products other than sheets, strip, wire and tube.

IS : 1599 Method of bend tests for steel products other than sheets, strip, wire and tube.

IS : 228 Methods of chemical analysis of pig iron, cast iron and plain carbon and alloy steel

IS : 2595 Code of practice for radio graphic testing.

IS : 1182 Recommended practice for radiographic examination of fusion welded butt joints in steel plates.

IS : 3664 Code of practice for ultrasonic testing by pulse echo method.

IS : 3613 Acceptance tests for wire flux combination for submerged arch welding. IS : 3658 Code of practice for liquid penetrant flow detection.

IS : 5334 Code of practice for magnetic particle flaw detection of welds.

# Materials

Structural steel rolled sections and plates shall conform to specified grade of IS:2062. However rolled sections and plates upto 20mm conforming to IS:226 may be used in place of grade-A of IS:2062. Pipes used in Handrails, embedments etc. Shall conform to IS:1161. Chequered plate shall conform to IS:3502. High strength steel shall conform to IS:8500 of specified grade. All other materials shall be as per the list of standards codes given above or mentioned elsewhere in the relevant sections.

All steel sections and plates shall be straight, sound, free from twists, cracks, flaws, laminations, rough, jagged and imperfect edges and other defects.

In case any defect like laminations is noticed in the steel sections and plates during fabrication and erection, the same shall be brought to the notice of the Project Engineer and Executing Agency. These sections and plates shall be rejected unless specifically approved for acceptance by the Project Engineer and Executing Agency.

# Fabrication

The fabrication and erection of works shall be carried out generally in accordance with IS:800 as well as the stipulations contained in this specification. All materials shall be completely fabricated at his own shop or at the shop established by him at project site and finished with proper connection materials for ready assembly in the field. Check list format, inspection certificate for fabrication, erection, alignment and protocol for handling over of structural steel shall be submitted by the Concessionaire in the form as agreed to by the Project Engineer and Executing Agency. Fabrication work shall be taken up based on the approved fabrication drawings.

# Cutting plans

Fabrication work shall be taken up based on the fabrication drawings duly approved by the Project Engineer and Executing Agency. The Concessionaire shall prepare necessary cutting plans before commencement of fabrication for all fabrication drawings.

# Straightening

All steel material shall be straight and free from bends or twists. If the sections are distorted or twisted during transit, storage, etc. They shall be straightened and/or flattened by straightening machine at ambient temperature, though minor kinks or bends may be corrected by limited heating under careful supervision.

# Bending

The bending of plates and sections to specially required shapes shall be done either on

appropriate machine or by angle smithy and black smithy processes.

# Cutting

Cutting may be effected by shearing, cropping, sawing or by gas cutting by mechanically controlled torch. Gas cutting by hand may only be used when specifically authorized in writing by the Project Engineer and Executing Agency. The edges of all plates shall be perfectly straight and uniform throughout. Shearing, cropping and gas cutting shall be clean, square and free from distortion and burrs, and should the Project Engineer and Executing Agency find it necessary the edges shall be ground afterwards by the Concessionaire.

# Grinding

All the edges cut by flame shall be ground before they are welded. Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. The maximum permissible gap between the bearing stiffeners and the flanges shall not be more than 0.2 mm locally.

In case of gantry girders, the bottom of the knife-edge support shall be accurately ground to provide effective bearing on the column bracket with a clearance not exceeding 0.2 mm locally at any place. The top surface of the column bracket shall also be ground similarly. The column splices and butt joints of struts and compression members shall be accurately ground and closely butted over the whole section with tolerance not exceeding 0.2 mm locally at any place. Notwithstanding the above, full load shall be transferred through welds.

The ends of shafts together with attached gussests, angles, channels, etc. After welding together shall be accurately ground so that the parts connected, butt over the entire surface of contact. Care shall be taken to see that these connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by grinding by more than 1 mm.

The slab bases shall be similarly ground over the bearing surface and shall have effective contact with the end of the shaft. The bearing face which is to be grouted direct to a foundation need not be ground if such face is true and parallel to the upper face. To facilitate grouting and escape of air, holes shall be provided wherever necessary in column bases.

# Clearances

The erection clearance for cleated ends of members connecting steel to steel shall not be greater than 2 mm at each end unless specifically approved by the Project Engineer and Executing Agency.

# Holes

Holes through more than one thickness of material for members, such as compound stanchion and girders, flanges, shall where possible, be drilled after the members are assembled and tightly clamped or bolted together. Sub-punching may be permitted before assembly, provided the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full

size. Punching shall not be adopted where the thickness of metal exceeds 16 mm.

When holes are being drilled in one operation through two or more separable parts, those parts, when so specified by the Project Engineer and Executing Agency, shall be separated after drilling and burrs removed.

Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 12 mm thick, except where required for close tolerance.

Matching holes for rivets and blacks bolts shall register with each other so that a gauge of 1.5 mm or 2.0 mm (as the case may be, depending on whether the diameter of the bolt is less than or more than 25 mm) less in diameter than the diameter of the hole will pass freely through the assembled members in a direction at right angles to such members. Finished holes shall not be more than

1.5 or 2.0 mm (as the case may be) larger in diameter than the diameter of the black bolt passing through them unless otherwise specified by the Project Engineer and Executing Agency.

Holes for bolts shall not be formed by a gas cutting process, except in special cases with specific permission of the Project Engineer and Executing Agency. Wherever a horizontal member is likely to collect water, suitable holes for drainage shall be provided.

# Notches

The ends of all joints, beams and girders shall be cut truly square unless required otherwise and joist flanges shall be neatly cut away or notched where necessary, the notches being kept as small as possible.

# Assembly

The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified chamber, if any, is provided. In order to minimize distortion in a member the component parts shall be positioned by using clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, parallel and tapered drifts shall be used to align the parts so that the bolts can be accurately positioned.

Items like roof trusses, galleries, plate girders etc. shall be trial assembled keeping in view the actual site conditions, prior to despatch to site for erection so that they can be conveniently preassembled before erection or conveniently preassembled during erection. Necessary match marks shall be made on these components before disassembly in the shop and despatching.

For columns which are fabricated in two or more parts, controlled assembly shall be carried out in the fabrication yard before despatch to the erection site.

# Bolting

Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

Flat washers shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with the square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

All bolts and nuts shall be of steel, with well-formed hexagonal heads unless specified otherwise, forged from the solid and shall be dipped in hot boiled linseed oil as soon as they are made. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

Notwithstanding anything to the contrary contained in IS:1363, IS:1364, and IS:1367, the unthreaded length of the bolt shall be equal to total thickness of metal being bolted together plus 2 mm. The threaded length shall be equal to at least the diameter of bolts plus 6 mm.

# Welding

The works shall be done as per approved fabrication drawing which would clearly indicate various details of joints to be welded, type of weld, length and size of weld, whether shop or site weld. Symbols for welding on fabrication drawings shall be according to IS:813. Efforts shall be made to reduce site welding so as to avoid improper welding due to constructional difficulties.

# Welding of structural steel work

Welding of Structural Steel shall be done by an electric arc process. The procedure to be followed, materials, plant and equipment to be used, testing and inspection procedures to be applied shall be subject to the approval of the Project Engineer and Executing Agency and shall conform generally to relevant acceptable standards viz. IS:816, IS:9595, IS:814, IS:4354 and Indian Standard Hand Book for metal arc welding, and other standard codes of practice internationally accepted.

Submerged-Arc-Welding/MIG (using Carbon dioxide) welding process employing semi- automatic welding machine and fully automatic welding machine (of approved make) shall be used for welding all butt joints and longitudinal fillet welds (connecting flange with web) respectively for fabrication of columns, framing beams & crane gantry girders, unless manual arc welding is specifically approved by the Project Engineer and Executing Agency. Necessary jigs & fixtures and rotation of structures shall be so arranged that vertically down-hand position of welding becomes possible.

-Arc-    other welded connections not covered under 6.02.02 and field welding.

Wherever welding is done for assembling the components of structures, the job shall be so positioned that down hand welding is possible. In cases where positioning of job is not possible

other manual welding positions could be resorted to.

Any structural joint shall be welded only by those welders who are qualified for all welding procedures and positions required in such joint that is welded. The entire weld of any structure joint shall be made by one welder.

Each welder shall be assigned an identification mark and such mark shall be marked on the structure adjacent to the weld on completion of any structural welded joint.

The Concessionaire shall maintain records of all the welders identification marks, the joints welded by each welder, the welding procedure adopted, welding machine employed, pre and post heating done & any non destructive test done and stress relieving heat treatment performance on such joints. All such records for entire welding operation shall be accessible to the Project Engineer and Executing Agency for scrutiny & such record shall be countersigned by Project Engineer and Executing Agency for welding work accomplished in the preceding months as token of acceptance. But such acceptance shall not relieve the Concessionaire of his responsibility regarding adequacy & safety of welding operation.

# Edge preparation for welding

Proper edge preparation shall be made for jointing of materials before welding. Suitable edge preparation shall be done for all processes of welding except for square-butt welds. Type of edge preparation shall depend on the thickness of parent materials that are to be joined. The edge forms shall be chosen to suit the design, technology and production conditions and shall be subject to the approval of the Project Engineer and Executing Agency. The edge form of weldments shall be prepared either by machines or by automatic gas cutting with surface roughness of the welding area not exceeding Rs.50/- All edges cut by flame shall be ground before they are welded.

# Electrodes

The electrodes used for welding shall be of suitable type and size depending upon specifications of the parent materials, the method of welding, the position of welding and quality of welds desired e.g. normal penetration welds or deep penetration welds. However, only low Hydrogen electrodes shall be used for plates thickness above 40 mm for IS:2062 steel and for all thickness of high strength steel conforming to IS:8500.

All low hydrogen electrodes shall be baked and stored before use as per manufacturers recommendation. The electrodes shall be rebaked at 250°C - 300°C for one hour and later on cooled in the same oven to 100°C. It shall be transferred to an holding oven maintained at 60°C - 70°C. The electrodes shall be drawn from this oven for use. Rutile type electrodes shall not be kept in the same oven.

Where coated electrodes are used they shall meet the requirements of IS:814 and relevant ASME- SEC IX and IIC. Coating shall be heavy to withstand normal conditions of handling and storage. They shall be free from all defects which would interfere with performance of electrodes.

Only those electrodes which give radiographic quality welds shall be used for welds which are subjected to radiographic testing.

Where bare electrodes are used these shall correspond to specification of the parent material. The type of flux-wire combination for submerged arc welding shall conform to the requirements of IS:3613. The electrodes shall be stored properly and the flux shall be baked before use in an oven in accordance with the



Specific approval of the Project Engineer and Executing Agency shall be taken by the Concessionaire for the various electrodes proposed to be used on the work before any welding is started.

# Preheating inter-pass temperature and post weld heat treatment

Mild steel plates conforming to IS:2062 and thicker than 20 mm, may require preheating of the parent plate prior to welding as mentioned in Table - 1. For high strength steel conforming to IS:8500 the minimum preheat temperature shall be as specified in Table - 1. However, higher preheat temperature may be required as per approved welding procedure and same shall be followed. In welding materials of unequal thickness, the thicker part shall be taken for this purpose.

Base metal shall be preheated, not withstanding provisions of IS:9595 to the temperature given in Table - 1 prior to welding or tack welding. When base metal not otherwise required to be preheated is at a temperature below 0 deg. C it shall be preheated to at least 20 deg.C, prior to tack welding or welding. Preheating shall bring the surface of the base metal to the specified preheat temperature and this temperature shall be maintained as minimum interpass temperature while welding is in progress.

# Table - 1: Minimum Preheat Interpass Temperature for Welding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Welding** | **used** |  |
| Thickness of thicker part at point of welding | Other than low hydrogen electrode  IS:2062 steel | IS:8500 steel | Low hydrogen electrodes/ or submerged arc welding IS:2062 steel | IS:8500  Steel |
| 1 | 2 | 3 | 4 | 5 |
| Upto 20 mm including | None | welding by  this | None | None |
| Over 20 mm including | 66ºC | electrode not  allowed | 20ºC | 66ºC |
| Over 40 mm to 63 mm  including | not allowed | - | 66ºC | 110ºC |
| Over 63 mm | not allowed | - | 110ºC | 150ºC |

Preheating may be applied by external flame which is non-carbonising like LPG, by electric resistance or electric induction process such that uniform heating of the surface extending upto a

distance of four times the thickness of the plate on either side of the welded joint is obtained.

Thermo-chalk, thermo-couple or other approved methods shall be used for measuring the plate temperature.

All butt welds with plater thicker than 50 mm require post weld heat treatment as per procedure given in AWS D-1.1. Post heating shall be done upto 600 deg c and rate of application shall be 200 deg C per hour. The post heat temperature shall be maintained for 60 minutes per 2.5 cm thickness. For maintaining slow and uniform cooling, asbestos pads shall be used for covering the heated areas. The Concessionaire shall submit and finalize post weld heat treatment procedure at the time of finalization of quality plans.

# Sequence of welding

The sequence of welding shall be carefully chosen to ensure that the components assembled by welding are free from distortion and large residual stresses are not developed. The distortion should be effectively controlled either by a counter effect or by a counter distortion. The direction of welding should be away from the point of restraint and towards the point of maximum freedom.

Each case shall be carefully studied before finally following a particular sequence of welding.

Butt weld in flange plates and/or web plates shall be completed before the flanges and webs are welded together.

The beam and column stiffeners shall preferably be welded to the webs before the web and flanges are assembled unless the web and flanges to the beam or column are assembled by automatic welding process.

Approval of welding sequence and procedure shall not relieve the Concessionaire of the responsibility for the correct welding and for minimizing the distortion in the finished structure which in no case shall exceed that laid down in Indian Standards.

All welds shall be finished full and made with correct number of runs, the welds being kept free from slag and other inclusions, all adhering slag being removed from exposed faces immediately after such run.

Current shall be appropriate for the type of electrode used. To ensure complete fusion, the welding procedure should go proper and rate of arc advancement should not be so rapid as to leave the edges unmelted.

Puddling shall be sufficient to enable the gases to escape from the molten metal before it solidifies.

Non-uniform and heating and cooling should be avoided to ensure that excessive stresses are not locked up resulting ultimately in cracks.

The welding shrinkage shall be minimized by adopting the correct welding procedure and method. In long and slender members extra length should be provided, at the time of fabrication, for shrinkage.

The ends of butt welds shall have full throat thickness. This shall be obtained on all main butt welds by the use of runoff and run on pieces adequately secured on either side of main plates. Additional metal remaining after the removal of extension pieces shall be removed by grinding or by other approved means and the ends and surface of the welds shall be smoothly finished.

The fusion faces shall be carefully aligned. Angle shrinkage shall be controlled by presetting. Correct gap and alignment shall be maintained during the welding operation.

All main but welds shall have complete penetration and except where it is impracticable they shall be welded from both sides, back surface of the weld being gauged out clean before first run of the weld is given from the back. However, partial penetration butt weld shall be permitted, when specifically shown in the fabrication drawings.

Intermittent welds shall not be permitted without the approval of the Project Engineer and Executing Agency. These shall be permitted only when specifically approved in the fabrication drawings.

# Testing of welders

All the welders to be employed for the job shall have to qualify the appropriate tests laid down in IS:817 and IS:1181. If the welder fails in these tests, two further set of tests shall be undertaken and the welder to qualify must pass both these sets of tests.

The Project Engineer and Executing Agency also reserves the right to have any welder retested at any time. All the necessary arrangements required for the testing of welders are to be provided by the Concessionaire.

# Inspection of welds

**Visual inspection**

100 percent of the welds shall be inspected visually for external defects. Dimensions of welds shall be checked. The lengths and size of weld shall be as per approved fabrication drawings. It may be slightly oversized but should not be undersized. The profile of weld is affected by the position of the joint but it should be uniform. The welds should have regular height and width of beads. The height and spacing of ripples shall be uniform. The joints in the weld run shall as far as possible be smooth and should not show any humps or craters in the weld surface. Welds shall be free from unfilled craters on the surface, under-cuts, slags on the surface and visible cracks. Such inspection shall be done after cleaning the weld surface with steel wire brushes and chisel to remove the spatter metal, scales, slag etc. If external defects mentioned above are noticed, there is every possibility of internal defects and further radiographic / ultrasonic examination shall be

undertaken as per Indian Standards. Weld gauges shall be used to measure the size of the welds.

# Mechanical testing

Test plates shall be incorporated on either side of 10% of main butt welds & the weld shall be continuous over the test plate. The test plate shall be cut from extensions of the main plates and shall be fixed so that metal lies in the same direction as that of the main plate. Test plates shall be prepared and tested in accordance with the accepted Standards, in the presence of the Project Engineer and Executing Agency or his authorized representative. All testing equipment and facilities for carrying out these tests shall be provided by the Concessionaire should any of these tests fail, further radiographic examination of the welds in question on the main members, shall be undertaken by the Project Engineer and Executing Agency as specified in the specification. These tests for the test plates and radiographic examination are additional to those contemplated under routine inspection and testing. The Concessionaire shall carry out these additional radiographic tests as per normal testing procedure.

# Non-destructive and special testing

In addition to the normal supervision and testing procedure, radiographic/ultrasonic or other non- destructive examination shall be carried out, as stipulated in the Fabrication/Erection checklist on butt or fillet welded joints and/or on test specimens, as per Annexure - B. All test of welds shall be carried out by the Concessionaire at his own cost as per Annexure - B. However, for checking the quality of weld, the Executing Agency shall carry out additional tests at his own cost. The Concessionaire shall provide necessary supporting facilities free of cost, as may be required by the Project Engineer and Executing Agency, including cordoning of radiation zone while Radiography testing is in progress. Prepared etched section of the welds may be required for examination. The Concessionaire shall, at his own cost, provide these prepared sections.

The case of failure of any of the tests, the cost of re-test of that portion of the test shall be recovered from the Concessionaire.

Rectification of defective welding work wherever defects like improper penetration, extensive presence of blow holes, undercuts, cracking, slag inclusion, etc. are noticed by visual inspection / other tests, the welds, in such location shall be removed by gouging process. The joints shall be prepared again by cleaning the burrs and residual matters with wire bushes and grinding, if necessary, and rewelded. The gouging shall as far as possible be done using gouging electrodes. Flame gouging shall be resorted to only in special cases with specific permission of the Project Engineer and Executing Agency.

# Acceptance of welded structures

The acceptance of the welded work shall depend upon current dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the joints and the test specimens as per quality check list and upon general workmanship being good meeting the tolerance requirements given in the quality check list as per Annexure - B.

# Erection procedure

* + 1. **Erection marks**

The erectability of the structures shall be checked by the Concessionaire before commencement of the fabrication work to avoid future modification.



accordance with the approved fabrication drawings and according to an approved marking plan.

The erection marks assigned to various components of the structural steel work, excepting secondary beams, shall also contain an erection sequence number indicating the sequence in which the various components are to be erected.

Erection marks shall be clearly painted on the work item, each piece being marked in at least two places. Each piece shall also have its weight marked thereon. In order to help identification, each erection piece, i.e. erection mark item, shall bear its items erection mark and erection sequence number. Erection marks shall be painted on the structures, during the process of fabrication to facilitate their identification during inspection. Where a number of components are identical and bear the same erection mark, these components shall be further identified by assigning numerals in addition to the common erection mark.

The centre lines of all column, elevations and girder bearings shall be marked on the sections with the utmost care to ensure proper alignment and assembly of the pieces at site.

# Erection

The Concessionaire shall submit for approval of the Project Engineer and Executing Agency his Erection Scheme for the erection of all types of structures. Erection shall commence only after



The erection scheme shall give full details of the method of handling, transport, hoisting and erection including false work/staging, temporary bracing, guying temporary strengthening etc. It will also give the complete details of the quantity and capacity of the various items of erection equipment that will be used. Any modifications to the erection scheme as directed by the Project Engineer and Executing Agency for various reasons or due to the interference with the work of other agencies shall be incorporated by the Concessionaire.

The Concessionaire shall examine the site conditions and transportation clearances before deciding whether columns are to be fabricated and erected in one piece or more than one piece. Erection of structures is to be carried out preferably with a crane and in case this is not possible, only the upper portion of the columns can be erected with a derrick. Further, the erection of columns and portals etc. shall be carried out in one single piece as far as practicable. No column shall be fabricated and erected in more than 3 pieces. Proper splicing shall be provided at the erection joints indicated in fabrication drawings. When erection joints are provided in columns, their location shall generally be just above a floor level.

The structural steel shall as far as practicable be erected frame wise. Thereafter, the frames shall be progressively aligned and all erection welding completed. The secondary beams shall thereafter be erected, aligned and welded completely as per the approved schedule of work. Touch up painting in these areas shall be completed and as soon as a particular portion of the structure/floor is completed in all respects, it shall be handed over to other Concessionaires for carrying out other civil works as well as mechanical/ electrical erection works. Conveyor galleries shall generally be erected as a completely fabricated box, i.e. the bottom chord and bracings, top chord and bracings, side vertical posts and bracings, end portals and roof-trusses shall be completely welded prior to erection. The inside sheeting runners and roof sheeting purlins may be erected individually.

# Protection against damage in transit

All steel work shall be efficiently and sufficiently protected against damage in transit to site from any cause whatsoever. All projecting plates or bars and ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers and small loose parts shall be packed separately in cases so as to prevent damage or distortion during transit. Should there be any distortion of fabricated members the Concessionaire shall immediately report the matter to the Project Engineer and Executing Agency. Distorted steel received from stores or distorted during transport from stores to the fabrication yard shall not be used in fabrication unless the distortions are minor which in the opinion of the Project Engineer and Executing Agency can be removed by acceptable methods.

These distortions shall be rectified by the Concessionaire by cold-bending. If heating is necessary to rectify the defects, the details of the procedure shall be intimated to the Project Engineer and Executing Agency whose approval shall be taken before such rectification. The temperature of teat treatment shall not exceed the limits beyond which the original properties of the steel are likely to be impaired.

If in the opinion of the Project Engineer and Executing Agency the steel has been unduly bent in transit from the project stores to the fabrication yard or during handling by the Concessionaire which cannot be rectified in the opinion of the Project Engineer and Executing Agency, such steel shall be counted as wastage .

# Stability of structures

The Concessionaire shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations. Guying and bracing shall be done in such a way that it does not interfere with the movement or working of other agencies working in the area. For the purpose of guying, the Concessionaire shall not use other structures in the vicinity which are likely to be damaged by the guy.

# Setting column bases

Column bases shall be set so that the column load is uniformly transmitted to the foundation. The Concessionaire shall carefully check the location and layout of anchor bolts embedded in foundations constructed to ensure that the structures can be properly erected as shown on the drawings.

The Concessionaire shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the columns are in plumb. The permissible erection tolerances for the

is specification.

Before erection of columns on their foundations, the top surface of base concrete shall be thoroughly cleaned with wire brushes and by chipping to remove all laitance and loose material. The Concessionaire shall also be responsible to provide all packing and shim, plates. No steel structure shall be erected on their foundation unless such foundations have been certified fit for erection of steel by the Engineer. Adequate number of air release holes and inspection holes shall be provided in the base plate. The grouting/under pinning of base plate and chipping of foundation to desired level are also in scope of Concessionaire.

# Painting

After inspection and issue of test and acceptance certificate, all steel surfaces shall be painted or otherwise treated. Except where encased in concrete, all steel work shall be given one coat of approved metal protection as may be specified, applied evenly and thoroughly and well worked into the joints and other open spaces.

# Materials

* + - 1. The touch-up primers and paints shall consist of Red oxide Zinc Chromate conforming to the requirements of IS:2074 with a pigment to be specified by the Executing Agency. However, the Concessionaire may have to use other type of primer wherever specified.
      2. The contents of paint drums shall be thoroughly mixed so that no material remains at the bottom before the paint is used and the paint shall be stirred at regular intervals while being applied.
      3. The primers should not be diluted or thinned except as hereinafter specifically provided. Where the paint has thickened due to loss of Solvent by evaporation in partially used tins it may be brought to consistency for application, in consultation with the manufacturer who shall give necessary information particularly with regard to appropriate viscosity.
      4. Material shall be of best quality available and procured directly from approved manufacturers. Samples shall be submitted to the Executing Agency or approval before procurement.

# Preparation of surface

1. The surface preparation shall be done in accordance with IS:1477 (Part I) Code of Practice for Finishing of Ferrous Metals in Buildings: Painting and Allied Finishes: Part I (Operation and Workmanship).
2. The surface shall be cleaned and degreased in accordance with one or more of the methods given in Clause 6.1 of IS:1477 (Part I).
3. The surface shall be derusted and de-scaled either mechanically or chemically by one or more of the methods given in Clause 6.2 of OS:1477 (Part I) to the satisfaction of the Executing Agency. However flame cleaning, sand, blasting, and shot blasting are excluded from the scope of Concessionaire.
4. While cleaning with power wire-brush, care shall be taken not to do it excessively, since mill scale easily gets burnished to a smooth even surface to which paints does not adhere, and this will be detrimental to the performance of paint. All accessible weld flux and splatter shall be removed by power tools.

# Application of priming coat, touch-up paint

1. Primers are generally applied by brushing. In areas which are difficult to reach either by brushing or spraying, daubers, mops or both may be used by dipping the same in paints and pulling or pushing them through the narrow spaces unless otherwise specified one coat of primer of 25 micron thickness shall be applied in shop.
2. During the painting, the air temperature shall be well above the dew point and not less than 4 C and relative humidity not greater than 80%. The time of painting shall be such that moisture does not condense on the structure before or during painting or until the painting is dry.
3. Primer coats shall be applied without any time lag after the pre-cleaning or pretreatment and care shall be taken to ensure that paint is not applied to damp surface (in early morning, under humid conditions dew etc.)
4. Surfaces of fabricated steel where shop priming coat has been removed or damaged during transit or defaced during welding including site welded locations shall be cleaned and applied with touch up primer coat of paint.

# Shop connections

* 1. Surfaces to be permanently in contact shall receive a priming coat immediately prior to being jointed together at the works except where jointed by welding.
  2. Galvanised steel shall not be prepared or painted at site.

Machined, sliding or rocking surfaces of casting blocks, slabs or pins shall be coated with a mixture of white lead and tallow after the work has been inspected and approved by the Executing Agency. Molybdenum disulphate (grease) will be used in rider pin connections.

Surfaces not in contact, but inaccessible after shop assembly shall receive two coats of shop paints, positively of different colours or such material to prove use of two coats before assembly. This does not apply to the interior of sealed hollow sections.

Shop contact surfaces shall be cleaned by effective means before assembly, but not painted.

In the case of surface to be welded, the steel shall not be painted or metal coated within minimum 50 mm distances of any edges to be welded, if the paint specified or the metal coasting would be harmful to welders or impair the quality of the welds. Welds and adjacent parent metal shall not be painted prior to deslaggings, inspection and acceptance.

# Site preparation of contract surface

1. The paint, on all contact surfaces, which was applied in the fabrication shop shall be carefully removed and a fresh coat of priming paint shall be applied to all surfaces in permanent contact, and the surfaces shall be brought together while the paint is still wet.
2. The Concessionaire shall provide and use sufficient number of drop cloths, covers, tarpaulin and other screens to protect adjacent surfaces and shall remove all spatter and stains from such surfaces. The Concessionaire shall also protect his own work.
3. The Concessionaire shall provide and use sufficient number of drop cloths, covers, tarpaulin and other screens to protect adjacent surfaces and shall remove all spatter and stains from such surfaces. The Concessionaire shall also protect his own work.
4. Painting shall be discontinued during rain and dust-storm and shall not commence until the surfaces are perfectly dry and clean. Wherever practicable, surfaces shall be painted when in shade or when the temperature is failing.
5. Welds and adjacent metal shall not be painted or touched up prior to deslagging inspection and approval.
6. Parts of the steel structures to be encased in concrete shall not be painted.
7. One coat of primer and touch-up paint shall be applied except for the item which shall be not dip galvanized.

# Steel grading

All grating units shall be rectangular in pattern and welded grating assembly. The size and the spacing of the bearing bars and cross bars shall be as approved in detailed drawings. The detail fabrication drawings for gratings shall be prepared by Concessionaire on the basic of approved design for grating.

The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing as indicated in the drawings or as directed by the Project Engineer and Executing Agency. The size of each panel shall be as approved by Project Engineer and Executing Agency.

The grating unit shall be accurately fabricated and finished, free from wraps, twists or any defects that would impair their strength, serviceability and appearance.

Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as follows.

The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

Opening in gratings for pipes or ducts that are 150 mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5 mm thickness and appropriate width, set flush with the bottom of the bearing bars.

Penetrations in gratings that are more than 50 mm but less than 150 mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

Unless otherwise indicated on the drawings, grating units to all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units and supporting structural steel framing members.

All fabricated grating section and accessories shall be primed and finish painted in the shop prior to erection at site. Painting shall consist of two coats of red lead primer and two coat of black enamel finish.

Prior to painting all surfaces shall be cleaned free from rust, millscale, grease, oil, or any other foreign matter that might affect the adherence of the paint by sand blasting. While the primer shall be applied by spray guns or by brushes, the final coat of finished paint shall necessarily be applied by means of spray guns only.

The applied coatings shall be uniform, free from voids and streaks, drilled or punched holes shall be touched up prior to erection or assembly.

Maximum deviation in linear dimension from the approved dimension shall exceed 12 mm.

# Stairs, railings and ladders

All stairs and intermediate landings shall be constructed to size dimensions and design, as indicated on the detailed drawings. Such stairway shall be fabricated as a complete unit which shall include struts, hangers, posts, cross bracings, cleats and accessories, as required for connection to structural steel framing and concrete.

Stair treads shall be furnished complete with punched and slotted carrier plates attached ready to bolt to stair stringers. Treads shall be provided with antislip nosing using chequered plate and set flush with the stair treads.

Pipe handrails, as specified in detailed drawings shall be assembled with flush type fittings and welded joints, ground and polished smooth. Railings shall be provided with all necessary fittings posts brackets, bolts, plates and similar accessories as shown on the approved drawings and as required for proper installation.

Hand rails shall be of standard weight black steel pipes of flush welded construction, ground smooth using 32 mm nominal bore medium class pipes with double rail about 1 metre above platform level and pipe posts spread not more than 1.5 metres apart.

Smooth uniform curves and bends are to be provided at stair returns and also wherever specified/required. The open ends of all pipe posts shall be plugged and welded. A minimum radius of 3 times the pipe diameter shall be provided at all points of direction changes in the hand rails.

Vertical ladders shall be as called for on the approved drawings. The ladders shall be provided with support arms formed of bent steel plate or clip angles. Where shown on the drawings the ladders shall have loose neck supports, designed to form hand grabs and end brackets for fastening to abutting construction. Maximum deviation in the linear dimensions of railings, stairs and ladders, from the approved dimensions, shall not exceed 12 mm.

# Chequered plate

Chequered plates shall be fixed to supporting members by welding as specified in relevant drawings or as directed by the Project Engineer and Executing Agency. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding of stiffening angles/vertical stiffening ribs.

# Ash storage silo / intermediate hopper

Shape of the silo/intermediate hopper shall be circular in plan. Bottom hopper portion shall be of conical shape and/or flat bottom type as specified in mechanical section.

For general requirements, fabrication and construction details, including design criteria, IS:9178 (Pt.I, II & III) shall be followed as general guidance.

Side walls shall be made of mild steel plates having horizontal and vertical stiffeners at regular interval as per the design requirements. Stiffeners shall be provided on the external face. Joints between the walls inside the silos should be continuously welded to ensure complete sealing. However, for the stiffeners provided on the outer shell, intermittent welding may be adopted.

Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process without resorting to heating, hammering, angle smithy and black smithy process.

Poking hole and 10 mm thick striking plate shall be provided to facilitate ash flow. Poking holes shall have circular m.s. pipe and cover cap as shown in the drawing.

# Lining

To cater for corrosion, abrasion or smoothness lining shall be provided in sloping/conical portion as specified in mechanical section. Lining shall generally be in the form of stainless steel sheet of 3 mm thickness of grade SS 316 or 10 mm thick alloy C.I. liners of 300-350 BHN (min.).

# Intermediate/buffer and storage silos hoppers

The hoppers shall be conical in shape with valley angle as 55 degrees and the details of hopper specifications are covered elsewhere in these specifications.

# Sampling, testing and quality control

* + 1. **General**

1. The Concessionaire shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as called for by the Project Engineer and Executing Agency. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Project Engineer and Executing Agency. Tests shall be done in the field and at a laboratory approved by the Project Engineer and the Concessionaire shall submit to the Project Engineer and Executing Agency, the test results in triplicate within three days after completion of a test. The Project Engineer and Executing Agency may, at his discretion, waive off some of the stipulations given for small and unimportant operations.
2. Material / work found unsuitable for acceptance, shall be removed and replaced by the Concessionaire. The work shall be redone as per specification requirements and to the satisfaction of the Project Engineer and Executing Agency.
3. Radiography and ultrasonic testing of welds shall be carried out by specialist agency only. In case, the Concessionaire does not have the required expertise, he shall engage specialist agency for this purpose.

An indicative programme of Inspection and testing for raw materials, welds and dimensional tolerances for fabrication & erection of steel structures are given in Annexure - B. The Concessionaire shall draw-up a comprehensive programme for executing the works based on this indicative programme.

# Annexure - B

**Inspection, testing and quality check list**

# Inspection & testing

The Concessionaire shall carry out a comprehensive inspection and testing programme of inspection / testing on the basis of details given below. The testing of all the materials supplied by the Concessionaire shall be carried out by him. This is however, not intended to form a

-up and carry out such a programme duly approved by the Project Engineer and Executing Agency. Such approval shall not relieve the Concessionaire of the responsibility about the correctness and adequacy of workmanship, materials etc.

# Raw material inspection

* + 1. **Steel**

# Conformity with specifications

* + - * 1. The conformity of the materials with the specification and the availability of the relevant test certificates shall be checked. Carbon equivalent value shall also be made available.
        2. Plates above 25 mm thickness shall be subjected to ultrasonic test as per ASTM A435 or equivalent to check the presence of lamination.

# Physical conditions:

* + - * 1. Steel shall not be pitted and should be free from scales and rust.
        2. If the rolled sections and plates are bent or distorted, bend or distortion shall normally be removed by cold treatment etc.
        3. Straightening under hot stage shall be resorted only under specific permission from the Project Engineer and Executing Agency.
        4. If any rolling defects, viz. lamination, cracks etc. are discovered in the steel during the processing, it is to be rejected.

# Storage

* + - * 1. Steel plates of different specifications shall be stacked separately.
        2. Steel of IS:2062 (different grades) and IS:8500 quality shall be given distinctive identification mark.
        3. Rolled sections shall be stacked profile-wise separately.
        4. Steel sections shall be stacked over spacers supported on posts of about 50 cm. height above ground. Passages and space between the stacks shall be sufficient for rigging operations.

# Electrodes

* + - 1. Electrodes for all welding shall be procured as envisaged in the welding procedure sheet predetermined before actual welding operation starts/
      2. Electrodes shall be properly stored dry as required by the IS Code or by the manufacturer.
      3. Electrodes shall bear the ISI or equivalent Certification mark.
      4. The approval for all the consumables for welding shall be specifically obtained beforehand.

# Nuts, bolts etc.

* + - 1. The quality of these shall be as per relevant IS codes.
      2. They shall be stored properly according to grade, diameter and length. However, special bolts like HSFG shall be stored separately as per the relevant clause.
      3. 



However, in case the Concessionaire is not able to produce the test certificate, the bolts can be accepted only after satisfactory cold bend and flattening tests. For the purpose of these tests, the inspecting officer should select at random 3 specimens each for cold bend and flattening tests. For the purpose of these tests, the inspecting officer should select at random 3 specimens each for cold bend and flattening tests out of each consignment of 1000 Nos. or less and instruct the Concessionaire to carry out the tests in his presence. Cost of testing shall be borne by the Concessionaire.

# Paints/primers

* + - 1. The relevant IS or equivalent mark on sealed tins shall be checked.
      2. A few tins shall be opened at random to check the condition of the paint. Paint from old stock and showing signs of solidification shall not be accepted.

# Cement

* + - 1. The quality of cement shall conform to relevant IS code.
      2. Cement is to be stored in a place of easy access for proper inspection and identification. It should be placed in a weather tight building, so that dampness and loss due to other causes is minimum.

# Welding procedure qualification

Welding procedure shall be established as per ASME Section IX or equivalent Indian Standards. Welding procedure, specifications shall be submitted by the Concessionaire for review and approval of the Executing Agency. Typical welding procedure data sheet is given in Proforma A.P-1.

# Welders qualification test

Welders qualification test shall be as per ASTM Section IX or equivalent Indian Standards.

# Inspection for tack assembly set up :

1. Bevel
2. Gap
3. Off-setting
4. Shrinkage allowance
5. Fitment Sequence
6. Principal overall size

# Preheating:

Temperature control by Thermochalk or suitable equivalent method.

Inspection of main welds of principal components for columns, crane girders, framing beams, trusses, etc.

# Fillet welds for :

* 1. Check size
  2. Macrotech examination of production test coupons for main fillet weld.
  3. 100% visual examination
  4. 100% dye penetration test/magnetic particle test - Major welds (including welds subjected to tension) like web to flange connection, splice plates, moment/shear connection.
  5. 10% All other areas.

# Butt welds :

1. Columns, Beams etc.
   1. 100% Visual examination
   2. 100% Dye penetration test after back gouging shall be carried out. Final weld shall also be tested.
   3. Mechanical testing of production test coupons - Minimum one joint per column/built up beam and crane grinder etc. The Project Engineer and Executing Agency may reduce the frequency of this test, after getting consistently satisfactory results for initial 10 tests.
   4. 100% Radiography test on tension zone (bottom flange of the girder) welds and 10% spot Radiography on compression zone for minimum 300 mm length (top flange of the girder) welds of crane girder shall be carried out. Where Radiography test is not possible, ultrasonic test shall be carried out after grinding the surface wherever required with prior approval of the Project Engineer and Executing Agency.
   5. All other butt welds and full penetration welds shall be subjected to 10% spot Radiographic test and for the balance ultrasonic test. Wherever Radiography is not possible, ultrasonic testing shall be carried out with prior approval of the Project Engineer and Executing Agency.

# Dry ash silo :

* 1. Dye penetration test after back gouging and for all finished welds.
  2. 10% spot Radiography test on fabrication shop butt welds and 10% spot Radiography test on site erected butt joints shall be carried out where access is available.

1. In case of failure of any weld in spot radiography the percentage for retesting shall be doubled at that particular location.

# Final inspection

1. Dimensional check as per fabrication check list detailed elsewhere.
2. Marking for holes for fitments or connection and hole sizes.
3. Erection mark
4. Painting
5. Dressing and surface preparation.
6. Final painting including dry film thickness (DFT) by using Elcometer or any other approved metho   

recommendation shall be checked.

# Inspection during fabrication and erection

1. All structural components/members shall be checked for dimensional tolerance during fabrication and erection.
2. Tolerance on dimensions for fabrication of structures shall be according to IS:7215 and check list given under table A-1 to A-5. In case of any conflict between the provisions of IS:7215 and those mentioned under the table, the stipulation of the latter shall govern.
3. Tolerance on dimensions for erection of steel structures shall be according to IS:12843. Relevant portion of the same is given under Table A-6 for ready reference.

# Welding tests on welds and weld defects

Mechanical testing of welds (destructive tests): Butt welds having one or more of thefollowing defects are not acceptable.

1. Bend Test : No crack on root/face on being bent through 180 degree with mandrel of 41 where t is the thickness of plate.
2. Tensile Test : Weld strength not l



# Radiographic examination

Sections of welds that are shown by Radiography to have any of the following type of imperfections shall be judged unacceptable:

1. Any type of crack or zone of incomplete fusion or penetration.
2. Any elongated slag inclusion which has length greater than :
   1. 6mm for t upto 20 mm
   2. 8mm for t from 20 mm to 32 mm iii)

3)  

of 12t, except whe length of longest imperfection in group.

4) Rounded indications in excess of that specified by the acceptance standard given in Appendix 4 of ASME section VIII Div. 1.

# Ultrasonic examination

The welded joints will be tested by suitable combination of Angle and Normal beam probe techniques to ensure scanning of the entire cross-section of weldments.

# Acceptance standard

All indications which produce a response greater than 20% of the reference level shall be investigated to the extent that operator can determine the shape, identify and location of all such reflectors and evaluate them in terms of the acceptance standards given in (a) and (b) below:

1. Discontinuities are unacceptable if the amplitude exceeds the reference level and discontinuities have lengths which exceed.

i) 

ii)

* 1. iii)

ns two members having different



1. Where discontinuities are interpreted to be cracks, lack of fusion, or incomplete penetration, they are unacceptable regardless of discontinuities or signal amplitude.

# Visual examination:

Following defects are not allowed:

1. Unsatisfactory appearance
2. Incomplete weld
3. Molten metal flow
4. Pits
5. Surface crack, lack of penetration
6. Insufficient length
7. Surface defects exceeding 5% of weld seam area

# Dye penetration test:

All surfaces to be examined shall be free of:

1. Relevant linear indications
2. Four or more rounded defects in a line separated by 1.5mm or less (edge to edge) except where the specification for the material establishes different requirements for acceptance so far as defects are concerned.

# Evaluation of indicators

1. Linear indications are those indications in which the length is more than 3 times the width. Only indicators with major dimensions greater than 1.5 mm shall be considered relevant.
2. Rounded indications or indications which are circular or elliptical with length less than 3 times the width.
3. Any questionable or doubtful indications shall be tested to verify whether or not actual defects are present.
4. Localised surface imperfections may occur from machining work surface conditions or an incomplete bond between base metal & cladding may produce similar indications which are relevant to the deletions of unacceptable discontinuities.

# Table:1 - Tolerable deviation from designed linear dimensions in mm in the parts processed for fabrication

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Characteristic** | **Deviation / tolerances in mm** | | | | | |
| **1.5m**  **& Below** | **1.5m to 2.5m** | **2.5m**  **to 4.5m** | **4.5m**  **to 9.0m** | **9m to 15m** | **15m & above** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| 1a | Deviation in length and width of  part cut out by: |  |  |  |  |  |  |
|  | i) Manual gas cutting | 2.5 | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
|  | ii)Gas cutting by  automatic and semi- automatic machines | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|  | iii) Shear or saw cutting | 1.5 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|  | iv) Parts machined by edge-  planning or milling machines | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| b | Difference in diagonal lengths of  sheet parts: |  |  |  |  |  |  |
|  | i) For butt welding | 4.0 | 4.0 | 4.0 | 5.0 | 6.0 | 6.0 |
|  | ii) For lap welding | 5.0 | 5.0 | 5.0 | 8.0 | 10.0 | 10.0 |
| c | Deviation in distances between  hole centres, formed as per: |  |  |  |  |  |  |
|  | i) Marking of extreme  ones | 2.0 | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|  | ii) marking of adjacent  ones | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| 2 | Deviation in the dimensions of  structural despatch members after finishing: |  |  |  |  |  |  |
| a | When assembled upon assembly  benches as per marking. | 3.0 | 4.0 | 5.0 | 7.0 | 10.0 | 15.0 |
| b | When assembled in the jig and  other devices fastening with fixtures. | 2.0 | 2.0 | 3.0 | 5.0 | 7.0 | 10.0 |
| c | Dimensions (length and breadth)  between milled surface (after finishing) | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
| 3 | Distance between groups of erection holes (in finished  members): |  |  |  |  |  |  |
| a | Formed during machining of  separate parts installed when assembling as per marking. | 3.0 | 4.0 | 5.0 | 7.0 | 10.0 | 15.0 |
| b | Formed during machining of  parts, installed when assembling | 2.0 | 2.0 | 3.0 | 5.0 | 7.0 | 10.0 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S.**  **No.** | **Characteristic** | **Deviation / tolerances in mm** | | | | | |
| **1.5m**  **& Below** | **1.5m to 2.5m** | **2.5m**  **to 4.5m** | **4.5m**  **to 9.0m** | **9m to 15m** | **15m & above** |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
|  | with the help of fixtures. |  |  |  |  |  |  |
| c | Drilled with the help of templates  in finished members. | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 | 4.0 |

**Fabrication Check List**

# Table 2 : Tolerable deviations of fabricated members from designed geometrical shape

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Characteristic** | **Deviation / Tolerance** | **Remarks** |
| 1. | Curvature of assembly Parts |  |  |
|  | a) Gap between a sheet and a steel rule face  over 1 m length | 1.5 mm |  |
|  | b) Gap between a taut string and vertex face of an angle flange or web of channel and joist. | 0.001 L, but not greater  than 10 mm. | L-length of member |
| 2. | Deviation of edge line steel sheet parts from  theoretical profile: |  |  |
|  | a) During butt and toe welding | 2 mm |  |
|  | b) During lap welding | 5 mm |  |
| 3. | Deviation of radius of the bend: |  |  |
|  | a) Clearance between template and the surface of rolled sheet flange or face of cold bend profile. | 2 mm | Template length (1.5m along  the curve) |
|  | b) -do- for hot bend profile | 3 mm | -do |
|  | c) Ellipticity (difference of diameters) in  space sheet structures. | 0.005D | D-diameter of  circumference |
|  | d) -do- in erection joints | 0.003D | -do- |
| 4. | Deformation of dispatch members: |  |  |
|  | a) Inclination of flanges with the web: |  |  |
|  | i) at junction | 0.005b | b-width of  flange |
|  | ii) at other places | 0.01b | -do- |
|  | b) Transverse bending of flanges: |  |  |
|  | i) at junction with members | 0.005b | b-width of  flange |
|  | ii) at other places | 0.01b | -do- |
|  | c) Warping of the web | 0.003h | h-depth of the  member |
|  | d) Sag of member | L/750 but not more than | L-length of the |





|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Characteristic** | **Deviation / Tolerance** | **Remarks** |
|  |  | 15 mm | member |
| 5. | Other deviations: |  |  |
|  | a) Shifting of axes of riveting/ bolting lines for lattice structures from theoretical  eccentricity. | 3.0 mm |  |
|  | b) Inclination of the milled surface from  designed position. | 1/1500 |  |

**Fabrication Check List**

# Table 3: Acceptance deviations in as fabricated steel structures

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Characteristic** | **Deviation / Tolerance** |
| **1.** | **Columns** |  |
|  | surface of the column footings, to the group of holes for elements to be connected to column. |  |
|  | When L is under 10 m | 10 mm |
|  | When L is over 10 m | 15 mm |
|  | column footing to the top of crane bracket. |  |
|  | When L is under 10 m | 5 mm |
|  | When L is over 10 m | 10 mm |
|  | c) Deviation in distance from bearing surface of the bracket  to the first fastener of the element to be connected to column. | 1 mm |
|  | d) Deviation in distance between any group of holes for  connection of bracings to columns. | 2 mm |
|  | e) Sag of column element (curvature) | 1/1000 of length element but not  more than 15 mm. |
|  | f) Difference in web depth of column |  |
|  | i) At splice joint | 2 mm |
|  | ii) At any other location | 10 mm |
|  | g) Deviation in distance from supporting surface of milled end of the dispatched element of column to the clear or heating plate or column to the cleat or seating plate for fastening of collar beams, purlins, girders etc. (Fish plates,  brackets). | 3 mm |
| **2.** | **Trusses** |  |
|  | he truss between end erection holes in gussets of supporting units or between external planes of supporting gussets or angles when trusses are  resting on brackets or supports: |  |

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Characteristic** | **Deviation / Tolerance** |
|  | When L is under 25 m | 7 mm |
|  | When L is over 25 m | 1/2500 but not more than  10 mm |
|  | b) Deviation in distance between the centres of holes or  webs of angles for fastening bracing, purlins, monitors, etc. | 3 mm |
|  | c) Deviation in distance between the first row of erection  holes and the | more than 15 mm. |
|  | d) Distance between holes for fasteners to top and bottom  chords of trusses on supports. | 3 mm |
|  | e) Sag of separate elements between node points. | 1/1500 of length of element but  not more than 10 mm. |
| **3.** | **Beams** |  |
|  | a) Deviation in span L of beams between bend erection  holes, outer surfaces of end plates: |  |
|  | When L is under 25 m | 10 mm |
|  | When L is over 25 m | 1/2500 length but not more  than 15 mm |
|  | b) Deviation in the height of beam as measured from the  bearing surface to the top of upper flange | 3 mm |
|  | c) Deviation in distance between the group of holes for  fastening of purlins, monitors, bracings, bracing grids etc. | 3 mm |
|  | d) Sag (curvature) of the girder despatch member | 1/1000 length but not more than  15 mm |
| **4.** | **Elements of framework** | Bracings, purlins etc. |
|  | a) Deviation in distance between end erection holes,  determining the span of element. | 3 mm |
|  | b) Sag of despatch members | 1/1000 length but not more than  15 mm |
|  | c) Deviation in distance between the groups of erection  holes of the element | 3 mm |
|  | d) Gratings, Stair, Railings, ladders, etc. | 12 mm |
| **5.** | Shop assembly (before for erection) | Despatch |
|  | a) Columns weighing more than 20 T | i) Every first and further every  tenth set of identical structure to be put for control assembly. |
|  | b) Roof trusses of 30 m or more span |  |
|  | c) Crane girders with span more than18 m |  |
|  | d) Bunkers | i) Number of erection bolts shall be atleast 30% of the total No. of  holes. |



**Fabrication check list**

**Table 4: Acceptable deviation in holes or bolts**

|  |  |  |  |
| --- | --- | --- | --- |
| **S.**  **No.** | **Characteristic** | **Deviation** | **Tolerance No. of deviation in each group** |
|  |  |  |  |
| 1. | a) Deviation of dia of holes for  rivet and bolts: |  |  |
|  | Upto 16 mm | 1 mm | No limit |
|  | Over 16 mm | 1.5 mm |  |
|  | b) Deviation of dia of turned and  fitted bolts: |  |  |
|  | Nominal dia of bolts and holes | Upper limit: + 0.125 mm |  |
|  |  | Lower limit: 0.00 | No limit |
| 2. | Ovalness (difference between the  greatest and lesser dia) |  |  |
|  | Upto 16 mm hole dia | + 1 mm | No limit |
|  | Upto 16 mm hole dia | + 1.5 mm |  |
| 3. | Deformity in size greater than 1.5  mm and cracks in the edge of holes. | Not permitted |  |
| 4. | Misalignment of holes in separate  plates in the joints: |  |  |
|  | i) Upto 1 mm |  | Upto 50% |
|  | ii) From 1 to 1.5 mm |  | Upto 10% |

*Note: In holes shall be removed, the depth and width of countersunk hole shall not deviate from the standard by more than 1.5 mm.*

# Fabrication check list

**Table 5: Permissible fabrication deviation of structural steel**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Type of structures**  **and constructions** | **Name of deviations** | **Value of deviation**  **(Tolerance)** |
| 1. | Column | Assembly fits |  |
|  |  | a) Base plate and column | 0.1 mm |
|  |  | b) Frame Joints | 2.0 mm |
|  |  | c) Web and flange | 1.5 mm |
|  |  | d) Web & stiffeners | 1.5 mm |
|  |  | e) Flange & stiffeners Intermediate  stiffeners& Bearing stiffeners | 1.5 mm |
|  |  | f) Cap plate & column | 0.1 mm |
|  |  | g) Crane girder seat | 0.1 mm |
|  |  | h) Beam brackets | 2.0 mm |
| 2. | Beams | (c), (d), (e) of S.No. 1 above | 1.5 mm |
| 3. | Crane Girders | (c), (d), (e) of S.No. 1 above and knife edge  supports | 0.1 mm |
| 4. | Silos & hoppers | a) Ring beam and wall | 1.5 mm |
|  |  | b) Stiffeners and walls | 1.5 mm |

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Type of structures**  **and constructions** | **Name of deviations** | **Value of deviation**  **(Tolerance)** |
|  |  | c) Stiffeners and ring beams | 1.5 mm |
|  |  | d) Deflection of straight section of  compression cord from the plane of truss, collar beam or girder. | 1/1500 of span but nore more than 10mm |
| 5. | Purlin | Deviation in distance between purlins. | 5 mm |

# Erection check list

**Table 6: Maximum permissible tolerances in steel structures**

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Description** | **Tolerance** |
| 1. | Erected steel columns: |  |
|  | i) Deviation of column axis at foundation top level with  respect to true axis: |  |
|  | a) in longitudinal direction | 5 mm |
|  | b) in lateral direction | 5 mm |
|  | ii) Deviation in the level of bearing surface of columns at  foundation top with respect to true level | 5 mm |
|  | iii) Out of plumbness (verticality) of column axis from true  vertical axis as measured at column top: |  |
|  | a) For columns without any special requirements: |  |
|  | 1) upto and including 30 m height | H or 25 mm  1000 whichever is less |
|  | 2) over 30 m height | H or 35 mm  1200 whichever is less |
|  | b) For column with special requirements like cranes or such  similar requirements: |  |
|  | 1) upto and including 30 m height | H or 25 mm  1000 whichever is less |
|  |  |  |
|  | 2) over 30 m height | H or 25 mm  1500 whichever is less |
|  | iv) Deviation in straightness in longitudinal and transverse of column at any point along the height. | H or 10 mm  1500 whichever is less |
|  | v) Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to  connecting trusses/beams with respect to true distance. | 5 mm |
|  | vi) Deviation in any bearing or seating level with respect to  true level. | 5 mm |
|  | vii) Deviation in difference in bearing levels of a member on  adjacent pair of columns both across and along the building. | 5 mm |

## Notes:

*1. Tolerance specified under iii (a) and iii (b) should be read in conjunction with iv and v. 2.*





# Table 6 (Contd.)

|  |  |  |
| --- | --- | --- |
| **S. No.** | **Description** | **Tolerance** |
| 2. | Erected steel trusses |  |
|  | I) Shift, at the centre of span of top chord member with respect to vertical plane passing through the centre of bottom chord. | 1 of height of  250 truss in mm at centre of  span or 15 mm whichever is less. |
|  | ii) Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss. | 1 of span of  1500 truss in mm or 10 mm whichever is less. |
|  | iii) Lateral shift in location of truss from its true axis in  plan. | 10 mm |
|  | iv) Lateral shift in location of purlin from true position. | 5 mm |
|  | v) Deviation of difference of bearing levels of trusses from the true difference. | 1 of span of  1200 truss in mm or 20 mm whichever is less. |
| 3. | Erected Crane Girder and Rails |  |
|  | i) Shift in the centre line of crane rail with respect to centre line of web crane girder. | (Web thk in mm) + 2 mm  2 |
|  | ii) Shift in plan of alignment of crane rail with respect to  true axis of crane rail at any point. | 5 mm |
|  | iii) Deviation in crane track gauge with respect to the  gauge: |  |
|  | a) For track gauge upto and including 15 mm | 5 mm |
|  | b) For track gauge more than15 mm | (5 + 0.25(S-15)) mm subject to a maximum of 10 mm, where S in meters is true track  gauge. |
|  | iv) Deviation in the crane rail level at any point from true  level | 10 mm |
|  | v) Difference in levels between crane track rails at: |  |
|  | a) Supports of crane girders | 15 mm |
|  | b) Mid span of crane girders | 20 mm |
|  | vi) Relative shift of crane rail surface at a joint plan and  elevation. | 2 mm subject to grinding of  surfaces for smooth transition. |

**Proforma - A.P.1**

# Typical welding procedure data sheet

Concessionaire...........................................................Address...........................................................

Quality of weld....................................................Specification.........................................................

Material Specification...........................................Thickness Batch/

Cast No........................................................Joint preparation (Fig)...................................................

Gap............................................................Location of Specimens....................................................

Whether condition..................................................Type of Day.......................................................

Wind break used................................................................................................................................

Electrode Group No.................................Make..................Specimen...............................................

Pre and Post Heating..........................................................................................................................

Welding position................................................................................................................................

Size of reinforcement................................................Whether removed............................................

Welding Sequence.............................................................................................................................

Backing strip used............................................Type..........................................................................

Welding process.................................................................................................................................

Current conditions Polarity................................................................................................................

Size of electrode.................................................................................................................................

Amperage and Voltage......................................................................................................................

Number of Electrodes used per run...................................................................................................

Cleaning method................................................................................................................................

Remarks.............................................................................................................................................

# Welding Engineer

**Executing Agency**

(Inspecting Authority)

Signature For and behalf of Concessionaire

Date:

# Sub section - C10

**Technical specification for glass and glazing**

# Sub section - C10

**Technical specification for glass and glazing Contents**

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1. 10.3Glazing, setting and finish

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1. 10.4Acceptance criteria

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1. 10.5IS codes

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**Sub section - C10: Technical specification for glass and glazing**

* 1. **Scope**

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement, etc. wherever required.

# Installation

* + 1. **General**

The Concessionaire shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvers, miscellaneous glazing and partitions, as approved by the Executing Agency, having very high optical clarity, brighter appearance, uniform thickness, consistent product quality manufactured out of molten glass coming out of the furnace floats on molten tin, thus being formed into float glass. The glass shall be delivered to site in containers with the maker's name, guarantee, type of glass and thickness, or weight of glass attached to the outside of the containers. Glass cut to size shall be straight and free from chips, spalls or any other damage on any cut edge.

# Materials

* + - 1. Clear glass shall be flat drawn sheet glass and shall be atleast 4 mm thick conforming to IS:2835. Sheet glass for doors shall be minimum 5.5 mm thick.
      2. Wired glass shall be thick rolled glass with centrally embedded 24G wire mesh of Georgian type. This may be of clear or coloured glass as shown in drawings and shall conform to IS:5437.
      3. Composite double glazing shall be made of double glazing of two 6 mm thick sheet glass either both sheets of tinted glass or one glass tinted & other plain or both sheets of plain sheet glass. Both the glasses shall be separated by an air gap of 12 mm. The trapped air shall be kept dry by means of suitable desiccant. The sealing shall be under strict quality control. The composite glazing shall be procured as finished product from reputed manufactures. Toughen glass conforming to IS:2553 shall be used.
      4. Obscure glass shall have a cast surface on one side.
      5. Coloured and figured glass shall be as per the approved sample.
      6. In general, the putty shall conform to IS:410 latest edition and be of best quality from an approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty shall be used for windows and sashes except when glare reducing glass is used where it shall be of non-setting type.
      7. Neoprene gaskets with snap-fit glazing shall be fixed as per manufacturer's instructions and shall fit firmly against the glass to give a leak proof installation.

# Glazing, setting and finish

All glazing clips, bolts, nuts, putty, mastic, cement, etc., shall be supplied by the Concessionaire.

All glass shall be thoroughly cleaned before placing in position. Each glass pane shall be held in place by special glazing clips of an approved type. Four glazing clips shall be provided per glass pane, except for large panes where six or more clips shall be used as instructed by the Project Engineer and Executing Agency. All holes that may be necessary for holding the clips, glazing beads and all other attachments shall be drilled by the Concessionaire.

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where mouldings or gaskets are specified. Putty, mastic cement etc., shall be smoothly finished to a true even line. Obscure and figured glass shall be set with smooth side out.

After completion of glazing work, the Concessionaire shall remove all dirt, stains, putty, etc., clean the glass panes and leave the work in perfectly acceptable condition. All broken, cracked or damaged glass shall be replaced by new at the Concessionaire's own cost.

# Acceptance criteria

1. All installations shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or unground edges.
2. Glazing shall be carefully done to avoid direct contact with metal frames.
3. All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak-proof installation.
4. At completion the panes shall be free from dirt, stains, excess putty, etc., to the complete satisfaction of the Project Engineer and Executing Agency.

# IS codes

Some of the important applicable Indian Codes for this section are listed below. Latest editions of these codes shall be followed:

IS:3548 Code of Practice for glazing in building.

IS:1083 Code of practice for fixing and glazing metal doors, windows and ventilators.

IS:419 Putty for use on window frames.

# Sub section - C11

**Technical specification for MS doors, windows, ventilators, louvers, etc.**

# Sub section - C11

**Technical specification for MS doors, windows, ventilators, louvers, etc.**

**Contents**

**Clause no. Description Page nos.**

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**Sub section - C11: Technical specification for MS doors, windows, ventilators, louvers, etc**

* 1. **Scope**

The work in general shall consist of supplying, erecting and installing of all MS doors, windows, ventilators, louvres, glazed partitions etc. as required with all materials, complete excluding supply of glass and glazing. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

# Installation

* + 1. **Materials**

Steel sections used for fabrication of doors, windows, etc. shall be standard rolled steel sections specified in IS:1038 and IS:1361. Mild Steel sheets for frames, shutters, louver blades, etc. shall be of the gauge mentioned in this specification.

Hardwares and fixtures of the best quality from approved manufacturers only shall be used. The



All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS:3564 latest edition and shall be suitable for doors weighing 61-80 kg unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed doors closers shall be either floor mounted or transform mounted suitable for installation with metal doors. They shall conform to the performance requirements and endurance test stated in Appendix A of IS 3564 (latest edition).

Aluminium sections for fabrication of doors, windows, partitions etc. shall be extruded section conforming to IS:1948 and 1949 or as manufactured by Indian Aluminium Company Ltd. or approved equivalent. The alloy used shall conform to IS designation HE-9-WP of IS:733. Heavy duty double acting floor springs where specified shall conform to IS:6315, shall be suitable for door shutters weighing upto 125 kg. shall be hydraulically regulated, shall be constructed of cast brass casting cover and shoe, gun metal piston player and all other parts of mild steel.

The Concessionaire shall submit samples of each type of hardware to the Project Engineer and Executing Agency. The approved samples shall be retained by the Project Engineer and Executing Agency for comparison of the bulk supply. The samples shall be returned to the Concessionaire towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Project Engineer and Executing Agency. In general the mastic for fixing of metal frames shall be as per IS:1081 latest edition and/or as approved by the Project Engineer and Executing Agency.

# Fabrication

**Steel doors, windows, ventilators, louvers, etc.**

# Door frames :

Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges, lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitred corners shall be used. Rubber door silencers shall be



finish flush with the floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with the floor ties/weather bars installed in place.

# Double plate flush door shutter

Door shutters shall be 45 mm thick completely flush design and shall comprise of two outer sheets of 18G steel sheets rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150mm centres. Both edges of doors shall be joined and reinforced to full height by steel channels placed immediately inside and welded to the door faces. The tops and bottoms of doors shall be reinforced horizontally by steel channels running to the full width of the door. Doors shall have proper level on lock stiles and rails to operate without bending and shall be reinforced at the corners to prevent sagging or twisting. Pairs of double doors shall have meeting stile edges bevelled or rebated. Wherever required the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

Door shall be mortised, reinforced, drilled and tapped in the shop for hinges, locks and bolts. They shall also be reinforced for closers, push plates and other surface hardware where necessary.

Any drilling and tapping required on the surface shall be done at site. Wherever required provision shall be made for fixing glazing, vision panels, louvers, etc. Glazing mouldings shall be of 18 g steel as directed by the Project Engineer and Executing Agency. Louvre blades shall be V or Z shaped and made out of 16 G sheets.

# Single sheet door shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with a semitubular edge and central stiffening rail which shall support the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required provision for fixing glass panels, louvers, etc. shall be made.



# Sliding doors

Sliding doors shall be either double plate or single plate construction as required and made out of 18 gauge steel sheets with adequate stiffeners.

The Concessionaire shall specify the weight of the door in his shop drawing and submit the

l make provisions where necessary for openings in the door for monorail beams. Doors shall close positively to exclude rain water from seeping in. Sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.



# Steel windows, sashes, ventilators, etc.

These shall conform in all respects to IS:1038 and IS:1361 latest editions. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc.

All welds shall be flush butt welded to form a solid fused joint, so that all frames are square and flat.

Where composite unit openings are envisaged the individual windows units shall be joined together with requisite transom and mullions. All windows shall be outside glazed fixed with putty or metal glazing beads. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal section No.2209) aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

# Welding

The joints for steel doors, windows, ventilators, etc. shall be electrically flash butt welded joint at all corners and junctions to form a solid fuses right angle joint.

# Fabrication of aluminium doors, windows, frames, etc.

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Project Engineer and Executing Agency before fabrication is taken up. Doors, windows, frames, mullions, transformers etc. shall be anodized in bath of sulphuric acid to provide a clear coating of minimum 10 micro-meter. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

Fabrication drawings shall be submitted by the Concessionaire which shall also include the weights of the materials used and got approved from the Project Engineer and Executing Agency.

# Shop coat of paint

The shop paint for steel doors, windows, etc. shall be best red oxide, zinc chromate primer paint from approved manufacturer conforming to IS:2074, latest edition. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales, etc. and given one coat of shop paint. Portions like mullions transoms, etc. which will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

# Handling and storage of fabricated material

All metal doors, windows, etc. shall be packed and crated properly before despatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in an undamaged condition. All metal doors, windows, etc. shall be stored under cover and handled in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminium products by rust, motor etc.

# Assembly and erection at site

In general the fixing of steel doors, windows, ventilators, louvres, etc. shall conform to IS:1081 latest edition. The Concessionaire shall assemble and install all steel doors, windows, sashes, fixed metal louvres, etc. including transoms and mullions for composite units in respective places keeping proper lines and levels, and in an approved workman like manner to give a trouble free and leak proof installation. If required by the Project Engineer and Executing Agency, the installation shall be carried out under the superv

After installation of steel doors, windows, etc., all abrasions to the shop-coat of paint shall be retouched and made good with the same quality of paint.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members shall be well bedded in mastic. The Concessionaire shall bring to site the mastic cement in

instructions.

Floor, shutters, partitions, hardware fixtures, etc. shall be fixed only after the major equipment has been installed in the rooms.

Wherever required, nylon cords of approved quality shall be supplied along with pivoted sashes. These shall be adequate length to terminate one metre from the floor. Loose ends of cords shall have a metal or plastic pull as approved by the Project Engineer and Executing Agency.

# Acceptance criteria

* + 1. **For fabricated items**
       1. Overall dimensions shall be within ± 0.5mm of the size.
       2. Mullions, transoms, etc. shall be in one length and permissible deviations from straightness shall be limited to plus minus 0.5 mm from the axis of the member.
       3. Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5mm. For double leafs the gap at the meeting stiles shall not be more than 1.5mm.
       4. Door leafs shall be undercut wherever required.
       5. Doors, windows, frames, etc. shall be on a true plane, free from warp or buckles.
       6. All welds shall be dressed flush on exposed and contact surfaces.
       7. Correctness of hardware and smoothness of operation of all shop installed hardware and fixture.
       8. Provisions for hardware and fixtures to be installed at site.
       9. Glazing beads shall be cut with mitred corners.
       10. Shop coats shall be properly applied.
       11. Exposed aluminium surface shall be free from scratches, stains and discolouration. Anodized surfaces shall present a uniform and pleasing look.

# For installed items

* + - 1. Installation shall be at the correct location, elevation and in general on a true vertical plane.
      2. All frames of external walls shall be mastic caulked to prevent leakage through the joint between frames and masonry.
      3. All openable sections shall operate smoothly without jamming.
      4. Locks, fasteners, etc. shall engaged positively. Keys shall be non-interchangeable.
      5. Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with a paint of the same quality as the shop paint.
      6. Aluminium doors, windows etc. shall be free scratches, stains or discolouration.
      7. It shall be the responsibility of the Concessionaire to see that the material is protected from mortar, paint, plaster, terrazzo framing members.

# Information to be submitted

Before starting fabrication of any metal doors, windows, etc. the Concessionaire shall submit detailed fabrication drawings to the Project Engineer and Executing Agency for approval. The fabrications shall be started only after approval of the drawings.

# IS codes

The important IS codes to be followed are listed below:

IS:1083 Steel doors, windows and ventilators. IS:1361 Steel windows for industrial buildings. IS:1451 Steel door frames.

# Sub section - C12

**Technical specification for rolling steel shutters / grills**

# Sub section - C12

**Technical specification for rolling steel shutters / grills Contents**

# Clause no. Description Page nos.

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1. 12.4IS codes

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**Sub section - C12: Technical specification for rolling steel shutters/grills**

* 1. **Scope**

This specification covers the design, supply of materials, fabrication, delivery and erection of rolling shutters grills with motor drives and/or manual operation during all accessories as hereinafter specified. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

# Installation

* + 1. **Components**
       1. States for rolling shutters shall be made from tested bright, cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 3.5 m wide and not less than 1.24 mm thick for shutters 3.5 m wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.
       2. Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm centres running horizontally flexibly connected with vertical links spa ed not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design, reinforced with 6 mm dia rods.
       3. End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats.
       4. Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.
       5. Guide shall be of such depth as to retain the shutter under a wind pressure of 150 kg/sq.m. The minimum thickness of guide shall be 126.
       6. Shafts shall be of steel pipes of sufficient size to carry the torsional load with a maximum deflection of 1/360th of span. Grease packed ball bearings or bushings shall be provided for smooth trouble, free operation.
       7. Hoods shall be formed of not less than 20 gauge steel, suitably reinforced to prevent sag.
       8. Locks shall be side belt and hasp or cylinder lock operable from one or both sides. Provision for to securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as desired by the Project Engineer and Executing Agency.
       9. Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. Power supply and shall be either floor or wall mounted unit. The motors shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor, each standard power unit shall include a magnetic brake, reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated. It is desirable that the button bar or motor operated doors

shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

* + - 1. Operating chains shall be of tested quality, heavily galvanized and with all ends rounded to assure smooth operation and hand protection.
      2. Reduction gears shall be of high strength grey cast iron, machine moulded from machine cut patterns.

# Manually operated shutters/grills

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 0.3 metres per second.

In general, manually operated shutters shall be push-pull type for opening upto 9 sq. metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as desired by the Project Engineer and Executing Agency.

# Power operated shutters/grill

These shall be operable from a push button station conveniently located beside the door or as shown on drawings. One emergency hand chain-crank operation shall also be provided for use in case of failure of the electrical system.

# Shop coat

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted with one coat of zinc chromate for adhesion of field coat.

# Acceptance criteria

* + 1. **Shop inspection**

After completion the manufacture of different components of the rolling shutter, an arrangement for shop inspection by the Project Engineer and Executing Agency shall be made to check the conformity with approved shop drawings.

# Field inspection

After installing the shutters, the Concessionaire shall test the performance of the shutter in the presence of the Project Engineer and Executing Agency. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault- free performance.

# Guarantee



* 1. **IS codes**

IS:6248 Metal rolling shutters and rolling grills.

uccessful operation of the shutters.

# Section - WS1

**Technical specifications for laying of pipes and fittings / specials**

# Section - WS1

**Technical specifications for laying of pipes and fittings / specials Contents**

# Clause no. Description Page nos.

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**Section - WS1: Technical specifications for laying of pipes and fittings / specials**

1. **Scope**

The work shall include providing of materials, all necessary plant and equipment, providing adequate engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire work as indicated on the drawings and/or described herein subsequently and/or as directed by the Project Engineer and Executing Agency. The Concessionaire shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein.

All works shall be executed to the satisfaction of the Project Engineer and Executing Agency.

# Applicable codes

The laying of pipes and fittings/specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to.

In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decision of Project Engineer in such case shall be final and binding on the Concessionaire.

Any approval, instructions, permissions, checking, review, etc. whatsoever by the Project Engineer and Executing Agency, shall not relieve the Concessionaire of his responsibility and obligation regarding adequacy, correctness, completeness, timely completion, safety, strength, quality & workmanship etc.

The Concessionaire shall make his own surveying arrangements for locating the coordinates and positions of all work and establish the reduced levels (RLs) at these locations, based on two reference grid lines and one bench mark which will be furnished by the Executing Agency. If need be the Executing Agency reserves the right to have the Concessionaire re-verify the coordinates at no cost to Executing Agency. The Concessionaire has to provide at site, all the required survey instruments, along with qualified surveyors, to the satisfaction of the Project Engineer and Executing Agency so that the work can be carried out accurately and according to the specifications and drawings.

# Codes of practice

All applicable standards, specifications, etc. and codes of practice shall be the latest editions, including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Concessionaire.

All work shall be carried out as per the stipulations contained in various sections of these specifications and the latest Indian Standards, Act, Codes and best practices.

In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian Standard Codes, etc. the requirements of stipulations contained in various sections of these specifications shall prevail over that of Indian Standards, Codes, etc. Concessionaire is responsible to notify Executing Agency in writing well in advance of such conflicts prior to execution of the work.

Some of the applicable Indian Standards, Codes are referred to herein below:

* + 1. IS.783 - Code of practice for laying of concrete pipes
    2. I.S. 3114 - Code of practice for laying of cast iron pipes
    3. I.S. 3764 - Excavation work - code of safety
    4. I.S. 5822 - Code of practice for laying of electrically welded steel pipes for water supply
    5. I.S. 6530 - Code of practice for laying of asbestos cement pressure pipes
    6. I.S. 1726 - Specifications for Cast Iron Manhole covers & frames
    7. I.S. 5455 - Specifications for C.I. steps for manholes.
    8. I.S.4111(Part -1) - Code of practice for ancillary structures in sewerage system (manholes)

# Carting & handling

Pipes and fittings/specials shall be transported to all the work sites at places along the alignment of pipe line as directed by Project Engineer and Executing Agency. Concessionaire shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading storage etc. Every care shall be exercised in handling pipes and fittings/specials to avoid possible damage. While unloading, the pipes and fittings/specials shall not be dropped down from the truck on to any hard surfaces. They should be unloaded on timber skids with steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/ specials and timber skids to avoid damage to the coating. Suitable gaps between pipes/stacks of pipe should be left at intervals in order to permit free access from one side to the other. In case of spigot & socket pipes care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking & spalling of pipe etc.) while unloading and shall be sorted out for replacement. Any pipe which shows any damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

# Storage

* 1. Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in

storing them. The height of the stack shall not exceed 1.5 m. Also necessary security arrangements should be provided to avoid these till the pipes are finally used.

* 1. Fittings/specials shall be stacked under cover and separated from pipes and with suitable security measures.
  2. Rubber rings shall be stored in a clean & cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they do not be left out on the ground in the sun or overnight under heavy frost or snow conditions.

# Laying

* 1. **General**

The Concessionaire shall visit the site before tendering and get himself acquainted with site conditions and the regulations regarding the laying of pipes in congested areas, heavy traffic areas etc.

# Excavation

Before excavating the trench the alignment of pipeline shall be approved by Project Engineer and Executing Agency. The excavation of trenches and pits for manholes/chambers shall be carried out in accordance with the specifications contained herein below and shall be done in such a manner that IT DOES NOT GET FAR AHEAD OF THE LAYING OPERATION as approved by Executing Agency.

After excavation of trenches, pipes shall not be lowered in position unless the dimensions of trenches and bedding work at the bottom of the trenches are-approved and measured by Project Engineer and Executing Agency. Pipes and fittings shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block etc. for lowering the pipes and fittings shall be made by Concessionaire at his own cost. In no case pipes shall be dropped. Slings of canvas or equally **NON ABRASIVE MATERIAL** of suitable width and strength or special attachment to fit the ends of pipes and fittings shall be used to lift and lower the coated pipes and fittings. The pipes and fittings shall be inspected for defects and, be struck with light hammer preferably while in suspended position to detect presence of any cracks. If doubt persists, further confirmation shall be done by pouring a little Paraffin on the inside of the pipe at the suspected spot and after doing vigilant investigation whether the Paraffin is leaking on to the external side of the pipe or not then only the non leaking pipe should be considered fit for use. Pipes and fittings damaged during lowering or aligning shall be replaced by Concessionaire at no extra cost.

To protect the persons from injury and to avoid any damage to property, adequate barricades, construction signs, red lanterns and guards, as required for smooth functioning of work and to avoid any minor or major accidents, shall be placed and maintained during the progress of the

construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regard to safety provisions shall be observed.

Suitable fencing/barricades shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm. in diameter or less than 1.2 m. above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 450 mm. above the ground and each shall be from 50 mm. to 70 mm. in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the posts and tying them together where they meet will not be allowed on any account. All along the edges of the excavated trenches a bund of earth about 1.2 m. high shall be formed where required by Project Engineer and Executing Agency (but due care shall be taken while stacking the excavated stuff to cause least inconvenience for day to day site activities) for further protection. The above work shall not be paid for separately and the Concessionaire shaft takes into account the costs of such works and quote accordingly.

Total quantity of water required for entire work including for testing- pipes and fittings at work site shall be arranged by Concessionaire at his own cost. Dragging of pipes and fittings along concrete and similar pavements with hard surfaces shall be prohibited.

The road metal and also the rubble packing obtained out of road surface excavations etc. shall first be stripped off for the whole width and entire length of the trench/pit and separately deposited in such place or places as may be determined by Project Engineer and Executing Agency. In case of the metal packing or "Khandkies" not being so deposited or being mixed up with excavated materials and not available for backfilling and making good the excavation, the cost of the new metal, packing or "Khandkies" required shall be charged to the Concessionaire.

The portions of trenches in stony or rocky ground are to be excavated all along to the entire length and for the full depth such that the bottom of the excavation shall not be higher at any point than the bottom of the concrete' bedding layer below the sewer pipe.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit or as may be necessary to prevent the sides of the trench/pit to "cave-in" or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manhole covers etc., and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service, organization or otherwise as Project Engineer and Executing Agency may direct.

Concessionaire also shall take into account while quoting his rates for possible additional excavations for trial pits of such sizes and depths that may be required to be undertaken by him as per the instructions of Project Engineer and Executing Agency for determining the locations of various existing underground service line such as water pipes, drains, sewers, gas pipe lines, electric and telephone cable etc. which may be met with. Concessionaire should also as per the instructions of Project Engineer and Executing Agency backfill and thoroughly compact all such

additional excavations and make the area as original after the purpose of locating is served. No additional payment will be considered by the Executing Agency on this account.

During the pendency of the contract the Concessionaire should take all due precautions for proper maintenance and protection against damage of all such service lines if met with during excavation, by means of shoring, strutting, planking over, padding- or otherwise as Project Engineer and Executing Agency may direct. Also all precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structures. In case if any such damages have occurred then those shall be made good either by Concessionaire or by other agency, as Executing Agency may decide and wholly in either case at the expense of Concessionaire.

If the work for which the excavation has been made is not completed by the expected date of the setting of monsoon or the setting in of rain whichever is earlier, or before the day fixed by Project Engineer and Executing Agency for filling in any excavation on account of any festival or special occasion, Concessionaire shall backfill such excavation and consolidate the filling at his own expenses as directed by Project Engineer and Executing Agency and shall re-excavate when required at his own cost.

Project Engineer and Executing Agency may order portions of shoring to be left in the trenches at such places, where it is found absolutely necessary to do so as to avoid any damage which may be caused (because of pulling out shoring from the- excavated trench/pit) to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation. Concessionaire shall be paid at the negotiated rate for the shoring left in the trenches / pit if directed by Project Engineer and Executing Agency. Concessionaire shall not claim, for any reasons whatsoever for the shoring which may have been left in position by him at his own discretion. Concessionaire shall not be paid for shoring left in the portions of the rakers, struts, or other timber cut off and not permanently left in the work.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than that as specified. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm. above the crown of pipe. If any extra width is provided in the area below this portion because of mistake on part of the Concessionaire, Concessionaire shall have to provide remedial measures in the form of lime concrete or rubble masonry or otherwise at the discussion and to the satisfaction of Project Engineer and Executing Agency. Concessionaire shall not be paid any additional for extra excavation as well as for the resulting remedial measures adopted to make up for the additionally done excavation. If rock is met with, it shall be removed to 15 cm. below the bottom of pipes and fittings / specials and the space resulting shall be refilled with granular materials and properly consolidated. No compensation will be paid to the Concessionaire on this account and financial implications for the same should be included by the Concessionaire in his rates. Bottom of trenches / pits shall be saturated with water and well rammed wherever Project Engineer and Executing Agency may consider it necessary to do so.

Wherever a socket or collar of pipe or fitting / special is to be accommodated a strip sufficient enough for this purpose is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm. below the bed of the pipe so that the pipe may have a fair bearing on its shaft and

does not rest upon its socket. Such strip shall be of sufficient size in every respect to admit the free movements of hand holding necessary tools of the skilled worker, all around the socket in order to make the joint completely water tight and the strip shall be maintained clear until the joint has been approved by Project Engineer and Executing Agency.

All the pipes are to be laid perfectly true both in alignment and to the gradient specified.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm. in depth and 90 cm. in length shall be made at joints in order to facilitate welding. The excess volume of this excavation should be brought to the acceptable level by making good with necessary fill material as directed by Project Engineer and Executing Agency. The charges on this account should be included in his rates by the Concessionaire.

The excess excavated material shall be carried away from site of works to a place up to a distance as directed by Project Engineer and Executing Agency. This shall be done immediately so as not to cause any inconvenience to the public or traffic.

# Dewatering

During the excavation, if subsoil water or water mixed with- day/slush- is met with Concessionaire shall have to provide necessary equipment and labourers for dewatering the trenches/pits by bailing out water or clay/slush; if pumping out subsoil water is found to be necessary, Concessionaire shall provide pumps in sufficient numbers/type for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Concessionaire shall also make foolproof necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by Project Engineer and Executing Agency. In no case the water shall be allowed to- spread indiscriminately over the adjoining area. Before discharging this water into public sewer/drain, Concessionaire shall take necessary permission from all the local authorities before implementing the draining arrangements.

# Special foundation in poor quality soil

Where the bottom of the trench at subgrade is found to consist of material which is unstable to such a degree that in the opinion of Project Engineer and Executing Agency, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings and as instructed and approved by Project Engineer and Executing Agency shall be constructed.

When the work of constructing the pipe lines has to be carried out in soft underground strata, such as puddle etc. or in a reclaimed land, a good foundation shall be provided for the pipes and manholes. For the former, excavation in the trench shall be taken 75 mm. deeper than what is ordinarily required and for this depth the whole of the trench shall be covered over with M-150 bed concrete of the required width, reinforced with B.R.C. fabric No.9 or any other fabric- approved-by the Project Engineer and Executing Agency.

The fabric shall be suitably cut to the requirement and securely joined together with adequate laps which should not be less than 200 mm. The fabric in the pipe line must also be securely jointed together. The rates in both the cases shall be held to include all lapping, jointing and also any probable wastage.

# Wooden shoring

Concessionaire shall suitably design polling boards, walling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall, be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Concessionaire shall be his sole responsibility. No part of shoring shall at any time be removed by Concessionaire without obtaining permission from Project Engineer and Executing Agency. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well watered & rammed with rammers.

Project Engineer and Executing Agency may order portions of shoring to be left in the trenches/pits at such places, where it is found absolutely necessary to do so as to avoid any damage which may be caused to the adjacent buildings, cables, gas-mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Concessionaire shall not claim, on any reason, whatsoever for the shoring which may have been left in by him at his own discretion.

# Steel plate shoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench/pit excavation the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances Concessionaire will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, walling etc., as per the instructions, manner and method directed by Project Engineer and Executing Agency. Concessionaire shall supply, pitch drive and subsequently remove trench sheeting or piling in accordance with other items of the specification.

# Boning staves and side rails

In laying the pipes and fittings/specials the centre for each pipe line shall be marked by a peg. Concessionaire shall dig holes for and set up two posts (about 100 mm. x 100 mm. x 1800 mm.) at each junction of pipe lines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a side rail when fixed at a certain level against the post shall cross the centre line of the manhole / chamber or pipe lines. The side rail shall not in any case be more than 30 m apart, intermediate rails shall be put up if directed by Project Engineer and Executing Agency.

Boning staves of 75 mm. x 50 mm size shall be prepared by Concessionaire in various lengths,

each length being of a certain whole number of metres and with a fixed tee-head and fixed intermediate cross pieces, each about 300 mm. long. The top-edge of the cross piece must be fixed below the top-edge of this tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of pipe etc. as the case may be.

The side rail of size 250 mm. x 40,mm. shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the centre lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of the sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee heads and cross piece of the boning staves shall be painted black.

For the pipes converging to a manhole / chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M. of the surface of the ground, a higher sight rail shall be fixed for use with the rail over the next point.

The posts and rails shall be in no case be removed until the trench is excavated, the pipes are laid and Project Engineer and Executing Agency gives permission to proceed with the backfilling.

# Encasing / being / hunching etc.

The pipes shall be provided with encasement / bedding / hunching etc. as specified in drawings.

# Laying of pipes and fittings / specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, etc. and excavation to proceed in accordance with the relevant of Clause of this specifications.

All the pipes are to be laid perfectly true both in alignment and to gradient specified In case of spigot and socket pipe the socket end of the pipe shall face upstream **EXCEPT WHEN THE PIPE LINE RUNS UPHILL IN WHICH CASE THE SOCKET ENDS SHOULD FACE**

**THE UPGRADE**. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings / specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings/ specials of proper dimensions to ensure such uniform space: Precaution shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Project Engineer and Executing Agency. During the period that the plug is on, the Concessionaire shall take proper precautions

against flotation of the pipe owing to entry of water into the trench: Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted, the deflection allowed at joints shall not exceed 2½°. In the case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

The cutting of pipe for inserting valves, fittings or closure pieces /specials shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used and skilled labourers only should be allowed to achieve this task.

# Thrust blocks

Thrust blocks shall be provided as directed by Project Engineer and Executing Agency to counteract hydraulic thrust, at places wherever directed and as per relevant drawing.

Where the hydraulic thrust is in an upward direction, anchor blocks as per the relevant drawing shall be provided to which the pipes shall be secured with steel straps.

# Jointing of pipes

Jointing for pipes and fittings / specials shall be done in accordance with: the relevant specifications depending on type of pipes being used.

# Testing and commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant specifications.

# Backfilling

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipe line. The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that the level of filling rises gradually and unequal pressure does not occur on the pipe. Back filling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care being taken not to damage to the pipe line. In case of mild steel pipes / specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipe line to aid alignment, these timbers shall be removed before backfilling.

# Reinstatement of road / footpath

Reinstatement of road / footpath shall be done as per requirements of local authorities and the

relevant specifications after the completion of work.

# Clearing of site

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by Project Engineer and Executing Agency and the construction site left clean to the satisfaction of Project Engineer and Executing Agency.

# Measurement

The measurements for excavation in trenches shall be done in following manner and will be paid accordingly.

1. Length (L) As per the actual length of pipe and fittings / specials laid at work site.
2. Width (B) O.D. + 600 mm. only where O.D. is the outside dia. of pipes in mm.
3. Depth (D) Average depth of trench from ground level to invert of pipe and fittings.

Excavation of asphalt road and reinstatement of road shall be measured on per square metre basis and the length and width at top of trench shall be considered same as those mentioned for excavation of trench.

The rate for this item should be inclusive of all excess excavated material to be transported from site of work to a place upto a maximum distance of 5 km. as directed by Project Engineer and Executing Agency immediately after his instructions so as not to cause any inconvenience to the public or traffic.

In case the excavation is done in wet condition either by bailing out water or by resorting to pumping, the respective items shall be paid according to the items in schedule of quantities and rates. The measurement for these items shall be made as per the units for relevant item(s) in schedule of quantities and rates. However, Project Engineer and Executing Agency will decide on site the mode of dewatering and his decision shall be final and binding on Concessionaire.

Shoring (open/ close) if to be paid separately shall be measured on the square metre basis of the actual area of trenches shored.

The measurement for removal of excess excavated material upto a specified distance shall be as per the relevant item(s) in the Schedule of Quantities and Rates and shall be measured on cubic metre basis. In case of soil 30% deduction shall be done to take account for voids where as it will be 40% in case of rubble.

Measurement for pipes and fittings / specials shall be in accordance with the relevant clause(s) of

specification for particular type of pipes.

# Notes

Fencing provided along the sides of trenches and pits shall not be paid for separately and Concessionaire shall take into account the costs of such works and quote accordingly.

In case of the road metal packing or dressed stones not being deposited as specified or being mixed up with excavated materials and not available for the reinstatement of road / pavement, the cost of the new metal packing or dressed stones required shall be charged to Concessionaire by Executing Agency.

Service lines if damaged during excavation shall be made good either by Concessionaire or by other agency as Executing Agency may decide and wholly in either case at the expense of Concessionaire.

Concessionaire shall not be paid any additional compensation for excess excavation over what is specified as well as for any remedial measures that are specified.

The excess excavated material shall be carried away from site of works as specified, failing which in view of public safety and traffic convenience at Concessionaire cost.

# Data Sheet A

Hydrostatic Test Pressure at Work Site - 30 m. Leakage Test Pressure at Work Site - 30 m.

Bedding - As per drawing

Width of trench - O.D. + 600 mm. only where O.D is the outside dia. of pipes in mm

# Section - WS2

**Technical specifications for laying of jointing of cast iron pipes and fittings (cast iron)**

# Section - WS2

**Technical specifications for laying of jointing of cast iron pipes and fittings (cast iron) Contents**

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**Section - WS2: Technical specifications for laying of jointing of cast iron pipes and fittings (cast iron)**

1. **Scope**

This specification covers the requirements for collecting from stores / warehouses as suggested by the Executing Agency, transporting to work sites, laying, jointing and field testing of cast iron pipes and fittings for the water distribution and transmission Network.

# Applicable codes

Various operations such as transporting to work sites, lowering in trenches, laying, jointing and field testing of cast iron pipes and fittings shall comply with all currently applicable standards. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards shall be referred to. In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decis ion of Project Engineer in such case shall be final and binding on the Concessionaire.

* 1. Cast Iron Pipes - LA Class - IS : 1536
  2. Specials (Tees, crosses, bends etc.) - IS : 1538
  3. Property connections & Fittings - IS: 1239 (Part I & II)
  4. Laying of C.I. pipes -IS: 3114
  5. Sluice Valves - IS : 780 and IS : 2906
  6. Butterfly Valves (Double flanged long body) - BS : 5155 / IS: 13095
  7. Kinetic Double Air Valves with isolating sluice valve - IVC make
  8. Fire Hydrants - IS : 908
  9. Rubber Gasket for Flanged Connection - IS : 638
  10. Ferrules - IS: 2692
  11. Specification for rubber sealing rings for gas mains, water mains and sewers. IS:5382
  12. Scour valve including C.I. L.A class drain pipe of dia. equivalent to that of Scour valve and 6 m. length IS:780 & IS:2906

# Laying

For Clauses No.3.0 i.e. Carting and Handling, 4.0 i.e. Storage and 5.0 i.e. Laying - please refer Sub-Section WS-1 for "Technical Specifications for Laying of Pipes and Fittings / Specials" which are common for this item also.

# Valves

* 1. **General**
     1. Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges and conform to ISO 7005, IS 6392 or BS 4504.
     2. Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.
     3. Valve buried or installed in underground chamber, where access to a hand wheel would be impractical shall be operated by means of extension spindle and / or keys.
     4. Valve of diameter 450 mm. and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing.
     5. Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.
     6. The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.
     7. Valves shall be free from sharp projections.

# Butterfly valves

1. Butterfly valve shall be as per IS 13095 / BS 5155. Valve shall suitable for mounting in any position.
2. The valve seat shall be secured to the valve body. When the valve is fully closed, a seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.
3. The valve seal shall be replaceable and securely clamped to the edge of the disc by stainless steel seal retention members, or equivalent so as to prevent leakage and to hold the seal securely during operation. The seal retention member shall be securely clamped with stainless steel fasteners. All fasteners shall be set flush so as to offer the least resistance possible to the flow-through the valve.
4. Valve shall be suitable for throttling purpose.
5. All valve spindles and hand wheels shall be positioned to give good access for operational personnel.
6. Valve of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.
7. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels

# Sluice valves

1. Sluice valve shall conform to IS 780 and IS 2906 or relevant internationally recognized standards.
2. They shall be of rising or non-rising spindle type depending on application. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.
3. The gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.
4. Valves of 450 mm. and above shall be provided with thrust bearing arrangement for ease of operation.
5. Valves of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.
6. Al1 valves, spindles and hand wheels shall be positioned to give good access for operational personnel.
7. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

# Non-return valve

1. The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.
2. The valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.
3. In case of multi door swing type check valve, the non-slam characteristic shall be achieved by providing suitable combination of door and hydraulic passages without any external damping arrangements or passages. The angle of sealing and door weight shall be designed to provide the most efficient working with least restriction to flow.
4. Valve of diameter greater than 450 mm. shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

# Air valves

1. The valve shall be capable of exhausting air form pipe work automatically when being filled. The air being released at a sufficiently high rate to prevent the restriction of the inflow rate. Similarly the valve shall be capable of ventilating pipe work automatically when being emptied, the air inflow rate being sufficiently high to prevent the development of a vacuum in the pipelines. The valve shall also automatically release air accumulating in pipe work during normal working conditions.
2. Air valve shall be of the double orifice type with a large orifice for ventilation or exhaust of the pipeline and smaller orifice for automatic release of air under normal working pressure.
3. Air valve shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the closed position but the float (ball) shall only be raised by the liquid and not by a mixture of air and liquid spray. The seating shall be designed to prevent the floats sticking after long periods in the closed position.

# Pressure relief valves

1. Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurized in excess of a preset maximum allowable pressure. The valves shall be drop tight under normal operating conditions.
2. The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valves.
3. The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weight or from a spring.

# Jointing

* 1. **Tyton joints**

The rubber rings shall be stored in a cool dark, dry and dust free environment. The storage location shall not be exposed to direct sunlight or any heat radiating appliances. The rings shall not be allowed to come in contact with any fuels and shall be stored free of tension.

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the size of pipe which they are to be used, the manufacturer's name or trademark and the month and the year of the manufacture.

The rings shall comply with IS:5382 regarding their material finish, tolerance in dimensions and physical requirements. Rubber ring bundles from every lot shall carry with them manufacturer's test certificate showing the results of following tests:

* + 1. Hardness
    2. Tensile Strength
    3. Compression test
    4. Oil immersion test
    5. Water absorption test
    6. Stretch test and visual examination

The test procedures, the scale of sampling and the criteria for acceptance shall be as per IS:5382 and lS:3400.

The rubber rings shall be such that they shall not show any signs of deterioration for any reasons during the contract period plus the defects liability period. Entire expenses associated with correcting defects in this regard including replacement of rubber rings shall be fully borne by the Concessionaire.

In jointing cast iron spigot and socket pipes and fittings with tyton flexible joints, the Concessionaire shall take into account the manufacturer's recommendations as to the methods and equipment to be used in assembling the joints, in particular the Concessionaire shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring as per IS::5382 is correctly positioned in the socket and that the two pipes are accurately in line, before the joint is made. The rubber rings and any recommended lubricant shall be procured only through the reputed pipe supplier or as directed by the Project Engineer and Executing Agency.

# Flanged joints

In case of flanged joints, the jointing material used between flanges of pipes and fittings shall be compressed fibre board or rubber conforming to IS:638 of thickness between 1.5 mm. to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per sq.m. shall be not less than 112 g./mm. thickness. Each bolt shall be tightened a little at a time taking care not to tighten the bolt which is located immediately adjacent to the tightened bolt and the bolt which is located diametrically opposite each other should alternatively be tightened.

The practice of fully tightening the bolts one after another shall not be allowed. The bolts shall be of mild steel unless otherwise specified.

# Lead caulking joint

The jointing shall be done with molten lead and spun yarn. Pig lead shall be of uniform quality, clean and free from any impurities and any foreign materials. It shall be of uniform softness capable of being easily caulked or driven. It shall conform to IS::782. Spun yarn shall be of clean hemp and of good quality. It shall conform to IS: 65S7. The quantity of lead and spun yarn to be used for jointing of different diameters of C.I. pipes and fittings shall be as per Table 1 of IS::3114.

Lead shall be heated in a melting pot kept in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour. Before pouring, all scum shall be removed. Each joint shall be made with one continuous pour filling in the entire joint space with solid lead. Spongy or imperfectly filled joints shall thoroughly cleaned by heating/burning till all the contents of the imperfectly tilled lead in the joint are cleared. After clearing the joint it should be re-poured as per the original procedure.

The joint runner shall fit snugly against the face of the socket and a bund of clay should be made on outside of the pipe to form a pouring lip to provide for filling the joint flush with the face and to the top of the socket.

The jointing is done by first caulking in spun yarn, then filling the remainder of the joint space by running in molten lead, taking care that no dross enters the joint, and then thoroughly caulking the lead. The spun yarn shall be used to centre the spigot in the socket and to prevent the flow of molten lead into the bore of the pipe.

After the lead has been run into the joint the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipes shall been laid and leaded. The leading ring shall first be removed and any lead outside the socket shall be removed with a flat chisel and then the joint caulked around three times with caulking tools of increasing thickness and hammer of 2 kg weight. Lead run joints shall be preferably finished 3 mm. behind the socket face. The joints shall not be covered till the pipe line has been tested under specified hydrostatic test pressure, though the rest of the pipe line should be covered up to prevent expansion and contraction due to variation in temperature.

# Proposed jointing of C.T. pipes

It is proposed to use spigot and socket pipes with rubber ring tyton joints and flanged joints for valves and other appurtenances.

The pipeline shall be laid such that the socket ends should face the upstream on level ground. When the line runs uphill the socket end should face the upgrade.

Whenever valve or hydrant connection is to be made socket and flanged specials or T specials as shown in the drawings shall be used.

In case of rubber ring joints, the groove and the socket shall be thoroughly cleaned before inserting the rubber gasket. While inserting the gasket, it shall be made sure that it takes the proper direction and that it is correctly seated in the groove. After cleaning dirt or foreign materials from the plain end, lubricant shall be applied in accordance with the pipe manufacturer's recommendations. The plain end of the pipe shall be pushed into the socket of the pipe and while pushing, the pipe shall be kept straight. If any deflections are to be made in the alignment, it may be made after the joint is assembled.

For joints between pipe and valve, socket and flanged specials shall be used. The gasket used between flanges of valves and pipe shall be compressed fibre board or natural / synthetic rubber (IS::63S) of thickness between 1.5 to 3.0 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square meter shall be not less than 112 g/mm thickness. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

# Property connections

A property connection should consist of following parts

1. Brass ferrule
2. Communication pipes with couplings, bends, elbows, union etc. (Length as per drawings)
3. Cap at the end of the communication pipe near the plot boundary.

The plot Executing Agency is expected to construct and connect the remaining portion of property connections at plot boundary. The desired arrangement of property connection is shown in Drawing No.15-A-101.

# Connection at main

Boring on water main should be done on top of main to reduce possible entry of silt into pipe and subsequently damaging of meters. A manual drilling and tapping machine should be used for this purpose. A bore shall be drilled and tapped on CI main and a ferrule shall be screwed directly into the bore. Upto 38 mm size of property connections, ferrules shall be used where as for higher size property connections, T connection shall be given. Ferrule shall be of gunmetal or brass as per IS: 2692. The ferrule should be so set in the main that the communication pipe leads off in line with the main before curving round right handed into its proper course as show in Drawing No. 15-A-I01. G I. Pipes to be used as property connections shall confirm to IS: 1239. Class C. the pipe should be provided, external protection of bitumen coating with hession cloth wrapped over it. It should be provided with PVC sheathing wherever they are exposed such as in case of drain crossings.

The specials to be used at crossing of pipelines, T joints, 90 deg. bends and valve joints are shown in the Drawing No. 15-A-101.

# Testing

After the pipes and specials are laid, jointed and the trench partially back filled except at the joints the stretch of pipe line as directed by Project Engineer and Executing Agency shall be subjected to pressure test and leakage test. Where any section of the rising main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until atleast five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the test shall not be made until atleast two days have elapsed after concreting.

Each section of pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the test have been completed. Specified pressure as per Data Sheet A, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe as directed by Project Engineer and Executing Agency. The duration of test shall not be less than 5 minutes. Where the field test pressure is less than two-third the work test pressure, the period of test should be increased to

atleast 24 hours. If a drop in pressure occurs, the quantity of water added in order to re-establish the test pressure should be carefully measured. This should not exceed 0.1 litre/mm, dia. per km. of pipe line length per day for each 30 m. head of pressure applied. The exposed joints shall be carefully examined and all such joints showing visible leaks shall be rectified until it becomes fully water tight. Any cracked or defective pipes and fittings as a consequence of this pressure test shall be removed from site and replaced by acceptable quality of pipes by Concessionaire and the test shall be repeated to the satisfaction of Project Engineer and Executing Agency.

After the satisfactory completion of pressure test, the section of pipeline shall be subjected to leakage test at a pressure as specified in Data Sheet A. The duration of test shall be 2 hrs. No pipe installation shall be accepted until the leakage is less than the number of CUM./hr. as determined by the formula;

qL =



3.3

where,

q L = the allowable leakage in CUM./hr.

N = number of joints in the length of the pipeline D = diameter in mm. and

p = the average test pressure during the leakage test in kg./sq.cm.

Should any test of pipe laid disclose leakage greater than that specified above the defective joints shall be repaired by Concessionaire at no extra cost to the Executing Agency until the leakage is within the specified allowance.

Necessary equipment and water used for testing shall be arranged by Concessionaire at his own cost. Damage during testing shall be Concessionaire's responsibility and shall be rectified by him at no extra cost to the Executing Agency. Water used for testing shall be drained out from the pipe to safe location and should not be released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of Project Engineer and Executing Agency, the backfilling of trenches shall be done as per specification.

# Disinfection of water mains

The mains intended for potable water supplies should be disinfected before commissioning them for use.

After pressure testing the main, it should be flushed with water with sufficient velocity to remove all dirt and other foreign materials. When this process has been completed the process of disinfection (using liquid chlorine, sodium or calcium hydrochloride) can proceed by one of the following methods.

# Continuous feed

In this method, water from the distribution system or other approved source and the chlorine are

fed at a concentration of atleast 20 to 50 mg./litre. A properly adjusted hydrochloride solution injected into the main with a hydro chlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump shall be used. The residual chlorine should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. The water should remain in the main for a minimum of 24 hours, during which time all valves, hydrants, etc. along the main should be operated to ensure their proper disinfection. Following the 24 hours period not less than 10 mg./l. residual chlorine should remain in the main.

# Slug method

In this method a continuous flow of water is fed with .a constant dose of chlorine but with rates proportioned to give a chlorine concentration of atleast 300 mg./l. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that will contact all interior surface of the main for a period of atleast three hours. As the slug passes tees, crosses etc., valves must be properly operated to ensure their disinfection. This method shall be used principally for large diameter mains.

Regardless of the method used, it is necessary to make certain that back flow of the strong chlorine solution into the supplying line does not occur. The' chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating to 0.2 tng./l. that throughout the rest of the system bacteriological tests should be taken and if the result fails to meet minimum standards, the disinfecting procedure must be repeated and the results again tested before placing the main in service.

# Measurement

The measurement for pipe laying shall be on running metres of net length along the centre line of pipe as laid including specials. The length of pipes shall not include the portion of spigots within the sockets of fittings and pipes.

The rate for providing and laying of C.I. pipes shall be deemed to include the extra excavation required for ordinary bedding of pipes as per IS: 783 and also for sockets or flanges if any and cost of jointing material.

# Procedure of measurements

* + 1. Length (L): As per the actual length of pipe and fittings / specials laid at work site.
    2. Trench Width (B): For payment of excavation, the width of trench shall be considered as O.

D. + 600 mm. only where O.D. is the outside diameter of the pipe in mm.

* + 1. Depth (D): Average depth of trench from ground level to invert of pipe and fittings.

# Data sheet - A

* 1. **Hydrostatic test pressure at work site - 30 m**

# Leakage test pressure at work site - 30 m.

* 1. **Bedding - As per drawing**

# Notes

Fencing provided along the sides of trenches and pits shall not be paid for separately and Concessionaire shall take into account the costs of such works and quote accordingly.

In case of the road metal packing or dressed stones not being deposited as specified or being mixed up with excavated materials and not available for the reinstatement of road / pavement, the cost of the new metal packing or dressed stones required shall be charged to Concessionaire by Executing Agency.

Service lines if damaged during excavation shall be made good either by Concessionaire or by other agency as Project Engineer and Executing Agency may decide and wholly in either case at the expense of Concessionaire.

Concessionaire shall not be paid any additional compensation for excess excavation over what is specified as well as for any remedial measures that are specified.

The excess excavated material shall be carried away from site of works as specified, failing which in view of public safety and traffic convenience Executing Agency / Project Engineer may carry out the work by any other agency at Concessionaire's risk and cost.

Portion of shoring left in the excavated trenches or pits shall be measured and paid separately, if instructed by Project Engineer and Executing Agency to do so.

# Section G4.1

**General mechanical specifications**

# Section G4.1

**General mechanical specifications**

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**Section G4.1: General mechanical specifications**

1. **Double entry split casing pumps**

The pumping unit shall consist of a horizontal split-case, single stage and double suction impeller directly connected through a flexible coupling to a horizontal induction motor. The pump shall be designed such that the rotating element can be removed without disturbing the pipework or the pump motor. All rotating parts individually and in assembly shall be statically and dynamically balanced to prevent vibration through a range of normal and reverse speeds.

The pumps shall be designed to operate satisfactorily without detrimental surges, vibration noise, or dynamic imbalance over the required head range. The head-capacity curve of the pump shall have a continually rising head characteristic with decreasing capacity over the whole range of total head.

The Concessionaire shall guarantee that adequate required Net Positive Suction Head (NPSH) is available to ensure that pumps can operate without cavitation under the worst operating conditions. The required NPSH at duty point shall be at least 0.5 M less than the available NPSH at the lowest water level in the sump.

Each pump must be capable of running satisfactorily in parallel with 3 to 5 other sets in the system without throttling and by itself, without cavitation or overload under all operating conditions within the system resistance indicated.

The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to water returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pumps shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 4.5 mm / sec. Noise level shall be limited to 85 dBA at a distance of 1.86 m.

Automatic float type air valve with cock shall be fitted in the highest part of the casing to assist priming.

Small bore pipework shall be provided for gland water drainage. Gland water drainage shall be piped to the drainage channel.

All the pumps shall be supplied with machined pads to allow the fitting of portable vibration monitoring transducers.

The pump casing shall be of the double suction type. Either single or double volute type could be adopted, to produce smooth flow with gradual changes in velocity. Unbalanced, hydraulic, radial thrust acting upon rotating elements shall be kept minimum.

Flanges shall be machined on faces and edges and conform to ISO 7005, IS 6392 or BS 4574. Back faces of flanges shall, where necessary, be machined to ensure they are parallel to the front

faces and that flange bolts can be fitted flush to the flanges.

The pump casing shall be provided with removable and renewable wearing rings where there are close-running clearances between the impeller and the casing. Suitable tapped holes shall be provided for air vents and for drains. The casing shall be so constructed that the drains will unwater the entire casing. One tapped hole shall be provided in the discharge flange and the suction flange for connection of pressure gauges.

The casing stuffing box and gland shall be designed to be suitable for easy maintenance of the conventional gland packings.

The pump base, or the supporting bracket, shall be drilled in the shop for doweling to the baseplate at the site.

The impeller shall be the enclosed type and shall be fastened to the shaft in such a manner as to make it readily removable. The water passages of the impeller shall be hand finished to remove rough spots and excessive irregularities. Removable and renewable wearing rings shall be provided on the impeller where there are close running clearances between the impeller and the casing. Materials and hardness of the casing and impeller wearing rings shall be selected to ensure that they are not susceptible to galling and premature wear.

The shaft shall be provided with replaceable stainless steel sleeves with proper hardness where it passes through the stuffing boxes and water passages. Water deflectors shall be provided on the shaft to prevent water from passing along the shaft and entering the pump bearings.

A stationery guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Guard shall be designed for easy installation and removal, complete with necessary support, accessories and fasteners.

The stuffing box shall be provided with a readily accessible soft packings of conventional type. The material of packing shall be of technically advanced and commercially available type.

The pump shaft shall be supported by two bearings of anti-friction type, one located on each side of the pump. Bush bearing will not be accepted. The bearings may be of the oil or grease lubricated, ball or roller bearing type. One bearing on the pump shall be of the thrust type, designed to withstand the unbalanced axial hydraulic thrust. Suitable fittings shall be furnished for the type of lubrication provided. Bearings shall have a minimum life of 40,000 hours of operation.

It is desired that bearings be furnished which do not require water for cooling. If the bearings are water cooled, the water shall be taken from the pump discharge and returned to the pump suction. Suitable cooling water supply piping and return drain piping shall be supplied, and a y-type strainer with blow off shall be provided in the cooling water supply piping.

Seals shall be provided to prevent loss of lubricant and entrance of moisture and dirt.

The pumping unit shall be provided with a structural / steel baseplate. The pump and motor may be mounted on a common baseplate or on separate baseplates. The baseplates shall be of sufficient size and rigidity to maintain the pump and motor in proper alignment and position. All contact surfaces between the pump and baseplate and between the motor and baseplate shall be machined. Means shall be provided for transmitting the entire load due to discharge shutoff pressure to the concrete structure. After the unit has been installed and properly aligned, the baseplates will be drilled and reamed for the dowels. The necessary dowels shall be furnished with the pumping unit.

# End Suction Pumps

End suction pumps shall be horizontally mounted complete with drive motor on a common base plate. The pump / drive coupling shall be of the spacer type to facilitate removal of the pump rotating element and bearing housing without dismantling the pump casing, adjoining pipework or drive motor.

The bedplate shall be of substantial fabricated steel construction with floor fixing bolt holes ready drilled. All holding down bolts etc. shall be supplied with the units.

Impellers shall be provided with means to prevent abrasive matter reaching the glands and with fully shrouded impellers, to prevent the trapping of matter between the impeller vanes and the casing.

The speed of any pump (excluding non-clog pumps) shall not exceed 1,500 rpm.

Glands may be fitted with suitable mechanical seals or conventional soft packing. The gland arrangement shall be designed for ease of adjustment or removal of the seal or packing material. Shafts shall be sleeved around the area of the gland when soft pack glands are used.

Flushing facilities shall be provided for mechanical seals or packed glands, where pump fluid may be contaminated with abrasive material. Where soft packed glands are used, means shall be provided for collection of the gland leakage water, which shall be piped into the drainage system through adequately sized ports.

Lubrication arrangements shall be so designed that there is no contamination of the pumped fluid.

The pumps and associated pipework shall be, wherever possible, arranged so that air can be completely expelled during priming. Where this is not possible, facilities shall be provided for the removal of the trapped air. Adequate facilities shall be provided for drainage of the pumps for inspection purposes.

Tappings shall be provided at both the suction and discharge flanges for pressure gauge equipment.

# Submersible pumps

Submersible pumps shall be of the totally submersible centrifugal or mixed flow type capable of operating below a 15m. head of water. The pumping unit shall be suitable for continuous operation, designed to meet the desired performance and capable of handling the pumped medium without undue wear and tear.

A built-in cooling system must allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not.

The motor shall be direct coupled to its pump and rated for continuous full load operation above or under water.

The insulation rating of the motor shall be Class F rated to run at Class B and supply rated output at deviations of upto + 5% of the rated frequency and voltage. The motor shall be to IP68 BS 5490.

The cable termination shall be water tight and provided with a cable sleeve and strain relief. The motor shall have ball type bearings permanently greased and maintenance free.

The pump and motor shall be separated by two mechanical face seals. The lower seal shall rotate in the water medium and the upper seal shall rotate in an oil bath medium.

The pump shall have a non-overloading performance characteristic and its efficiency shall be high at the duty point and remain at a reasonably high level over the duty range of the pumping system.

Rotating assemblies of pumps shall be statically and dynamically balanced. The pump wear rings shall be easily replaceable.

# Induction motor

* 1. **Design Requirements**

The motors shall generally conform to IS:325 or relevant, equivalent internationally approved standards. Additionally the specific requirements mentioned in the following clauses shall also be met.

# Performance and Characteristics

* + 1. Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions :
       1. Variation in supply voltage + 10%
       2. Variation in supply frequency + 5%
       3. Combined voltage and frequency variation + 10%
    2. Motors shall be suitable for full voltage direct-on-line starting.
    3. The power rating of the motor shall be the larger of the following :
       1. 115% of the power input to the pump at duty point.
       2. Maximum power input while operating within maximum and minimum system resistance.

# Insulations

* + 1. Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation.
    2. Motors shall be given power house treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersions and bakings shall be applied to the assembly.

# Constructions Features

* + 1. The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.
    2. Motors weighing more than 25 kg. Shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
    3. The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.

# Terminal Box

* + 1. Terminal boxes shall be of weather proof construction designed for outdoor service. To eliminate entry to dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees.
    2. The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample

phase to phase and phase to ground clearances. Suitable cable glands and cable lugs shall be supplied to match specified cables.

# Accessories

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box.

# H.V. Motors

1. Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 80% of the rated voltage.
2. Motors shall be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.
3. The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than starting time at minimum permissible voltage by atleast two seconds or 15% of the accelerating time whichever is greater. The locked rotor current of motors shall not exceed 600% of full load current of motors which is inclusive of 20% tolerance.
4. Motors when started with the drive imposing its full starting torque under the specified supply voltage variations shall be capable of withstanding atleast two successive starts from cold condition and one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.
5. The three phases shall be segregated by metal barriers within both line and neutral terminal box.
6. The earthing pads shall be of non-corrodible metal, welded / brazed at two locations on opposite sides. The pad size shall be 75 x 65 x 25 mm. With two holes drilled at 40 mm. centers, tapped and provided with suitable bolts and washers for connecting the earthing strip.
7. At least six resistance type temperature detectors for the stator winding each having D.C. resistance of 100 ohms at 0 degrees Celsius, embedded in the stator winding at locations



shall be platinum.

1. Motors shall have space heaters suitable for 240 V single phase 50 Hz AC supply. These shall be placed in easily accessible position in the lower part of motor frame. Provision shall be made to measure temperature of bearing by inserting hand held temperature measuring device.
2. Motors shall have drain plugs so located that they will drain water, resulting from condensation or other causes from all pockets in the motor casing.

# L.V. Motors

* + 1. Motors shall be suitable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated motor voltage.
    2. The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard).
    3. Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.
    4. Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamp type terminals.

# Valves

* 1. **General**
     1. Valves shall be as per internationally recognised standards. Flanges shall be machined on faces and edges and conform to ISO 7005, IS 6392 or BS 4504.
     2. Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centreline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.
     3. Valve buried or installed in underground chamber, where access to a handwheel would be impractical shall be operated by means of extension spindle and / or keys.
     4. Valve of diameter 450 mm. and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing.
     5. Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.
     6. The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.
     7. Valves shall be free from sharp projections.

# Butterfly Valve

* + 1. Butterfly valve shall be as per IS 13095 / BS 5155. Valve shall suitable for mounting in any position.
    2. The valve seat shall be secured to the valve body. When the valve is fully closed, a seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.
    3. The valve seal shall be replaceable and securely clamped to the edge of the disc by stainless steel seal retention members, or equivalent so as to prevent leakage and to hold the seal securely during operation. The seal retention member shall be securely clamped with stainless steel fasteners. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
    4. Valve shall be suitable for throttling purpose.
    5. All valve spindles & handwheels shall be positioned to give good access for operational personnel.
    6. Valve of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.
    7. All handwheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the handwheels.

# Sluice Valves

* + 1. Sluice valve shall conform to IS 780 and IS 2906 or relevant internationally recognised standards.
    2. They shall be of rising or non-rising spindle type depending on application. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.
    3. The gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.
    4. Valves of 450 mm. and above shall be provided with thrust bearing arrangement for ease of operation.
    5. Valves of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.
    6. All valves, spindles and handwheels shall be positioned to give good access for operational personnel.
    7. All handwheels shall be arranged to turn in a clockwise direction to close the valve, the direction to close the valve, the direction of rotation for opening and closing being indicated on the handwheels.

# Non-Return Valve

* + 1. The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.
    2. The valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.
    3. In case of multidoor swing type check valve, the non-slam characteristic shall be achieved by providing suitable combination of door and hydraulic passages without any external damping arrangements or passages. The angle of sealing and door weight shall be designed to provide the most efficient working with least restriction to flow.
    4. Valve of diameter greater than 450 mm. shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

# Air Valve

* + 1. The valve shall be capable of exhausting air form pipework automatically when being filled. The air being released at a sufficiently high rate to prevent the restriction of the inflow rate. Similarly the valve shall be capable of ventilating pipework automatically when being emptied, the air inflow rate being sufficiently high to prevent the development of a vacuum in the pipelines. The valve shall also automatically release air accumulating in pipework during normal working conditions.
    2. Air valve shall be of the double orifice type with a large orifice for ventilation or exhaust of the pipeline and smaller orifice for automatic release of air under normal working pressure.
    3. Air valve shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the closed position but the float (ball) shall only be raised by the liquid and not by a mixture of air and liquid spray. The seatings shall be designed to prevent the floats sticking after long periods in the closed

position.

# Pressure Relief Valve

* + 1. Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurised in excess of a preset maximum allowable pressure. The valves shall be drop tight under normal operating conditions.
    2. The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valves.
    3. The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weight or from a spring.

# Electric Actuator

1. All local controls shall be protected by a lockable cover.
2. Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.
3. The actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.
4. The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.
5. The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for



and s

1. Each starter shall be equipped as follows :
   1. 2 Nos. - Three phase magnetically operated line contactors with no-volt release and electrical and mechanical interlock.
   2. 1 No. - Three phase terminal cut-out device.
   3. 1 No. - Control circuit transformer fully protected by fuses on primary and secondary circuit.
   4. 1 No. -



* 1. 1 No. - Local - Off-remote switch with padlocking facilities.
  2. 1 No. -



* 1. Valve position indicator and handwheel for manual operation.

(ix) Reduction gear unit.

1. Gearbox shall have a life of 1,00,000 hours, and be selected in accordance with AGMA recommendation.

# Pipe Work

All pipes, fittings, bolts, nuts, jointing materials and appurtenances for piping required for execution of the Works shall be manufactured and erected in accordance with the erection plans, specifications and directives of the Project Engineer and Executing Agency. All pipework and fittings shall be to a class in excess of the maximum pressure attained in service including any surge pressure.

The pipework installation shall be so arranged to offer ease of dismantling and removal of pumps or other major items of equipment. Flanged adapter shall be included in the suction and delivery pipe work of all pumps as well as on delivery header for easy dismantling, and provision shall be made for a flexible joint arrangement to building structures. All loose flanges shall be secured to fixed flanges by suitable tie-bolts. All pipe work shall be adequately supported with purpose- made fittings. When passing through walls, pipe work shall incorporate a puddle flange or other suitable sealing device. Flange adapters and unions shall be supplied and fitted in pipe work runs, wherever necessary, to permit the simple disconnection of flanges, valves and equipment. The final outlet connection of the pipe work shall match the connecting point of the transmission main.

Flanged joints shall be made with minimum 3 mm thick full face, fabric reinforced rubber gaskets, pierced to take the bolts, and the face of all flanges shall be machined to give a true angle of 90o to the centre line of the pipe or fittings. All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valves, meters and other devices mounted in the pipe work shall be supported independently of the pipes to which they are connected.

The whole of the jointing work and materials necessary to fix and connect the pipes, including adequate and efficient pipe support shall be included in the Contract. The Concessionaire shall be responsible for ensuring that the internal surface of all pipe work is thoroughly clean before and during erection and before commissioning. Cleaning shall include removal of all dirt, rust, scale and welding slag due to site welding. Before despatch fr the pipes, branch pipes, etc., shall be suitably capped and covered to prevent any accumulation of

dirt or damage. This protection shall not be removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Project Engineer and Executing Agency.

Material of steel pipes and fittings shall conform to IS:2062. Fabrication and testing shall be in accordance with IS:3589 for pipes and IS:6392, ISO 7005 or P.S. 4804 for flanges.

All the underground buried mild steel piping shall be protected by the application of hot coal tar enamel and fibre glass wrapping. The coating shall consist of one coaltar primer coat, one coaltar enamel coat, wrapping of fibre glass and one more coat of enamel and then final wrap of enamel impregnated fibre glass.

# Hand operated travelling cranes

Hand operated travelling cranes shall be manufactured in accordance with medium duty class 2.

The term crane shall be deemed to include also hoists, gantry, rails end stops, holding down bolts and all other items required for complete installation.

Sufficient slings, ropes, shackles, lifting beams and all other necessary equipment shall be supplied to handle all items of plant served by the crane. They shall be labelled or marked with their safe working load in accordance with the safety code and with the purpose, for which they are intended.

# Sluice Gate

* 1. **Design Requirements and Construction Features**
     1. The construction of sluice gates shall be in accordance with the Specification and generally as per AWWA C 501 or IS:13349.
     2. The sluice gates shall be capable of performing the duties set in this Specification without undue wear or deterioration. They shall be constructed so that maintenance is kept to a minimum. All parts of sluice gate, including lifting mechanism components shall be designed for the heads specified with a minimum safety factor of five.
     3. All sluice gates shall be of the rising spindle type.

# Frame

The frame shall be of ample section and cast in one piece. All surface forming joints and bearings shall be machined. The frame shall be of the flange back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble.

# Guide

* + 1. Guide shall be bolted to the frame or cast integrally with it and shall be machined on all bearing and contact faces.
    2. The length of guide shall be such that it should support the gate upto the horizontal line of stem nut pocket.
    3. Arrangement shall be made to prevent lateral movement of bolted on guides. They shall be capable of taking the entire thrust produced by water pressure and wedging action. Wedges shall be attached securely to the guides at points where, in the closed position, they will make full contact with the wedging surfaces on the slides.

# Seating Faces

* + 1. Seating faces shall be made of full width, solid section. They shall be secured firmly by means of counter sunk fixings in finished grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place, free from distortion and loosening during the life of the sluice gates.
    2. The faces shall be of ample section and finished smooth. The maximum clearance between the seating surfaces, with the slide in the closed position shall not exceed 0.10 mm.

# Wedging Devices

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices as required to provide contact between the slide and frame facing when the gate is in closed position. All faces shall be machined accurately to give maximum contact and wedging action. Wedges shall be fully adjustable with suitable adjusting screws and locknuts and so designed that they will remain in the fixed position after adjustment.

# Gate Slides

* + 1. The slide shall be with strengthening ribs where required and a reinforced section to receive the seating faces.
    2. The slide shall have tongues on each side extending its full length, and the tongues shall be machined accurately on contact surfaces. Surfaces of the slide that come in contact with the seat facing and wedges shall be machined accurately. The maximum allowable clearances between the slide and the slide guide shall be

1.6 mm.

(c) An integrally cast stem nut pocket with reinforced ribs shall be provided above the horizontal centre line of the slide. The stem nut pocket shall be provided with drain.

# Stem Nut and Lift Nut

Gate shall be provided with a lower fixed stem nut for connecting the stem to the slide and a revolving lift nut located in the lifting mechanism in the head stock. They shall be of ample design to endure the thrust developed during gate operation under maximum gate operating condition loads in opening and closing direction. The stem nut and slide shall be constructed to prevent turning of the stem nut in the pocket in the slide. The stem be threaded and keyed or threaded and pinned to the stem.

# Stem

The threads of the stem shall be machined cut or rolled and of the square or acme type. The number of threads per inch shall be such as to work most effectively with the lift mechanism used. The top of the stem be provided with a stop collar.

# Stem Coupling

The coupling shall be threaded and keyed or threaded and bolted, and shall be of greater strength than the stem.

# Stem Guides

Stem guides shall be cast, with bushings and mounted on cast brackets. Guides shall be adjustable in two directions and shall be so constructed that when properly spaced they shall hold the stem in alignment. Number of stem guides shall be such that unsupported length of stem shall not exceed one hundred times its diameter.

# Lifting Mechanism

* + 1. Sluice gate shall be operated through suitable lifting mechanism which shall incorporate suitable gearing, if required.
    2. Lifting mechanism shall be suitable for operation by one man under all conditions. Lifting mechanism shall incorporate a strong locking device suitable for use with a padlock or padlock and chain.
    3. The manual operation shall be of the handwheel or crank operated type and shall have a lift nut threaded to fit the operating stem. Crank shall be removable. Ball or roller thrust bearings shall be provided above and below the flange on the lift nut to take the load developed in opening and closing the gate with a torque of 14 kg-m. on the crank. Fittings shall be provided to lubricate gears and bearing.
    4. The design of the lift mechanism of the hand operated gates shall be such that the slide can

be operated with a torque of not more than 7 kg-m. on the operator after the slide is unseated from wedges based on the operating head. The maximum crank radius shall be 380 mm.

* + 1. All gears and bearings shall be enclosed in a cast iron housing with labyrinth seals. The lifting mechanism shall be with a cast iron pedestal, machined and drilled to receive the gear housing and suitable for bolting to the operating floor. The gates shall close with clockwise rotation of the crank. The direction of rotation to close the gates shall be indicated on the lift mechanism.
    2. A suitable means shall be provided for lubricating the stem threads directly adjacent to the lift nut. An inspection cover shall be provided to access the lift nut and gearing.
    3. Stem shall be provided with a GI pipe cover shall be fixed to the head stock.

# Fasteners

All anchor bolts, assembly bolts, screw, nuts, etc. shall be of ample section to safety withstand the forces created by operation of the gate.

# Wall Thimbles

* + 1. Wall thimbles shall be made of cast iron and shall be supplied along with the gate. The wall thimbles shall provide a rigid mounting, designed to prevent warping of the gate frame during installation.
    2.  



mounting flange, shall be machined and shall be drilled and tapped to the same template used for its particular gate frame. The frame shall be attached to the thimble with bolts of studs. The depth of the wall thimbles shall not be less than 300 mm.

* + 1. To permit entrapped air to escape as the thimble is being encased in concrete, holes not lesser than 35 mm. diameter at more than 600 mm. span, shall be cast or drilled in each entrapment zone formed by the reinforcing ribs or the flange and water stop.

# Lifting Lugs

Lifting lugs shall be provided for all gates.

# Section - G5.1

**General electrical specifications**

# Section G5.1: General electrical specifications

1. **Scope of works and responsibility of the concessionaire**

The concessionaire is advised to peruse the document in full and understand the scope of work as detailed elsewhere in this document. He is / they are also advised to make himself / themselves aware of the site requirements and conditions before submission of his / their bid. Clarification, if any, required shall be made with the consultant before submission of bid.

However, nothing shall absolve the concessionaire to carry out and complete the entire works including those minor / incidental works required for the completion of the work whether it is explicitly brought out in this document or not.

The Concessionaire shall make appropriate arrangement for power supply provisions during Construction Period. All power and lighting circuits shall be constructed with due regard for personnel safety and shall comply with recognized codes of practice and local regulations. All circuits shall be fitted with earth leakage systems.

This specification is a general specification and the applicability of various component requirements shall be as per actual requirements from site to site basis

# Interpretation

All the technical terms referred in this document shall have the interpretation as per the relevant Indian standard code / Indian Electricity Rules / Indian Electricity Act etc., In case on any doubt in any of the meanings / interpretations, the tenderer shall get the same clarified from the owner prior to submission of bid.

# 3.

The electrical works shall be carried out by persons holding valid competency certificate issued / recognised by the Licensing Board of the locality / State in which the works is to be done. The Concessionaire holding valid Licence / Authorisation from the Licensing Board of the locality / State for carrying out the installation work of such nature and voltage grade.

# Design philosophy

All equipment offered by the Concessionaire shall offer the following features:-

Safety to personnel and equipment during operation and maintenance. Reliability of Services.

Ease of maintenance.

Facility for ready addition of future loads. Convenience of operation.

Maximum Inter-changeability of equipment. Minimum fire risk.

# Codes and Standards

Whether explicitly mentioned in this specification document or not, all the engineering, systems, equipment, materials and works being provided by the Concessionaire for this project shall conform to the requirements of the respective latest editions / amendments of the Indian Standards Specifications. In particular cases where relevant Indian Standards are not available, other International Codes and Standards may be accepted, subject to Execut  specific approval.

The design and the installation shall be in accordance with established and sound engineering practices, standard specifications and must conform to the statutory regulations applicable.

The equipment and installation shall conform to (but not be limited to) the following (Latest versions/editions).

Indian Electricity Act, 1910 Indian Electricity Rules, 1956 The Factory Act, 1948

In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decision of Project Engineer in such case shall be final and binding on the Concessionaire.

# Electrical system

Unless and until specified, otherwise the complete electrical system shall be suitable to work satisfactorily with the following system parameters

|  |  |  |
| --- | --- | --- |
| System Voltage (High Voltage) | **:** | 11 kV (E) 3 wire 50 Hz AC system of supply and subject to  permissible variations as per IE Rules |
| System Voltage (Medium  Voltage) | **:** | 415 Volts, 3 phase, 4 Wire AC system of supply subject to  permissible variations as per IE rules |
| System Voltage (Low Voltage) | **:** | 240 Volts Single phase 3 wire AC system of supply subject to  permissible variations as per IE rules |
| Frequency | **:** | 50 Hz and subject to permissible variations as per IE rules |
| Neutral Earthing | **:** | Solidly earthed |
| Fault Level | **:** | 50 kA at Main / Incomer level |
| Control Voltage | **:** | 110 Volts AC |

# Service conditions

All equipment to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

|  |  |  |
| --- | --- | --- |
| Maximum ambient temperature (deg C) | : | 50 |
| Maximum temperature in shade (deg C) | : | 45 |
| Average temperature in air (deg C) in shade | : | 35 |
| Relative Humidity (%) | : | 60 to 80 |
| Maximum altitude above mean sea level  (Meters) | : | 1000 |
| Operating Environment | : | Moderately hot and humid tropical climate  conducive to rust & fungus growth. |

# Drawings and data

The concessionaire shall furnish the following drawings and data as part of the work:

* 1. General arrangement showing plan, elevation and typical section views.
  2. Foundation plan showing location of fixing channels, floor openings etc.
  3. Schematic wiring drawings for each breaker.
  4. Technical literature on the equipment offered.
  5. Make/ Model No. of various major electrical equipment

The Concessionaire shall also furnish the following drawings for each major equipment such as HV panels, Transformers, MV panels, APFCR Panel, Street lighting Poles etc., after the award of contract.

1. Overall outline dimensions and general arrangement including plan, front elevations, clearances required in front and back etc.,.
2. Schematic control diagrams to cover controls, protection, interlocks, switch instruments, space heaters, etc., for each type of module.
3. Itemized bill of material for each module, listing all devices mounted and cable glands, indicating all type, rating quantity and special notes, if any.
4. Detailed internal wiring diagram of each type of module, including terminal block number, ferrule numbers and the external cable connection designations.
5. Inter panel interconnection wiring diagram including terminal numbers and ferrule numbers.

# The energy measurement point:

1. The "point of supply" of the utility connections for measuring the electrical energy consumption when the Facilities are running on utility power.
2. The Concessionaire shall also install meters and gauges at the DG Sets to measure the total number of energy units (in kWh) consumed from the DG Sets in each month of the O&M Period.
3. If the Concessionaire sets up a Power Plant at the Site, then the Concessionaire shall install meters at the Power Plant to measure the total number of energy units (in kWh) generated from the Power Plant in each month of the O&M Period.
4. All the energy recording meters shall be in conformance with the required class of accuracy and type as mandated by the utility rules and regulations.

# Specific project requirements for electrical equipment

* 1. **11 KV Ring Main Unit (RMU)**

# Scope

This specification describes the minimum requirement for design, manufacture, inspection and testing before despatch, packing and delivery F.O.R. (Destination) of SF6 insulated RMUs complete with other accessories and auxiliaries equipments and mandatory spares, described herein and required for their satisfactory operation.

The objective of the RMUs is for extremely small construction width, compact, maintenance free, independent of climate, easy installation, operational reliability, safe and easy to operate, minimum construction cost, minimum site work and minimum space requirement.

The RMUs shall conform in all respects to high standards of Engineering design, workmanship and latest revisions of relevant standards at the time of offer.

The type of the 11 KV circuit breaker shall be VCB. Insulating medium for load break isolators,



# General

The insulation / dielectric media inside the stainless steel welded tank should be SF6 gas. The RMU should be of extensible type on both sides with provision of attaching /connecting with SNAP FIT arrangement without external bus bars additional load break switches and circuit breakers in future whenever required.

The RMU shall be for a nominal voltage of 12 KV for 11 kV RMU using SF6 gas as insulating and Vacuum as arc quenching medium. The RMU and combination shall be tropicalized and outdoor metal enclosed type. The RMU metal parts shall be of high thickness, high tensile steel which must be grit /short blasted, thermally sprayed with Zinc alloy, phosphate or should follow the 7 tank pre-treatment process and be subsequently painted with polyurethane based powder

paint. The overall paint layer thickness shall be not less than **80 microns**.

Relevant IE rules for clearances, safety and operation inside the enclosure shall be applicable. The enclosure shall be **IP54** and type tested from recognized laboratories by National Accreditation Board of Laboratories (NABL). All live parts except for the cable connections in the cable compartments shall be insulated with SF6 gas.

The SF6 gas tank shall be made of **TIG** welded **stainless steel**, to have the best weld quality. The gas cubicle shall be metal enclosed with stainless steel of minimum 2 mm thickness and should be provided with a pressure relief arrangement away from operator.

The gas tank shall be of completely welded construction. The connection of different welded sections of gas tank by gasket and bolts, to form a RMU chamber is not acceptable.

Both the load break switches and the tee off circuit breaker shall be suitable for **motorization in future**. The cable box of isolators and circuit breakers both should be of front access type. The side and rear access cable box are not preferred as they require greater space for cable connection and maintenance at site. Any accidental over pressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the rear-bottom part of the enclosure. Gas will be release to the rear of the switchboard away from the operator and should be directed towards the bottom, into the trench to ensure safety of the operating personnel and the pedestrians / civilians. All the manual operations should be carried out on the front of the switchboard.

The entire units of RMU shall be enclosed in a single compact metal clad, outdoor enclosure suitable for all weather conditions. The switchgear/steel gas tank shall be filled with SF6 as per IEC/IS Standards relative pressure to ensure the insulation and breaking functions. The steel gas

with the IEC 298 standard. The RMU must be a system for which no handling of gas is required throughout the 20 years of service life.

The RMU shall have a design such that in the event of an internal arc fault, the operator shall be safe. This should be in accordance with IEC 298 and relevant Test certificates shall be submitted during design and detailed Engineering stage.

# The RMU shall be tested for an minimum internal arc rating of 20 kA for 1 Sec.

Suitable temperature rise test on the RMU shall be carried out & test reports shall be submitted during design and detailed Engineering stage. Each switchboard shall be identified by an appropriately sized label, which clearly indicates the functional units and their electrical characteristics devices is visible to the operator on the front of the switchboard and operations are visible as well.

The entire system shall be totally encapsulated. There shall be no access to exposed conductors. In accordance with the standards in effect, the switchboards shall be designed so as to prevent access to all live parts during operation without the use of tools.

The entire 11 KV RMU are insulated by inert gas (SF6) suitable for operating voltage up to 12 KV respectively. The 11 KV circuit breakers must be VCB breaker. **It is necessary to fit an absorption material in the tank to absorb the moisture from the SF6 gas**. The SF6 insulating medium shall be constantly monitored via a temperature compensating gas pressure indicator offering a indication at different temperature ranges, like -25, 0, 20, 40, 60 deg centigrade, having distinctive RED and GREEN zones for safe operation.

# Sulphur Hex fluoride Gas (SF6 GAS)

The SF6 gas shall comply with IEC 376, 376A and 376B and shall be suitable in all respects for use in 11 KV and 22 kV RMUs under the operating conditions. The SF6 shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC 376, 376A and 376B.

# Standards

Unless otherwise specified elsewhere in this Specification, the RMU, Switchboard (Switchgear), Load break isolators, Instrument Transformers and other associated accessories shall conform to the latest revisions and amendments thereof to the following standards.

IEC 60 298/IEC 62 271-200/IS 12729:1988 - General requirement for Metal enclosed switchgear

IEC60129/IEC62271-102/IS 9921 -  break

isolators) and earthing switch

IEC 62 271-100/IEC 60 056/IS 13118:1991 - Specification for alternating current circuit breakers.

IEC 62 271-1/IEC 60694 - Panel design, SF6/Vacuum Circuit Breakers IEC 60044-1/IEC 60185/IS 2705:1992 - Current Transformer

IEC 60265/IS 9920:1981 - High voltage switches. IEC 376 - Filling of SF6 gas in RMU.

IEC 60273/IS :2099- Dimension of Indoor & Outdoor post insulators with voltage> 1000 Volts.

IEC 60529/IS 13947(Part-1) - Degree of protection provided by enclosures for low voltage switchgear and control gear.

Indian Electricity Rules/Bills

Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned above shall also be acceptable. If the

  Concessionaire conform to other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail. One copy of such standards with authentic English Translations shall be furnished along with the offer.(Hard copy)

# Specific requirements in RMU

The RMUs going to be installed in the field network, will be hooked with **SCADA t**hrough RTUs and hence, RMUs used shall be compatible with SCADA **RMU outdoor metal clad enclosure.**

The RMU enclosure must be a metallic, it shall follows an industrialized process of manufacturing**.** The RMU and combination shall be tropicalized and outdoor metal enclosed type. The RMU metal parts shall be of high thickness, high tensile steel which must be grit/short blasted, thermally sprayed with Zinc alloy, phosphate or should follow the 7 tank pre-treatment process and be subsequently painted with polyurethane based powder paint. The overall paint layer thickness shall be not less than 80 microns.

The rating of enclosure shall be suitable for operation on three phase, three wire, 11 KV, 50 cycles, A.C. System with short-time current rating of 20 kA for 3 seconds with RMU Panels. The enclosure should have two access doors one for the operation and relay monitoring and other for the cable access. Both the doors should have the locking facility.

# Take OFF terminal units for future automation:

The RMU should be provided with necessary take off terminal units for future automations, located in the front recesses / LV cubical of the RMU.

# Isolators (Load Break Type)

The load break isolators for Incoming and Outgoing supply must be provided. These should be fully insulated by SF6 gas. The load break isolators shall consist of 630 Amp fault making/load breaking spring assisted ring switches, each with integral fault making earth switches. The switch shall 

same time. The selection of the main and earth switch is made by a lever on the facia, which is allowed to move only if the main or earth switch is in the off position. The load break isolators should have the facility for future remote operation. Each load break switch shall be of the triple pole, integral earthing arrangement.

The isolating distance between the OFF and the ON position in the isolator should be more than **80 mm**, so as to have enough isolating distance for ensuring safety during DC injection for Cable testing.

# Earthing of Isolators and breakers (earth switch)

Necessary arrangements are provided at Load break isolators / Distribution Transformer Breaker for selecting Earth position. Mechanical interlocking systems shall prevent the RMU function

position.

# Tee Off breaker (Vacuum)

The VCB breaker for the controlling of Transformer must be provided inside welded stainless steel SF6 gas tank with the outdoor metal clad enclosure. The VCB circuit breaker must be a spring assisted three positions with integral fault making earth switch. The selection of the main/earth switch lever on the facia, which is allowed to move only if the main or earth switches is in the off position.

The manual operation of the circuit breaker shall not have an effect on the trip spring. This should only be discharged under a fault (electrical) trip; the following manual reset operation should recharge the trip spring and reset the circuit breaker mechanism in the main off position.

The circuit breaker shall be fitted with a mechanical flag, which shall operate in the event of a fault (electric      from any other flag or mimic. Both the circuit breaker and ring switches are operated by the same unidirectional handle.



The protection on the circuit breaker shall comprise of the following components:-



a low burden trip coil and

a **self-powered (No external DC or AC source required) IDMT protection relays (Numeric/Microprocessor based)** 3 x over current and earth fault element shall be Definite Time type relay. The protection system should be suitable for protecting transformers of rated power from 250 KVA onwards. The relay should be housed within a pilot cable box accessible.

# Bushings

The units are fitted with the standardized bushings that comply with IEC standards. All the bushings are the same height from the ground and are protected by a cable cover.

# Cable boxes

All the cable boxes shall be air insulated suitable for dry type cable terminations and should have front access only. Side and rear cable entry / access should be avoided, so not to have extra space at site for cable connection and cable testing. The cable boxes at each of the two ring switches should be suitable for accepting HV cables of sizes 3C x 240 sq.mm and circuit breaker cable suitable up to 3C x 300 sq.mm.



two cables per phase.

# Cable testing facility

It shall be possible to test the cable after opening the cable boxes. The cable boxes should open only after operation of the earth switch. Thus ensuring the earthing of the cables prior to

performing the cable testing with DC injection.

# Voltage indicator lamps and phase comparators

The RMU shall be equipped with a voltage indication to indicate whether or not there is voltage on the cable. There should be a facility to check the synchronization of phases with the use of external device. It shall be possible for the each of the function of the RMU to be equipped with a permanent voltage indication as per IEC 601958 to indicate whether or not there is voltage on the cables.

# Extensible

Each RMU shall have the provision for extension by load break isolators / breakers in future, with suitable accessories and necessary Bus Bar. The equipment shall be well designed to avoid any kind of extension / trunking chamber for connecting and housing extensible Busbars. Extensible isolators and circuit breakers shall be individually housed in separate SF6 gas enclosures. Multiple devices inside single gas tank / enclosure will not be acceptable. In case of extensible circuit breakers, the Breaker should be capable of necessary short circuit operations as per IEC at 20 KA, and the Breaker should have a rated current carrying capacity of 200 A.

# Wiring & Terminals

The wiring should be of high standard and should be able to withstand the tropical weather conditions. All the wiring and terminals (including take off terminals for future automation, DC, Control wiring), Spare terminals shall be provided by the Concessionaire. The wiring cable must be standard single-core non-sheathed, Core marking (ferrules), stripped with non-notching tools and fitted with end sleeves, marked in accordance with the circuit diagram with printed adhesive marking strips. The wiring should be of high standard and should be able to withstand the tropical weather conditions. All wiring shall be provided with single core multi strand copper conductor wires with PVC insulation.

The wiring shall be carried out using multi-strand copper conductor super flexible PVC insulated wires of 650/1100 V Grade for AC Power, DC Control and CT circuits. Suitable colored wires shall be used for phase identification and interlocking type ferrules shall be provided at both ends of the wires for wire identification. Terminal should be suitably protected to eliminate sulphating. Connections and terminal should be able to withstand vibrations. The terminal blocks should be stud type for controls and disconnecting link type terminals for CT leads with suitable spring washer and lock nuts.

Flexible wires shall be used for wiring of devices on moving parts such as swinging Panels (Switch Gear) or panel doors. Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals, terminal blocks and wiring gutters. The cables shall be uniformly bunched and tied by means of PVC belts and carried in a PVC carrying trough. The position of PVC carrying trough and wires should not give any hindrance for fixing or removing relay casing, switches etc., Wire termination shall be made with solder less crimping type of tinned copper lugs. Core identification plastic ferrules marked to correspond with panel

wiring diagram shall be fitted with both ends of each wire.

Ferrules shall fit tightly on the wire when disconnected. The wire number shown on the wiring shall be in accordance with the IS. 375. All wires directly connected to trip circuits of breaker or devices shall be distinguished by addition of a red color unlettered ferrule. Inter-connections to adjacent Panels (Switch Gear) shall be brought out to a separate set of Terminal blocks located near the slots or holes to be provided at the top portion of the panel. Arrangements shall be made for easy connections to adjacent Panels (Switch Gear) at site and wires for this purpose shall be provided and bunched inside the panel. The bus wire shall run at the top of the panel. Terminal block with isolating links should be provided for bus wire. At least 10% of total terminals shall be provided as spare for further connections. Wiring shall be done for all the contacts available in the relay and other equipment and brought out to the terminal blocks for spare contacts. Color code for wiring is preferable in the following colours.

* + 1. Voltage supply Red, Yellow, Blue for phase and Black for Neutral
    2. CT circuits similar to the above
    3. DC circuits Grey for both positive and negative
    4. 250 V AC circuits Black for both phase and neutral
    5. Earthing Green

The wiring shall be in accordance to the wiring diagram for proper functioning of the connected equipment. Terminal blocks shall not be less than 650 V grade and shall be piece-molded type with insulation barriers. The terminal shall hold the wires in the tight position by bolts and nuts with lock washers. The terminal blocks shall be arranged in vertical formation at an inclined angle with sufficient space between terminal blocks for easy wiring. The terminals are to be marked with the terminal number in accordance with the circuit diagram and terminal diagram. The terminals should not have any function designation and are of the tension spring and plug-in type.

# Earthing

The RMU outdoor metal clad, Switch Gear, Load break isolators, Vacuum circuit breakers shall be equipped with an earth bus securely fixed along the base of the RMU. The size of the earth bus shall be made as per IEC/IS standards Necessary terminal clamps and connectors shall be included in the scope of supply.

All metal parts of the switchgear which do not belong to main circuit and which can collect electric charges causing dangerous effect shall be connected to the earthing conductor made of **copper** having CS area of minimum 75 sq.mm. Each end of conductor shall be terminated by M12/equivalent quality and type of terminal for connection to earth system installation. Earth conductor location shall not obstruct access to cable terminations.

The following items are to be connected to the main earth conductor by rigid or **copper**

conductors having a minimum cross section of 75 sq.mm

1. Earthing switches
2. Cable sheath or screen
3. Capacitors used in voltage control devices, if any.

The metallic cases of the relays, instruments and other panel mounted Equipment shall be connected to the earth bus by independent copper wires of size shall be made of IEC/IS standards. The colour code of earthing wire shall be green.

Earthing wires shall be connected on the terminals with suitable clamp connectors and soldering shall not be permitted.

# Accessories

The following spares and acces

1. Charging lever for operating load break isolators & circuit breaker of each RMU.
2. The pressure gauges indications 1 numbers
3. Provision shall be made for padlocking the load break switches/ Circuit breaker, and the earthing switches in either open or closed position with lock & master key.

# Testing of equipment & Accessories

Provision for testing CTs, Relays, Breakers and Cables shall be made available. The supplier shall provide procedure and schedule for Periodical & Annual testing of equipments, relays, etc.

# Tests:

**Type test**

The Concessionaire should, after award of contract during design detailed engineering, submit copies of all Type test certificate of their make in full shape as confirming to relevant ISI/IEC of latest issue obtained from a International/National Govt. Lab/Recognized laboratory along with quality plan, inspection plan as per applicable Indian standards.

# Acceptance and Routine tests

All acceptance and routine tests as stipulated in the latest IEC/ IS shall be carried out by the

advance intimation to the owner to enable them to depute their representative for witnessing the tests. The partial discharge shall be carried out as routine test on each completely assembled RMU gas tank and not on a sample basis. As this test checks and guarantees for the high insulation level and thus the complete life of switchgear.

# Additional tests

The Executing Agency reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/laboratory or at any other recognized laboratory/research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the Executing Agency to satisfy that the material complies with the intent of this specification.

# Pre-commissioning tests

All the pre-commissioning tests will be carried out in the presence of the Project Engineer and Executing Agency and necessary drawing manual and periodical test tools shall be

be present till the RMUs are put in to service.

# Inspection:

The owner may carry out the inspection at any stage of manufacture. The supplier shall grant free access to owner representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the owner shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

The supplier shall keep the owner in advance, about the manufacturing programme so that arrangement can be made for inspection. The owner reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. The owner has rights to

al shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested / unless the same is waived by the owner in writing.



# Quality Assurance Plan:

The Concessionaire shall invariably furnish following information during Design and detail engineering stage

1. Statement giving list of important raw materials including but not limited to:
   1. Contact material
   2. Insulation
   3. Sealing material
   4. Contactor, limit switches, etc. in control cabinet.

Name of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of



1. Information and copies of test certificates as in (i) above in respect of bought out accessories
2. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
3. Special features provided in the equipment to make it maintenance free.
4. List of testing equipment available with the Concessionaire for final testing of RMUs and associated combinations vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements. The supplier shall, within 15 days from the date of receipt of Purchase Order submit following information to the owner.
5. List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished during Design and Detailed Engineering stage.
6. Necessary test certificates of the raw material and bought out accessories**.**
7. Quality Assurance Plan (QAP) withhold points for owner inspection. The quality assurance plan and hold points shall be discussed between the owner and supplier before the QAP is finalized.

The supplier shall submit the routine test certificates of bought out items and raw material, at the time of routine testing of the fully assembled breaker.

# Training

The supplier shall give rigorous training to the engineers & staff at the site for 2 days in attending trouble shooting and maintenance.

**SCADA Connectivity:** Specific requirement for SCADA connectivity following requirement shall be fulfilled:

1. FPI shall be provided per isolator

# DC control supply system should be 24 V DC.

1. Battery charger to cater load of minimum 10 motorized operation cycles (CLOSE / OPEN) in absence of battery.
2. Battery to cater load of minimum 10 motorized operation cycles (CLOSE-OPEN) in absence of battery charger. **The battery backup should be minimum of 2Hrs**
3. Availability of MCB's for battery charger supply, RMU Motor supply & FRTU supply (Minimum 2 Amp circuit for future use of FRTU).
4. Individual control circuit of isolator/CB/BC to have point of isolation/protection.
5. Individual motor circuit of isolator/CB/BC to have point of isolation/protection.
6. RMU shall have minimum protection of IP 54 with gland plate & knock outs. Provision for control cable entry should preferably be from Right/ Left top through LV cable box & shall be independent of HV isolator/CB/BC status. It should be vermin proof.
7. Control cable gland plate shall be independent of power cable gland plate.
8. A point of earthing for control cables shall be electrically isolated from power cable earthing.
9. Ambient temperature of 50 degree C max. Allowable temperature rise of battery & battery charger above ambient 40 degree C.
10. Local / Remote switch shall be provided on all the isolator & breaker panels for selection of controls
11. CT & PT terminals for all the circuit breakers only.

Following is the list of I/O requirements for RMU modules. Please note that all DI & DO should be potential free contacts.

1. List of potential free contacts for Isolator (Terminals shall be provided):

# Digital Indications

* 1. Isolator ON
  2. Isolator OFF
  3. Isolator Earth switch Status (ON/OFF)
  4. FPI Operated
  5. LOCAL/REMOTE switch position

# List of commands

1. Isolator Close
2. Isolator Open
3. FPI reset
4. List of potential free contacts for Circuit Breaker / Bus coupler (Terminals shall be provided):

# Digital Indications

* 1. Circuit Breaker ON
  2. Circuit Breaker OFF
  3. Auto trip
  4. LOCAL/REMOTE switch position

# List of commands

1. CB Close
2. CB Open

# Requirement for Multifunction Meters (MFMs):

1. Terminals shall be provided for CT and PT connections.
2. Space may be provided for MFM mounting inside control panel.
3. List of potential free signals for AUXILIARY:

# Digital indications

* 1. RMU Battery charger fail
  2. Battery Low indication
  3. SF6 low

# Documentation and drawings

All drawings shall conform to relevant International Standards Organization (ISO) Specification.

The Concessionaire shall submit after award of contract during design and detailed engineering stage, dimensional general arran   illustrative and descriptive literature in triplicate for various items in the RMUs, which are all essentially required for future automation.

1. Schematic diagram of the RMU panel
2. Instruction manuals
3. Catalogues of spares recommended with drawing to indicate each items of spares
4. List of spares and special tools recommended by the supplier.
5. Copies of Type Test Certificates as per latest IS/IEC. vi)



1. Foundation drawings of RMU.
2. Dimensional drawings of each material used for item Vii.
3. Actual single line diagram of RMU/RMUs with or without Extra combinations shall be made displayed on the front portion of the RMU so as to carry out the operations easily.

The following sho     ordered.

Two copies of printed and bound volumes of operation, maintenance and erection manuals in English along with the copies of approved drawings and type test reports etc.

# Nameplate



indelibly marked with at least the following information.

1. Name of manufacturer
2. Type, design and serial number
3. Rated voltage and current
4. Rated frequency
5. Rated symmetrical breaking capacity
6. Rated making capacity
7. Rated short time current and its duration
8. Purchase Order number and date
9. Month and Year of supply
10. Rated lighting impulse withstand voltage
11. Feeder name (Incoming and Outgoing), DTs Structure name, 11000 Volts Dangers etc.

**Note:** Recognized abbreviations may be used to express the above and auxiliary supply shall be stated either on the circuit breaker name plate or any other acceptable position.

# Fault Passage Indicators (FPI):

These shall facilitate quick detection of faulty section of line. The fault indication may be based on monitoring fault current flow through the device. The unit should be self-contained requiring no auxiliary power supply. The FPI shall be integral part of RMU. The FPI shall have ***LCD/LED display***, automatic reset facility. The sensors to be bushing mounted. **FPI shall be provided per Isolator**

# Tropicalisation

Due regard should be given to the climatic conditions under which the equipment is to work. Ambient temperature normally varies between 20 °C and 32 °C, although direct sun temperature may reach 50 °C. The climate is humid and rapid variations occur, relative humidity between 60% and 90% being frequently recorded, but these values generally correspond to the lower ambient temperatures. The equipment should also be designed to prevent ingress of vermin, accidental contact with live parts and to minimize the ingress of dust and dirt. The use of materials, which may be liable to attack by termites and other insects, should be avoided.

# Motorization

All the functions within the RMU i.e. Isolators / Breakers should be suitable for motor drive

mechanism and closing coil making it suitable to make it ON from remote. Control Supply and Auxiliaries : Following Auxiliaries has to considered

1. Shunt trip coil 24VDC for Isolators and Breakers
2. Closing Coil 24VDC
3. 6NO+6NC Potential free auxiliary contacts for breakers / isolator
4. Auxiliary supply should be 24 V DC
5. Local / Remote switch for breaker and Isolators

# Metering

Separate Metering Modu

ratio

shall be as per transformer Rating. The metering is required only in breaker functions**.**

# 10.1.1. Guaranteed Technical particulars for RMU

The Concessionaire shall submit the Guaranteed Technical particular for RMU during design and detailed Engineering stage.

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Parameter / value** | **parameters / values as offered by the**  **Concessionaire** |
| **I** | Tag No. of Panel |  |  |
|  | Quantity |  |  |
|  | Location |  |  |
|  | Service |  |  |
|  | Combination type | 2 LBS + 1 VCB |  |
|  | Functional Requirement |  |  |
|  | Make / Model |  |  |
|  |  |  |  |
| **II** | **11 KV Bus Bar** |  |  |
|  | Current carrying capacity | 630 Amps. |  |
|  | Short time rating current for 3  secs | 20 KA |  |
|  | Insulation of bus bar | SF6 |  |
|  | Bus bar connections | Anti-oxide grease |  |
|  |  | |  |
| **III** | **Parameters for VCB and load break isolators** | |  |
|  | Type | Metal enclosed |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Parameter / value** | **parameters / values**  **as offered by the Concessionaire** |
|  | No of Phases | 3 |  |
|  | No. of poles | 3 |  |
|  | Rated voltage | 12 KV |  |
|  | Operating voltage | 11 KV |  |
|  | Rated lightning impulse  withstand voltage | 75 KV |  |
|  | Rated power frequency  withstand voltage | 28 KV |  |
|  | Insulating gas | SF6 |  |
|  | Rated filling level for insulation | As per IEC |  |
|  | Isolating distance between ON  and OFF position in isolator | 80 mm (min). |  |
|  | Rated short time current | 20 KA |  |
|  | Rated short time | 3 s |  |
|  | Rated peak withstand current | 50 KA. |  |
|  | No of operations in Short circuit | 15 Nos (minimum) |  |
|  | Operating mechanism | Circuit breaker with spring assisted anti reflex / trip free  mechanism. |  |
|  | Rated current (Bus) | 630 *A* |  |
|  | Rated current (breaker) | 200 A |  |
|  | Circuit Breaker interrupter | VCB |  |
|  | Rated frequency | 50 Hz |  |
|  | Rated operating sequence | O-3 min - CO |  |

# 11 kV Metal enclosed switchgear Applicable standards

The switchgear and its components shall conform to the latest applicable standards specified

below. In the event of conflict between any of these Specifications and the Cddes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decis ion of Project Engineer in such case shall be final and binding on the Concessionaire.

|  |  |
| --- | --- |
| IS : 13118 | Circuit Breakers |
| IS : 3427 | Metal enclosed switchgear |
| IS : 2705 | Current Transformers |
| IS : 3156 | Voltage Transformers |
| IS : 5576, 11353 | Arrangement for switchgear, bus bars, main connections and auxiliary wiring |
| IS : 2544 | Bus bar support insulators |

|  |  |
| --- | --- |
| IS:13947 (Part I) | Degree of Protection |
| IS:3231, 3842 | Electrical relays for power system protection |
| IS:1248 | Electrical indicating instruments |
| IS:9385 | High voltage fuses |
| IS:722, 8530 | AC Electricity Meters |
| IS : 613 | Specification for copper rods and bars for electrical purposes |
| IS : 6005 | Code of practice for phosphating iron & steel |
| IS : 9920 | Alternating current switches for voltages above 1000 V |
| IS : 13703 | Low voltage fuses |
| IS : 3452 | Toggle switches |
| IS : 10118 | Code of Practice for selection, installation and maintenance of switchgear and  control gear |
| IS : 6875 | Control switches |

# Features of construction

* + 1. The switchgear shall be outdoor, metal enclosed with separate compartments for
       1. Circuit breaker
       2. Control, metering and relaying devices
       3. Busbars
       4. Instrument transformers

(vi) Power cable terminations

1. Adjacent switchgear cubicles shall be provided with side sheets on either side to ensure complete isolation. The bottom of the switchgear shall be fully covered by sheet steel.
2. Separate removable gland plates shall be provided for power and control cables. The gland plate for the power cables shall be of non-magnetic material.
3. All sheet steel work shall be thoroughly cleaned of rust, scale, oil, grease, dirt, and sward by pickling, emulsion, cleaning etc. The sheet steel shall be phosphated and then painted with two coats of zinc rich primer paint. After application of the primer, two coats of finishing synthetic enamel paint over baked / stoved shall be applied.
4. The circuit breaker shall be fully draw out type. The circuit breaker shall have distinct service and test positions. In the test position, the circuit breakers shall be capable of being tested for operation without energising the power circuits. Four normally open auxiliary contacts shall be provided for each of the service and test limit position switches.
5. The test position should preferably be obtained without the need to disconnect normal control connections and use of extension cords for testing.
6. The switchgear shall fully house the breaker both in the service position as well as in the test position.
7. The current transformers shall be mounted on the fixed portion of the switchgear and not on the breaker truck.
8. The cable compartment shall house all power cable connections along with associated cable terminations. Wherever zero sequence current transformers are provided for earth fault protection, these shall also be located inside the cable compartment.
9. Each switchgear cubicle shall be fitted with a label in the front and rear of the cubicle. Each switchgear shall also be fitted with label indicating the switchgear designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate labels.

# Safety interlocks and features

1. Withdrawal or engagement of circuit breakers or disconnecting switch shall not be possible unless it is in the open position.
2. Operation of circuit breaker or disconnecting switch shall not be possible unless it is fully in service position, or in test position or in fully drawn-out.
3. Operation of a disconnecting switch shall not be possible unless the associated circuit breaker is open.
4. Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the exposed live parts when the breaker is withdrawn.
5.  - 

points, where the terminals are likely to remain live and isolation is possible only at remote end, e.g. incoming terminals of main disconnecting switch.

1. A draw-out with breaker of given rating shall be prevented from engaging with stationery element of higher rating.

# Main Bus Bars

1. Busbars shall be fully insulated by encapsulation in epoxy resin, with mould caps protecting all joints.
2. Busbars shall be supported on insulators capable of withstanding dynamic stresses due to short circuit.
3. Busbars shall be of electrolytic aluminium conductor of hard drawn and high conductivity.

# Circuit Breakers:

1. **Auxiliary contacts:**

Auxiliary switch mounted on the fix portion of the breaker and directly operated from the



contact multiplication for other requirements shall be provided. The contacts shall be rated for 10 amps, 240 V A.C and 1 Amp. (Inductive breaking), 110 V D.C. The above auxiliary switches shall not operate when the breaker is withdrawn to test position and operated.

# Spring operated mechanism:

The operating mechanism shall be complete with motor, opening and closing springs, limit switches for automatic charging and all necessary accessories. Facility for manual charging of the closing spring shall be provided. The operating mechanism shall be trip- free and non-pumping electrically. An anti-pumping relay to achieve electrical anti- pumping feature shall be provided even if the breaker has provision for anti-pumping by mechanical arrangement.

# Earthing:

1. An earthing bus shall be provided at the bottom and extend throughout the length of the switchgear. It shall be bolted / welded to the framework of each unit and each breaker earthing bus.
2. All non-current carrying metalwork of the switchgear shall be effectively bonded to the earth bus. Hinged doors shall be earthed through flexible earthing braid.
3. Positive earthing of the circuit breaker frame shall be maintained both in service and test position.

# Annunciators:

(a) Facia annunciators, suitable for operation on 24 V DC shall be provided. Facia annunciators shall be:

i.   

each annunciator on individual panels;

ii. Provided with two lamps connected in parallel on each facia window with series resistors;

iii.

1. Suitable for annunciating subsequent faults with the specified sequence, immediately after acknowledging the previous fault;
2. Facia window of minimum size of 35 mm. x 50 mm;
3. Designed for an operating sequence indicated below :

|  |  |  |  |
| --- | --- | --- | --- |
| **Alarm condition** | **Fault contact** | **Audible alarm** | **Visual alarm** |
| Normal | Open | Off | Off |
| Abnormal | Closed | On | Flashing |
| Sound Cancel | Closed or Open | Off | Flashing |
| Acknowledge | Closed or Open | Off | Steady on |
| Back to Normal | Open | Off | Steady on |
| Reset | Open | Off | Off |
| Lamp Test | Open | Off | Steady on |

# Switchgear accessories and wiring

1. Switchgear shall be supplied completely wired internally upto equipment and terminal blocks and ready for external cable connections at the terminal blocks. Inner panel wiring between cubicles of same switchgear shall be provided.
2. All auxiliary wiring shall be carried out with 650 volts grade, single core, stranded copper conductor with PVC insulation. The sizes of wire shall not be less than 1.5 sq.mm.
3. Terminal blocks shall be of stud type, 650 volts, 10 amps, rated complete with insulated barriers.
4. All spare contacts and terminals of cubicle mounted equipment and devices shall be wired to terminal blocks.
5. Accuracy class for indicating instruments shall be 1.0. Instruments shall be 110 mm. Square with 240o scale for flush mounting with only flanges projecting.
6. Ammeters, voltmeters, shall be of moving iron type. The accuracy class shall be 1.0. The range shall be indicated on the drawing / data sheets. Digital microprocessor based power monitor shall be provided to monitor all electrical parameters, such as KVA, KW with resettable maximum demand recorder and indicator, KVAR, KWH, KVARH, Power Factor PF, Frequency, Voltage current etc. The power monitor shall operate off a PT secondary of 110 volts, suitable for operation on 3-phase, 3-wire system and to measure unbalanced loads.
7. Relays shall be suitable for flush mounting with only flanges projecting.
8. All protective relays shall be in draw-out cases with built-in test facilities. Necessary test plugs shall be supplied loose. All auxiliary relays and timers shall be supplied loose. All auxiliary relays & timers shall be supplied in non-draw-out cases. Externally operated hand reset flow indicators shall be provided on all relays and timers. Timers shall be of electromagnetic or electronic type only.
9. Control and instrument switches shall be rotary type provided with inscription plates clearly marked to show operating position and suitable for semi-flush mounting with only switch front plate and operating handle projecting out.
10. Breaker control switches shall be pistol grip black and selector switches shall be oval or knob and black. Breaker control switches shall be three-position spring return to neutral type. Instrument selector switches shall be of the maintained stay-put type. Contacts of the switches shall be spring assisted and contact faces shall be with rivets of pure silver. The contact ratings shall be adequate to meet the requirements of circuit capacity in which they are used.
11. All push buttons shall have two normally open and two normally closed contacts unless specified otherwise. The contacts shall be able to make and carry 5 A at 110V DC and shall be capable of breaking 1 A inductive load at 110V DC. They shall be provided with inscription plates engraved with their functions.
12. Indicating lamps shall be panel mounting type with series resistors. The wattage of lamps shall be 5 to 10 watts.
13. Space heaters of adequate capacity shall be provided inside each panel. They shall be suitable for 240V, 1 pH, 50 Hz supply. They shall be complete with HRC fuses, isolating switches and thermostat to cut off heater at 45o C.
14. Each switchgear panel shall be provided with 240 Volts, 1 phase, 50 Hz, 5 amps, 3 pin receptacle with switch located in a convenient position.
15. An interior illuminating lamp together with operating door switch and protective fuse shall be provided.
16. Provision shall be made for receiving, distribution, isolating and fusing of auxiliary D.C. and A.C. supplies for controls, space heating, etc. The fuse ratings shall be so chosen as to ensure selective clearance of sub circuit faults.
17. Fuses shall be HRC cartridge type mounted on plug in type fuse base.
18. The D.C. and A.C. auxiliary supply shall be distributed inside the switchgear with necessary isolating arrangements at the point of entry and with sub-circuit fuses as required.

# Instrument transformers

1. The CTS shall withstand momentary and short time current ratings of the associated switchgear. CTS and PTS shall be of the cast resin type and completely encapsulated.
2. The core balance CTS shall be suitable for the respective outgoing feeders and shall be suitably supported.
3. PTS shall be single phase, draw out type. PTS shall be provided with fuses on both primary and secondary sides, except those terminals that are required to be connected to earth. These shall have an isolating link. Fuses on primary side shall have rupturing capacity equal to the switchgear rating.

# Cable termination

1. Necessary number of cable glands shall be supplied for terminating auxiliary power and control cables. Glands shall be of heavy-duty brass castings, machine finished and complete with check nut, washers, neoprene compression ring.
2. Cable lugs for all power and control cable connections shall be supplied. The lugs shall be tinned copper / aluminium depending on cable conductor and of solder less crimping type.
3. All necessary materials required for terminating the power cables such as tapes, filters, binding wires, armour clamps, brass glands etc., shall be supplied.

# Drawings and data

1. **The Concessionaire shall furnish the following drawings & data during design and detailed engineering stage:**

General arrangement showing plan, elevation and typical section views. Foundation plan showing location of fixing channels, floor openings etc. Schematic wiring drawings for each breaker.

Technical literature on the beakers offered.

Bill of material listing equipment designation, make type, rating etc., of various equipment mounted on switchgear panel.

# The Concessionaire shall furnish the following drawings for each panel & switchgear after the award of contract.

Overall outline dimensions & general arrangement including plan, front elevations, clearances required in front and back, details of bus duct connections, if any.

Overall outline dimensions & general arrangement including plan, front elevations, clearances required in front and back, details of bus duct connections, if any.

Schematic control diagrams to cover controls, protection, interlocks, instruments, space heaters, etc., for each type of module.

Itemized bill of material for each module, listing all devices mounted and cable glands, indicating all type, rating quantity and special notes, if any.

Detailed internal wiring diagram of each type of module, including terminal block number, ferrule numbers and the external cable connection designations.

Inter panel interconnection wiring diagram including terminal numbers and ferrule numbers.

# 10.2.1. Guaranteed Technical particulars for 11 kV panel

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Parameter / value** | **Offered parameter / value (to be filled in by the concessionaire during Design**  **and detailed engineering stage)** |
| **I** | Tag No. of Panel |  |  |
|  | Quantity |  |  |
|  | Location | Near STP and pump house |  |
|  | Service | Outdoor |  |
|  | Functional Requirement | Transformer primary control |  |
|  | Type | ICOG |  |
|  |  |  |  |
| **II** | **11 KV Bus Bar** |  |  |
|  | Current Carrying Capacity | 630 Amps. |  |
|  | Short time rating current for  3 secs | 20 KA |  |
|  | Insulation of bus bar | Air |  |
|  |  | |  |
| **III** | **Parameters for VCB** | |  |
|  | Type | Metal enclosed |  |
|  | No of Phases | 3 |  |
|  | No. of poles | 3 |  |
|  | Rated voltage | 12 KV |  |
|  | Operating voltage | 11 KV |  |
|  | Rated lightning impulse  withstand voltage | 75 KV |  |
|  | Rated power frequency  withstand voltage | 28 KV |  |
|  | Insulating gas | Air |  |
|  | Rated filling level for  insulation | As per governing IS |  |
|  | Isolating distance between  ON and OFF position in isolator | 80 mm (min). |  |
|  | Rated short time current | 20 KA |  |
|  | Rated short time | 3s |  |
|  | Rated peak withstand  current | 50 KA. |  |
|  | No of operations in Short  circuit | 15 Nos (minimum) |  |
|  | Operating mechanism | Circuit breaker with spring assisted anti reflex / trip free  mechanism. |  |
|  | Rated current (Bus) | 630 *A* |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Parameter / value** | **Offered parameter / value (to be filled in by the concessionaire during Design**  **and detailed engineering stage)** |
|  | Rated current (breaker) | 200 A |  |
|  | Circuit Breaker interrupter | VCB |  |
|  | Rated frequency | 50 Hz |  |
|  | Rated operating sequence | O-3min- CO |  |
|  |  |  |  |

* 1. **11 kV XLPE Power cables**

# Scope

The specification covers design, manufacture, shop testing, packing and delivery of 11 kV multi core, cross-linked polyethylene insulated power cables suitable for effectively earthed neutral system.

# Standards

Unless otherwise specified elsewhere in this specification, the rating as well as performance and testing of the HT XLPE power cables shall conform to the latest revisions available at the time of placement of order of all the relevant standards as listed in, but not limited to table below

|  |  |
| --- | --- |
| IS: 8130 1984 | Conductors for insulated electric cables and flexible cords. |
| IS :7098 (Part 2)  1985 | XLPE PVC sheathed cable for working voltages from 3.3 kV up to and  including 33 kV. |
| IS: 5831 1984 | PVC insulation and sheath of electric cables. |
| IS: 3975 1988 | Mild steel wires , formed wires and Tapes for armouring of cables |
| IS :10462 ( Part I)  1983 | Fictitious calculation method for determination of  dimensions of protective coverings of cables. |

# General constructional requirements

The HT multi core power cables shall normally be with stranded compacted H2/H4 grade aluminium conductor as per IS: 8130 - 1984, provided with conductor screening (of extruded semi-conducting cross link material) and shall be insulated with XLPE of natural colour. Identification of cores shall be by colour, as per provision of clause 13.1 of IS: 7098 (Part 2) - 1985. The insulation (XLPE) screening shall be provided consisting of extruded semi- conducting cross link material in combination with a metallic layer of copper tapes. Three such screened cores shall be laid up together with fillers and/or binder tapes where necessary and provided with extruded inner sheathing of heat resistant PVC conforming to type ST-2 of IS: 5831- 1984. Maximum continuous operating temperature shall be 90 deg C under normal operation and 250 deg C under short circuit condition Armouring shall be provided consisting

of single galvanized round steel wires (In case of Single core cable armouring shall be of Non- magnetic material) conforming to IS:3975 - 1988 (amended upto date) and over the armouring a tough outer sheath of PVC compound shall be extruded. The PVC compound for the outer sheath shall conform to type ST-2 of IS: 5831 - 1984 (amended upto date). The colour of the outer sheath shall be black. The cable shall be manufactured strictly conforming to IS:7098 (Part 2) 1985 amended upto date and shall bear ISI mark.

# Sequential marking of length of cable

Non-erasable Sequential Marking of length shall be provided by embossing on outer sheath of the cable for each meter length. The quality of insulation should be good and insulation should not be deteriorated when exposed to the climatic conditions.

# Discharge free construction:

Inner conductor shielding, XLPE insulation and outer core shielding shall be extruded in one operation by special process (viz. Triple Extrusion Process) to ensure that the insulation is free from contamination and voids and perfect bonding of inner and outer shielding with insulation is achieved.

# Continuous A.C. Current carrying capacity:

Continuous a.c. current capacity shall be as per Table given below.

|  |  |  |
| --- | --- | --- |
| **Conductor sizes in sq.mm.** | **Continuous a.c. current capacity in Amps. at maximum conductor temp. of**  **90 deg .C.** | |
| **When laid direct in the ground 30 deg. C** | **When laid in air 40 deg. C** |
| 70 sq mm | 160 | 165 |
| 95 sq mm | 190 | 200 |
| 120 sq mm | 215 | 230 |
| 150 sq mm | 240 | 265 |
| 185 sq mm | 270 | 310 |
| 240 sq mm | 315 | 345 |
| 300 sq mm | 355 | 396 |
| 400 sq mm | 405 | 460 |
| 500 sq mm | 450 | 590 |

# Short circuit current

Short circuit current of 11 kV XLPE cable shall be as per Table given below.

|  |  |  |
| --- | --- | --- |
| **Duration of Short Circuit in sec** | **Area of Al. Conductor** | **Short circuit current in kA** |
| t | A | I=0.094 x A/sq.rt (t) |
| 1 | 70 sq.mm | 6.58 |
| 1 | 95 sq.mm | 8.93 |

|  |  |  |
| --- | --- | --- |
| **Duration of Short Circuit in sec** | **Area of Al. Conductor** | **Short circuit current in kA** |
| 1 | 120 sq.mm | 11.28 |
| 1 | 150 sq.mm | 14.10 |
| 1 | 185 sq.mm | 17.39 |
| 1 | 240 sq.mm | 22.56 |
| 1 | 300 sq.mm. | 28.20 |
| 1 | 400 sq.mm. | 37.60 |
| 1 | 500 sq.mm | 47.00 |
| 1 | 630 sq.mm | 59.20 |

# Routine tests

All the Routine tests as per IS: 7098 (Part 2) - 1985 amended upto date shall be carried out on each delivery length of cable. The result should be given in test report. Partial discharge test must be carried out in a fully screened test cell. It is, therefore, essential that the manufacturer should have the appropriate type of facility to conduct this test, which is routine test.

# Acceptance tests

All Acceptance tests as per IS: 7098 (Part 2) - 1985 as modified upto date including the optional test as per clause no 18.4 and Flammability Test shall be carried out on sample taken from the delivery lot.

# Packing and marking:

**Identification marks on cable**:

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

* + - 1. Manufactures name and/or Trade name.
      2. Voltage grade.
      3. Year of manufacture.
      4. Successive Length.
      5. Size of cable
      6. ISI mark

The cable shall be supplied in continuous standard length of 250 running meters with plus or minus 5% tolerance wound on non-returnable wooden drum of good quality and non-standard lengths not less than 100 meters upto 5% of the ordered quantity shall be accepted. Alternately, cable can be supplied wound on non-returnable steel drum without any extra cost to the purchaser. Packing and marking shall be as per Clause No. 21 of IS: 7098 (Part 2) - 1985 amended up to date.

# Transformers

* + 1. **Applicable standards**

The power and auxiliary transformers shall conform to the latest applicable standards specified below. In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decision of Project Engineer and Executing Agency in such case shall be final and binding on the Concessionaire.

|  |  |
| --- | --- |
| IS : 2026 | Power Transformer |
| IS : 3639 | Fittings and Accessories |
| IS : 1180 | Auxiliary Transformer |
| IS : 6600 | Loading of oil immersed transformer |
| IS : 335 | Insulating oil |
| IS : 2099 | Bushings for > 1000 V, AC |
| IS : 7421 | Bushings for < 1000 V, AC |
| IS : 13947 (Part I) | Degree of Protection |
| IS : 1271 | Electrical insulation classified by thermal stability |

# Features of construction

* + - 1. The transformer shall be designed for adequate capacity with 100% stand by transformer.
      2. The transformer tank shall be made from high-grade plate steel, suitably reinforced by means of stiffeners made of structural steel sections. All seams, flanges, lifting lugs, braces and other parts attached to the tank shall be welded. The interior of the tank shall be cleaned by shot blasting and painted with two coats of heat resistant and oil insoluble paint. Adequately sized manholes shall be provided for easy inspection and maintenance. All joints which may have to be opened from time to time in the course of operation shall be of a design to permit them to be made easily oil tight in reassembly. Steel bolts and nuts exposed to atmosphere, shall be galvanised. The tank cover shall be suitably sloped so that it does not retain rainwater.
      3. Lifting lugs and eyebolts shall be so located that a safe clearance is obtained between sling and transformer bushings, without the use of a spreader.
      4. Transformer of rating above 500 KVA shall be equipped with detachable or separately mounted radiator banks. Transformers of rating 500 KVA and below shall be provided with fixed type radiators.
      5. When transformers are provided with separately mounted radiators, flexible joints shall be provided on the main oil pipes connecting the transformer tank to the radiator banks to

reduce vibration and facilitate erection and dismantling. The interconnecting pipes shall be provided with drain plug and air release vents.

* + - 1. The transformer tank, radiators and conservator shall be designed taking into account the loss of thickness due to shot blasting.
      2. The transformer core shall be constructed from high grade, non-ageing, cold rolled, grain oriented, silicon steel laminations coated with insulation varnish. The steel laminations



* + - 1. Each lamination shall be coated with insulation, which is unaffected by the temperature attained by the transformer during service.
      2. Core lamination shall be annealed and burrs removed after cutting. Cut edges shall be insulated.
      3. The frame work and clamping arrangements of core and coil shall be securely earthed inside the tank by copper strap connection to the tank.
      4. Windings shall be of suitably insulated copper wire or copper strip. The windings shall be fully shrunk under vacuum before assembly.
      5. High voltage end windings shall be suitably braced to withstand short circuit stresses and stresses set up by surges.
      6. All taps shall be provided on the HV winding.
      7. The core and coil assembly shall be dried out and impregnated under vacuum.
      8. Cable boxes shall have sufficient space for segregating the cable cores and to give adequate clearance in air between bare conductors at the terminals. Cable boxes shall be complete with necessary cable lugs and armour grips.
      9. All auxiliary wiring from current transformers, winding temperature indicators, etc., shall be marshalled to a separate weatherproof and vermin proof marshalling box with an independent access cover.
      10. The marshalling box shall be complete with necessary cable glands and cable lugs. The marshalling box and components shall comply with the requirements specified for control cabinets indicated elsewhere in this specification.

# Performance requirements:

* + - 1. Transformers shall operate without injurious heating at the rated KVA at any voltage within

+ 10 percent of the rated voltage of that particular tap.

* + - 1. Transformers shall be capable of delivering the rated current at a voltage equal to 105 percent of the rated voltage without exceeding the limiting temperature rise.
      2. Transformer for two or more limits of voltage or frequency or both shall deliver its rated KVA under all the rated conditions of voltage or frequency or both; provided an increase in voltage is not accompanied by a decrease in frequency.
      3. Transformers shall operate below the knee of the saturation curve at 110 percent voltage to preclude ferro-resonance and non-linear oscillations.
      4. Transformers shall be capable of operation continuously, in accordance with the applicable standard loading guide at their rated KVA and at any of the specified voltage ratios. Under these conditions, no limitations by terminal bushings, on-load tap changers or other auxiliary equipment shall apply.
      5. The neutral terminal of windings with star connection shall be designed for the highest over current that can flow through this winding.
      6. The transformers shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave form distortion and any possibility of high frequency disturbances reaching a magnitude as to cause interference with communication circuits.
      7.   



same does not meet the specification requirement subject to tolerances as per IS: 2062. The rejected transformers shall be replaced by transformers complying with the requirements to



* + - 1. If the commissioning of the project is likely to be delayed by the rejection of a transformer,

Representative reserves the right to accept the rejected transformer until the replacement transformer is made available. Transporting the rejected and replacement transformers as well as installation and commissioning of both the transformers shall be at



# On Load Tap Changing Gear for transformer:

* + - 1. The OLTC gear shall be designed to complete successfully tap changes for the maximum current to which transformer can be loaded, i.e. 150% of the rated current. Devices shall be incorporated to prevent tap change when the through current is in excess of the safe current that the tap changer can handle. The OLTC gear shall withstand through fault currents without injury.
      2. When a tap change has been commenced it shall be completed independently of the operation of the control relays and switches. Necessary safeguard shall be provided to allow for failure of auxiliary power supply or any other contingency, which may result in the tap changer movement not being completed once it is commenced.
      3. Oil in compartments, which contain the making and breaking contacts of the OLTC shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to a separate oil conservator or to a segregated compartment within the main transformer conservator. A Buchholz relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.
      4. Oil, in compartments of OLTC which do not contain the make and break contracts, shall be maintained under conservator head by valved pipe connections. Any gas leaving these compartments shall pass through the Buchholz relay before entering the conservator.
      5. Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketed and bolted cover with lifting handles.
      6. OLTC driving mechanism and its associated control equipment (Local) shall be mounted in an outdoor, weatherproof cabinet with IP 55 protection, which shall include:

Driving motor (415V, 3-phase, 50 Hz, AC squirrel cage).

Motor starting contactor with thermal overload relays, isolating switch and HRC fuses.

Control switch: Raise / off / lower (spring return to normal type). Remote / local selector switch (maintained contact type).

Mechanical tap position indicator showing rated tap voltage against each position and resettable maximum and minimum indicators.

Limit switches to prevent motor over-travel in either direction and final mechanical stops.

Brake or clutch to permit only one tap change at a time on manual operation. Emergency manual operating device (hand crank or head wheel).

A five-digit operation counter.

Electricity interlocked reversing contactors (preferably also mechanically interlocked).

240V, 50 Hz, AC space heater with switch and HRC fuses. Interior lighting fixture with lamp door switch and HRC fuses. Gasketted and hinged door with locking arrangement.

Terminal blocks, internal wiring, earthing terminals and cable glands for power and control cables.

Necessary relays, contactors, current transformers etc.

* + - 1. Control Requirements for OLTC:

The following electrical control features shall be provided:

Positive completion of load current transfer, once a tap change has been initiated, without stopping on any intermediate position, even in case of failure of external power supply.

Only one tap change from each tap change impulse even if the control switches or push button is maintained in the operated position.

Cut-off of electrical control when manual control is resorted to cut-off of a counter impulse for a reverse tap change until the mechanism comes to rest and resets the circuits for a fresh operation.

Cut-off of electrical control when it tends to operate the tap beyond its extreme position.

* + - 1. Automatic Control of OLTC:

Automatic OLTC control shall include the following items:

Voltage setting device

Voltage sensing and voltage regulating devices

Line drop compensator with adjustable R and X elements

Timer 5-25 seconds for delaying the operation of the tap changer in the first step for every tap change operation

Adjustable dead band for voltage variation

# OLTC panel:

The OLTC remote control equipment shall be suitable for 24 V DC supply and shall be housed in an indoor sheet steel cubicle to be located in a remote control room. The OLTC control panel shall comprise of rigid welded structural frames made of structural steel section or of pressed and formed cold rolled steel and frame enclosures, doors and partitions shall be of cold rolled steel of thickness 2 mm. Stiffeners shall be provided wherever necessary. All doors, removable covers and plate shall be gasketed all around

with neoprene gaskets. Panel shall be dust, weather and vermin proof providing degree of protection of IP 54, colour of finish shade for interior and exterior shall be glassy white and light grey semi glossy shade 631 of IS-5 respectively. Earthing bus shall be of 25 x 6 mm copper.

The panel shall consist of:

* + - * 1. Control Switch : Raise / Off / Lower (spring return to normal type)
        2. Auto / manual selector switch (maintained contact type)
        3. Tap position indicator
        4. 

Supply failure

Drive motor auto tripped Tap change delayed

* + - * 1. Necessary auxiliary relays
        2. Lamp indications for:

Tap change in progress Lower limit reached Upper limit reached

* + - * 1. Cable glands for power and control cables
        2. 240 V rated panel space heater with ON-OFF switch
        3. Fluorescent type interior lighting fixture with lamp and door switch
        4. HRC fuses
        5. Terminal blocks
        6. Internal wiring
        7. Earthing terminal

# Fittings and accessories:

The following fittings and accessories shall be provided with transformer:

* + - 1. Inspection manhole in the cover
      2. Lifting lugs for both the transformer and the core
      3. Two earthing terminals on opposite ends of the transformer tank
      4. Name plate, rating plate and diagram plate
      5. Detachable radiator banks, complete with top and bottom shut-off valves, air release plug, drain valve and lifting lugs, suitably located thermometer pockets for measuring inlet and outlet oil temperature and one grounding terminal for connection of grounding conductor. Fins of the radiators shall not have sharp edges but shall be rounded shape.
      6. Conservator, complete with filling plug, sump and drain valve, and a shut-off valve on the pipe connection between transformer tank and conservator, to permit removal of the conservator. The conservator shall be designed to maintain an oil seal through a temperature range of 100 degree C.
      7. Oil level indicator with minimum marking.
      8. Weather proof dehydrating breather with activated alumina or silicagel as the dehydrating agent.
      9. Magnetic type oil level gauge with low oil level alarm contact, mounted on the conservators with waterproof and dustproof terminal box.
      10. Gas detector relays with separate alarm and trip contacts complete with shut-off valves.
      11. Separate drain valve, oil sampling valve with plug and top filter valve shall be provided on the tank.
      12. Explosion vent with diaphragm for relieving pressure inside the transformer. The device shall be rain proof after operation. For transformers of 500 KVA and above an equaliser pipe connecting the pressure relief device to the conservator shall be supplied.
      13. Separately mounted, water proof and dustproof marshalling box housing the oil temperature indicator and winding temperature indicator with alarm and trip contacts and marshalling facilities for electrical devices mounted on transformer.
      14. For transformers rated 500 KVA and above, adequate number of air vents for reliving trapped air during oil filling and during maintenance.
      15. Thermometer pockets and sensing element mounted on the transformer tank cover for measuring top oil temperature.
      16. Four jacking pads for lifting the transformer with jacks.
      17. Pulling eyes and skids for the movement of the transformers.
      18. Bi-directional wheels for movement of the transformers.
      19. Accessories for clamping the wheel mounted transformer to the foundation in order to withstand earthquake forces with a seismic acceleration of 0.2 g.
      20. Noise level of transformers shall be less than 80 dB.
      21. Transformer shall be supplied complete with insulating oil required for first filling plus 10% excess oil.

# Drawings and data



* + - 1. General outline drawing with binding dimensions and weights shall be submitted during design and detailed engineering stage.
      2. General outline drawings showing plan, front elevation, and side elevation, with all fittings and accessories, locating dimensions of cable entries, earthing terminals, foundation / floor fixing details, jacking pads and weights of the following. :

OLTC (Local and Remote) cabinets Marshalling box

Cable boxes Disconnecting chambers

* + - 1. Cable junction box details, mounting details, make and type number, current and voltage rating, creep age distances and principal characteristics.
      2. Rating and diagram plates
      3. OLTC cabinets: schematic circuit diagram and actual detailed wiring diagram giving terminal numbers within 5 months of award of Contract.
      4. Marshalling box terminal connections wiring diagram.

# Guaranteed Technical particulars for Transformer

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **requirement** | **Offered parameter / value (to be filled in by the Concessionaire during Design and Detailed Engineering**  **stage)** |
| 1 | Make |  |  |
| 2 | Service | Outdoor |  |
| 3 | Rating | As per requirement of  individual facility in KVA |  |
| **4** | **Rated Voltage** |  |  |
| a | HV winding | 11,000 V |  |
| b | LV winding | 433 V |  |
| 5 | Number of Phases | 3 phase |  |
| 6 | Rated Frequency | 50 Hz |  |
| 7 | Vector group | DYn 11 |  |
| 8 | Type of cooling | ONAN |  |
| **9** | **Tapings :** | **on 11 kV side** |  |
| a | Range | + 5%, to 15% |  |
| b | Number of steps | 8 steps 9 position |  |
| c | Losses at 75° C & Principal tapping | As per IS 1180 |  |
| 10 | No load loss at rate voltage and  frequency | As per IS 1180 |  |
| 11 | Load losses at rated current | As per IS 1180 |  |
| 12 | Total loss at maximum rated power | As per IS 1180 |  |
| **13** | **Impedance voltage at 75° C** |  |  |
| A | At principle tapping |  |  |
| B | At Maximum tapping |  |  |
| C | At minimum tapping |  |  |
| 14 | Hottest spot temperature in winding limit |  |  |
| **15** | **Efficiency at 75° C and 0.9 PF** |  |  |
| A | At full load | As per IS 1180 |  |
| B | At 75 % load | As per IS 1180 |  |
| C | At 50 % load | As per IS 1180 |  |
| 16 | Maximum efficiency | As per IS 1180 |  |
| **17** | **Maximum current density at rated power** |  |  |
| A | HV winding |  |  |
| B | LV winding |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **requirement** | **Offered parameter / value (to be filled in by the Concessionaire during Design and Detailed Engineering**  **stage)** |
| **18** | **Maximum flux density in iron at rated voltage & Frequency** |  |  |
| A | At 100 % rated voltage |  |  |
| B | At 110 % rated voltage |  |  |
| **19** | **Maximum clearances in air** |  |  |
| A | Between phases (HV / LV ) |  |  |
| B | Between phases & earth |  |  |
| **20** | **Insulation level** |  |  |
| A | Impulse |  |  |
| B | HV |  |  |
| C | LV |  |  |
| **21** | **Power frequency** |  |  |
| A | HV |  |  |
| B | LV |  |  |
| **22** | **Winding type** |  |  |
| A | HV winding |  |  |
| B | LV winding |  |  |
| **23** | **Details of core** |  |  |
| A | Core lamination material |  |  |
| B | Insulation of lamination |  |  |
| C | Thickness of lamination |  |  |
| D | Type |  |  |
| E | Specific loss of core steel at 1.5  tesla |  |  |
| **24** | **Details of tank** |  |  |
| A | Material |  |  |
| B | Thickness of side |  |  |
| C | Thickness of bottom |  |  |
| D | Thickness of cover |  |  |
| E | Thickness of tube |  |  |
| F | Maximum internal pressure withstanding capacity of the tank |  |  |
| G | Details of Radiator |  |  |
| H | No. of Radiator tanks |  |  |
| I | Thickness of radiator plate |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **requirement** | **Offered parameter / value (to be filled in by the Concessionaire during Design and Detailed Engineering**  **stage)** |
| J | Weight of each radiator tank |  |  |
| K | Cooling surface area |  |  |
| L | Volume of conservator |  |  |
| M | Total oil required |  |  |
| N | Whether first filling of oil with 10%  excess furnished | Required |  |
| **25** | **Details of bushing** |  |  |
| A | Type |  |  |
| b | Voltage class |  |  |
| c | Creep age distance |  |  |
| d | Weight of bushing |  |  |
| e | Current rating |  |  |
| f | Insulation level |  |  |
| g | Impulse |  |  |
| h | Power frequency dry KV |  |  |
| i | Power frequency wet |  |  |
| j | Length of insulator |  |  |
| k | loss angle at working voltage |  |  |
| **26** | **Explosion vent material** |  |  |
| A | Thickness |  |  |
| B | Maximum rupturing pressure of the  diaphragm |  |  |
| **27** | **Tank pressure test** |  |  |
| A | Pressure |  |  |
| B | Duration |  |  |
| C | Tank vacuum test |  |  |
| D | Pressure |  |  |
| E | Duration |  |  |
| 28 | Maximum noise level |  |  |
| **29** | **Overall dimensions including**  **coolers** & **fittings** |  |  |
| A | Height |  |  |
| B | Breadth |  |  |
| C | Length |  |  |
| C | Crane lift for dismantling core and  coil assembly |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **requirement** | **Offered parameter / value (to be filled in by the Concessionaire during Design and Detailed Engineering**  **stage)** |
| D | Weight of core & winding |  |  |
| E | Tank & Fittings weight |  |  |
| F | Oil weight |  |  |
| G | Total weight including radiator,  OLTC, and oil |  |  |



* 1. **MV Panel Board / Switch Board construction**

All MV and LV panel boards / switch boards, unless and mentioned otherwise, shall meet the following requirements.

|  |  |  |
| --- | --- | --- |
| Type | : | Floor mounting, free standing, single front, fully compartmentalized, totally enclosed, dust & vermin proof, modular in construction & fully  extensible on either sides |
| Conforming to | : | IEC 60439 |
| Construction | : | 2.00 mm thick for frames and other load bearing members  1.6 mm thick for doors and partitions  3.0 mm for gland plates & of non-metallic construction for termination of single core armoured cables |
| Form of separation | : | Form 3 B |
| Bus bar configuration, MOC, busbar supports, busbar insulation, busbar compartments, cable alley and feeder compartments | : | TPN bus bars with 50% neutral for all applications not involving harmonic loads and with 100 % neutral for loads with harmonics.  Risers (vertical busbars) shall have a continuous current rating at least 125% of combined feeder ratings of the particular vertical section.  Completely enclosed busbar compartment running horizontally at the top / bottom as per actual panel configuration  Completely enclosed compartments for vertical busbars. Individual feeder modules in multi-tier modular formation.  Vertical cable alleys with removable gland plates at the bottom/ top Busbar supports- Non-hygroscopic / SMC/ DMC supports with anti- tracking design and strength to withstand the dynamic forces during short circuit current of appropriate value  Busbar insulation 1.1 kV grade Heat shrinkable colour coded  Busbar connections- by using cadmium plated high tensile hardware |
| Bus bar MOC and sizing | : | MOC High conductivity, high strength Aluminium alloy  complying to requirements of Grade E 91E of IS 5082 (or) E.C |

|  |  |  |
| --- | --- | --- |
|  |  | grade copper  All bus bars to be dimensioned considering the maximum  permissible rise in temperature of 50 Degrees over ambient temperature under normal operating conditions. |
| Earth bus | : | Continuous Aluminium strip of adequate cross section to carry the fault current to be run inside each shipping section.  All compartment doors to be provided with insulated earth  continuity conductors / jumper wires |
| Panel height, door and shipping sections |  | Panel height shall generally not exceed 2100 mm including the bottom mounting channel.  The operating handle of the switchgear at the top most tier shall be not more than 1800 mm from FFL.  The operating handle of the switchgear at the lower most tier shall be not less than 300 mm from FFL  Panel doors (Front) Hinged Panel doors (rear) Bolted  Bus bar chamber and cable chamber doors Bolted Gaskets Continuous type of neoprene  Locks Each compartment shall be with interlock to ensure that the doors do not open with switch ON. Interlock defeat also required to be provided  All switchgear compartments to be suitable for LOTO arrangement. The panel shall generally be made in sections not exceeding 2.50  mtrs long for ease of handling and movement inside panel rooms. |
| Degree of protection |  | IP 42 for indoor panels  IP 54 for panels meant for use in dusty and humid operating environment  IP 65 for outdoor panels |
| Finish |  | Powder coat finished as per IS 3618. |
| Cable termination |  | From top / bottom as per data sheet.  Shall be suitable for terminating the number of cable runs and the type of cable as per SLD / data sheet. |
| Wiring |  | All control wiring (Other than CT circuit) to be done using 1.5 Sq.mm PVC insulated wires  All CT wiring shall be not less than 2.5 Sq.mm PVC insulated wires |
| Meters |  | All MFMs / Ammeters / Voltmeters and other meters as called for in the SLD shall be suitable for flush mounting type on panel compartment doors and shall be digital versions with RS 485  communication feature. |
| Relays |  | Shall be as per SLD /data sheet |



|  |  |  |
| --- | --- | --- |
| Control Supply |  | Shall be derived using 415 / 110 V AC control transformer and with  MCB protection on both primary and secondary side of the control transformer. |
| Space Heaters |  | All bus bar compartments shall be provided with space heater to prevent moisture condensation and maintain cubicle temperature 5 degree C above the ambient. The space heaters shall be located suitably and shall be controlled through thermostats with suitable  setting with MCB. |
| Indication lamps |  | LED cluster type. The lamps shall have red, green, amber, Blue and white caps as applicable made out of temperature resistant prismatic glass. The lamp holders and caps shall be guaranteed for continuous  operation of lamps without any damage. |
| Control switches / Push  button actuators |  | Control and instrument selector switches shall be rotary type provided with escutcheon plates clearly marked to show operating position and suitable for semi-flush mounting with only the switch joint plate and operating handle projecting out. The connection shall  be from the back. |
| Legend plates / name  plates / warning boards |  | Each compartment of the PANEL / MDB / PDB / MCC/ PMCC shall be provided with a nameplate engraved with its designation. The nameplates shall be rear engraved perspex with white letters on black background. The name plate shall also indicate the rating of the switchgear, the equipment fed and its rated power (in kw or hp) Metallic nameplate shall be provided on any one side of the panel / switch board duly indicating as a minimum the name of the panel vendor, the P.O No. & date, the month & year of installation, Warning stickers with danger signage & text in trilingual (English / Hindi and Local language) red letters on white background shall be  provided at appropriate locations. |
| Mimic display |  | The panel front facia shall be provided with mimic key SLD (either  red painted or with red sticker) |



# Control and switchgear specifications

All control gear and switchgear shall be ROHS compliant

All control and switchgear, unless and mentioned otherwise, shall meet the following requirements.

|  |  |  |
| --- | --- | --- |
| ACB | : | EDO type |
| Pole configuration | : | As per equipment requirement |
| Breaking Capacity | : | As per system requirements |
| Protection type | : | O/L, S/C and E/F |

|  |  |  |
| --- | --- | --- |
| Accessories | : | UV, Earth Fault and Shunt release (two of the accessories as per  data sheet) |
| Auxiliary contacts | : | 2 NO and 2 NC minimum |

|  |  |  |
| --- | --- | --- |
| MCCB | : | Panel internal mounted with door mounted rotary handle operated  type |
| Pole configuration | : | As per equipment requirement |
| Breaking Capacity | : | As per system requirements |
| Protection type | : | Thermal magnetic up to 250 Amps  Microprocessor based for ratings 250 Amps and above |
| Cable termination | : | All MCCBs for terminating cables above 35 Sq.mm shall be with  spreader links |
| Accessories | : | UV, Earth Fault & Shunt release (two of the accessories as per data  sheet) |
| Auxiliary contacts | : | 2 NO and 2 NC minimum |

|  |  |  |
| --- | --- | --- |
| MCB | : | DIN rail mounted with dolly handle operated type |
| Pole configuration | : | As per requirement at individual facility |
| Breaking Capacity | : | As per requirement at individual facility |
| Protection | : | O/L & S/C |
| Cable termination | : | All MCBs for terminating cables above 16 Sq.mm shall be with  spreader links |
| Fault Level | : | 10 kA for MCBs rated more than 25 Amps |

|  |  |  |
| --- | --- | --- |
| Motor Starter  component rating | : | Based on Type -2 co-ordination charts |
| Motor starter type | : | Upto and including 10 HP DOL  Above 10 HP and upto and including 30 HP Star Delta starting Above 30 HP and upto and including 50 HP Soft start  Above 50 HP VFD |
| Additional protection | : | Current sensing type single phase and phase reversal protection |
| Metering and CT | : | For motors upto 10 HP CT shall be provided in the centre phase complete with ammeter. For motors above 10 HP CT shall be provided  in all three phases complete with ammeter and ammeter selector switch |
| Cable termination | : | All terminations for cables above 16 Sq.mm shall be with spreader  links |

***Note: Apart from the above guidelines, the concessionaire shall consider VFD for various applications irrespective of their rating wherever the process / application warrants provision of such variable speed requirements.***

# Soft starters for LV motors

The soft starters shall comply with the requirements of IEC 60034, 60947 and IS 325 including those standards referred to therein.

Constructional and performance features

Motor soft starters shall be switched or electronic type.

Soft starter panel shall be indoor, metal clad with separate metal enclosed compartments for

* + - 1. control, metering and current transformers for differential protection, if specified
      2. shorting (bypass) arrangement
      3. bus bars
      4. power cable terminations
      5. push buttons with indicating lamps.

Soft starter shall achieve smooth starting by torque control for gradual acceleration of the drive thus preventing jerks and extending the life of equipment.

Starting current shall be limited to 2.5 to 3 times the rated current of the motor. The soft starter manufacturer shall co-ordinate with motor manufacturer for this purpose.

Separate removable gland plates shall be provided for power and control cables.

Each cubicle shall be fitted with a label in the front and rear of the cubicle, indicating the panel designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate labels.

Necessary wiring diagram shall be provided considering starting interlock, trip circuit, starting and running mode signal.

It shall be possible to manually start the motor locally from the starter panel or in Auto mode through PLC.

# Variable Frequency Drives (VFD)

AC induction motor in clear water pumping station for rural distribution shall be coupled with a Frequency drive of rating commensurate with the rated motor.

The Frequency drives shall be of Current Source Inverter Pulse Width Modulated (CSIPWM) with GTO/IGBT/IGCT/SGCT/DTC technologies or later version, which performs precise speed and torque control of standard squirrel cage motors with optimum efficiency. Each drive must have a soft starting feature and a by pass arrangement for DOL starting of motors. All frequency dives shall be suitable for data connectivity with PLC/SCADA system and shall have Ethernet TCP/IPsuitable communication 99 port and protocol. The drives must be easily programmable. The drives shall be provided with surge protection, programmable lockable code. The Frequency drive shall have following characteristics:

Accurate open loop torque control

Torque step rise time typically less than 5 ms

Speed control inaccuracy typically 0.1% to 0.5% of nominal speed 150% overload capacity for 60 second

Total Harmonic distortion shall comply with the provisions of IEEE 519. Necessary metering, self-diagnostic arrangement (including display and alarm facilities) shall be provided for local/ remote monitoring.

Technical Parameters

Main connection

Voltage : 3 phase, 415 +/- 10 % permitted tolerance Frequency : 45 to 65 Hz, maximum rate of change 17%/s

Imbalance : Max. +/- 3% of nominal phase to phase input voltage Fundamental Power factor : 0.97 (at nominal load)

Motor connection

Voltage : 3 phase, from 0 to applied incoming supply voltage, 3-phase symmetrical

Output Frequency : 0 to 250 Hz Frequency Resolution : 0.01 Hz

Continuous Current : 1.0 \* I2N(normal use)

Short Term Overload Capacity (1min./10min)

: I2max = 1.1 \* I2N

Field Weakening point : 8 to 300 Hz Acceleration Time : 0 to 1800 sec Deceleration Time : 0 to 1800 sec

Efficiency : Min. 97% at nominal power level Environment limits

Ambient temperature : 0 to 45 deg. Cent.

General Standard Control Connections or as per Process Requirement

3 programmable differential analogue inputs (1 voltage signal, 2 current signals) 7 programmable digital inputs

2 programmables analogues outputs (current signal) 3 programmable digital outputs (from C relays)

Power Torque Speed value must be configurable to the etherrnet tcp/ip port for their remote data acquisition in PLC/ SCADA. Optional analogue and digital extension modules can be added as well as a wide range of field bus adapters.

Protection

Over current

Short circuit at start-up Input phase loss

Output phase loss Motor overload Earth fault Overvoltage Undervoltage Over temperature Motor stall

Application macros

The features a selection of built-in, pre-programmed application macros for configuration of inputs, outputs, signal processing and other parameters. It shall have interfacing facilities to communicate data to SCADA system. These include:

FACTORY SETTING for basic industrial applications HAND/AUTO CONTROL for local and remote operation PID CONTROL for closed loop processes

TORQUE CONTROL for process where torque control is required. SEQUENTIAL CONTROL for processes where torque control is required.

Comprehensive testing and diagnostic function

Tests

Each unit of Variable freq the motor they have been assigned to work for at the STP(s)/FSTP(s)

Test result must satisfy the efficiencies on various loads and at different frequency levels against their quoted values.

|  |  |  |
| --- | --- | --- |
| Contactor | : | Air break |
| Pole configuration | : | Three pole / Four Pole as per data sheet |
| Auxiliary contacts | : | 2 NO + 2 NC |
| Utilisation category | : | As per data sheet |

|  |  |  |
| --- | --- | --- |
| CT | : | Cast resin type |
| Ratio, class & Burden | : | As per SLD / Data sheet |
| Insulation class | : | 1.1 kV |

|  |  |  |
| --- | --- | --- |
| Control Transformer | : | Cast resin type |
| Voltage Ration | : | 415 / 110 V AC |
| Insulation class | : | 1.1 kV |
| Rating | : | 1000 VA |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Capacitor** |  |  | | | |
| Type | : | Dry type, Mixed Di-electric  capacity conforming to IS 13340. | versions | with | self-healing |
| Voltage | : | 220 Volts to 575 Volts based on application | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Push button Actuators** | | | | | | |
| Type | : | Panel door mounted shrouded  Mushroom type for STOP / RESET | type | for | START | and |
| Contact ratings | : | 6 Amps | | | | |

# 1.1 kV XLPE cable

* + 1. **Scope**

This part of the specification covers the requirements of design, manufacture, inspection, testing and supply at site of 1.1 kV grade XLPE power and control cables.

# Standards

The 1.1 kV grade Power & Control Cables conform to the requirements of the latest Indian Standard Specifications including but not limited to the following:

|  |  |  |
| --- | --- | --- |
| IS 7098 | : | Cross-linked polyethylene insulated PVC sheathed cables |
| IS 3975 | : | Mild steel wires, strips and tapes for armouring of cables |
| IS 10418: 1982 | : | Drums for electric cables. |
| IS 10810 | : | Methods of test for cables |
| IS 1554 (Part I) | : | PVC Cables for voltage up to and including 1100 volts |
| IS 8130 | : | Conductors for insulated electric cables |
| IS 5831 | : | PVC insulation and sheath of electric cables |
| IS 3975 | : | Mild steel wires, strips and tapes for armouring of cables |

# General construction

The cables shall be suitable for laying in trays, trenches, ducts, conduits and buried underground installation with uncontrolled backfill and possibility of flooding by water. These shall have following constructional features.

All power and control cables for use on low voltage system shall be heavy of 1100 V grade with aluminium / copper conductor, XLPE insulated, PVC inner sheathed, armoured and overall PVC sheathed.

The construction of the conductors shall be SOLID for aluminium conductor cables up to 10 mm sq. and for copper conductor cables up to 2.5 mm sq. For cables above 10 mm sq. and for copper cables above 2.5 mm sq. the conductor shall be STRANDED. Conductors of nominal cross sectional area less than 10 sq.mm shall be circular only. Conductors of nominal cross

section area 16 sq.mm and above may be circular or sector shaped.

The core insulation shall be with XLPE applied over the conductor by extrusion and shall conform to the IS 7098. Control cables having 6 cores & above shall be identified with prominent & indelible numerals on the outer surface of the insulation. Colour of the numbers shall be white with a spacing of maximum 500 mm between two consecutive numbers.

The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC conforming to the requirements of type ST2 PVC compound per IS 5831. The extruded inner sheath shall be of uniform thickness of size not less than 0.5 mm up to 16 sq.mm, 0.8 mm from 25 sq.mm upto 120 sq.mm and 1.0 mm above 120 sq.mm conductor size. Taped inner sheath shall also be acceptable.

For multi core cables, the armouring shall be by single round galvanized steel wires where the calculated diameter below armouring does not exceed 13 mm and galvanized steel strips where this dimension is greater than 13 mm. Requirement and methods of tests for armour material and uniformity of galvanization shall be as per IS 3975 and IS 2611.

The outer sheath for the cables shall be applied by extrusion and shall be of PVC compound and conforming to the requirements of type ST 2 compound per IS 5831. To protect the cables against rodent and termite attack, suitable chemicals shall be added into the PVC compound of the outer sheath.

The dimensions of the insulation, armour and outer sheath materials shall be governed by values given in IS 1554 (Part I).

# Packing

The cables shall be supplied in standard drum lengths duly wound on non-returnable wooden drums.

Vendor shall ensure that the bending radii of cables are not less than 12 times their overall diameters when wound on drums. Both ends of the cables shall be sealed.

Following information shall be printed on the flange of each cable drum.

* + - 1. Type
      2. Size
      3. Voltage grade
      4. Length in meters
      5. ISI Mark
      6. Gross weight
      7. Direction of rolling

# Specification for power / lighting distribution boards

* + 1. **Scope**

This part of the specification covers the requirements of design, manufacture, assembly, inspection, testing and delivery at site of Power/ Lighting Distribution Boards / Panels.

# Standards

The Power / Lighting Distribution Boards shall conform to the requirements of the latest Indian Standard Specifications including but not limited to the following:

IS 13947 : Low Voltage Switchgear and Control gear

IS 11353 : Guide for Uniform System of marking and identification of conductors and apparatus

IS 2705 : Current Transformers

IS 8623 : Low voltage switchgear and control gear assemblies

IS 4237 : General requirements for switchgear and Control gear for voltages not exceeding 1000 V

IS 13032 : Miniature air-break circuit breakers for voltages not exceeding 1000 V

IS 13947 : Switches, disconnectors, air break Switch (Part 3) disconnectors and fuse combination units

IS 13703 : LV Fuses for voltages not exceeding 1000 V ac or 1500 V dc Part 1 General requirements

IS 1248 : Direct acting electrical instruments

IS 722 : AC Electricity Meters

# Construction & component specification

The boards shall be sheet steel enclosed on all sides and shall be dust and vermin proof, providing a degree of protection equivalent to IP 54. The sheet steel used shall be 14/16 Gauge CRCA.

The distribution boards shall be provided with hinged doors for access to components. Doors shall be provided with gasket all around with neoprene gaskets.

The Power Distribution Boards (PDBs) / Lighting DB, shall be suitable for wall mounting. Cable entries to these boards for incoming as well as outgoing cables shall be from the Top The bus bars of Power Distribution Boards (PDBs) / Lighting DB shall be of electrical grade Copper of adequate size. These shall be supported on SMC/ DMC/ Epoxy non-hygroscopic supports at suitable intervals to withstand the thermal and dynamic stresses developed due to short circuit current of 10KA for Power DBs & Lighting DB.

Internal Earth bus of adequate size of copper flat shall be provided extending through the entire length of the boards

# Earth Leakage Circuit Breakers (ELCBs)

The ELCBs shall be designed to operate within 30 milliseconds to provide effective protection against electrocution risks and fires caused by earth leakage faults of 30 mA and above. All parts of the switching mechanism shall be of non-corroding self-lubricating material thus providing consistent and trouble free services. These shall have short circuit withstand capacity of 10 KA.

# Miniature Circuit Breakers

These shall be hand operated type. The miniature circuit breaker shall incorporate thermal overload and magnetic short circuit tripping devices. These shall have short circuit withstand capacity of 10 KA.

Provide    corridor lights, night lights and other circuits requiring continuous supply.

Provide a neatly typed directory on each panel, listing the locations of devices and equipment served by each circuit, mounted on the inside of the front cover in a frame with hard transparent shield.

# Internal wiring

The boards/ panels shall be supplied completely wired, ready for the external connections at the terminal blocks. Wiring shall be carried out with 1100V grade PVC insulated, stranded copper conductor of adequate size (min. 2.5 mm sq.) Identification ferrules shall be provided to correspond with wiring diagrams. All wiring shall be terminated on terminal block. Terminals of Power Distribution Boards / Lighting DB shall covered terminals.

# Painting

Sheet metal work of the Boards / Panels shall undergo a thorough surface treatment comprising rust removal, degreasing, pickling and phosphating prior to painting. The pre-treated boards/ panels shall be painted / Powder coated with two coats of suitable primer and finished with two coats of Power coated of approved shade as per IS-5.

# Specification for cable carrier / cable containment system and accessories

* + 1. **Scope**

This part of the specification covers the requirements of design, manufacture, assembly, inspection, testing and delivery at site of cable carrier / cable containment system with accessories.

# Standards

The Cable carrier system with accessories shall conform to the requirements of the latest Indian Standard Specifications including but not limited to the following:

IS 513 : Cold rolled low carbon steel and strips

IS 1079 : Hot rolled carbon steel and strips.

IS 2629 : Recommended practice for hot dip galvanizing

IS 2611 : Methods for testing uniformity of coating of Zinc coated articles IS 1367 : Technical supply conditions for threaded steel fasteners.

IS 1663 : Method for tensile testing of steel sheet & strip of thickness 0.5 mm to 3 mm

# Construction

Cable carries, fittings and accessories shall be fabricated out of rolled Mild Sheel sheets free from flaws such as laminations, rolling marks, pitting etc. conforming relevant codes.

Minimum thickness of Mild Steel sheets used for fabrication of cable carries and fittings shall be 1.60 mm up to 450 mm wide trays and 2.0 mm above 450 mm wide trays. The thickness of side coupler plates shall be minimum 3 mm.

All accessories like bends, reducers, tees, crosses coupler plates, etc., shall be pre-fabricated and not fabricated at site.

Structural supports shall be made out of Mild steel with hot dip galvanized of adequate size and load carrying capacity.

Structural supports shall be located appropriately and the distance between any two supports shall not be more than 1500 mm.

In RCC trenches, the cable carriers shall be of cantilever construction and erected with anchor fasteners / insert plate with adequate load carrying capacity. Fittings like bends, reducers, tees, crosses, etc. accessories like side coupler plates etc. and hardware GI bolts, nuts, springs, washers as may be required shall be treated as part of the supply item.

In masonry brick work the cable carrier support shall be grouted adequately with appropriate supports using cement mortar.

In vertical sections the cable carriers shall be of ladder / perforated construction with one or multi tiers complete with matching fittings like bends, reducers, tees, crosses etc., accessories like side coupler plat etc. and hardware GI bolts, nuts, springs, washers, etc. as may be required.

The standard length of each size and type of cable tray / ladder shall be not more than 2.5 metre.

# Support system for cable carriers

The support system shall be fabricated from standard structural steel members. The cable carriers and support system shall be hot dip galvanised

# Galvanizing

Galvanising of steel components and accessories shall conform to relevant code The galvanising shall be uniform, clean, smooth, continuous and free from spots. Should the galvanizing of the samples be found defective, the entire batch steel shall have to be re- galvanised at Concessionaire's cost after pickling.

The amount of zinc deposit over threaded portion of bolts, nuts, screws a washers shall be as per relevant codes. The removal of extra zinc on threaded portion of components shall be carefully done to ensure that the threads have the required zinc coating on them.

The hot dip galvanized thickness shall not be less than 80 micron thickness.

# Section G5.2

**Technical specification for Diesel generator set**

# Section G5.2: Technical specification for Diesel generator set

1. **General**

# Scope of work

This specification covers the technical requirements and essential particulars for the Design, manufacture, supply, inspection, testing and commissioning of adequate size of Diesel Generator systems as covered in the specification documents and drawings. The Concessionaire shall demonstrate that the DG set satisfies the requirements of the specification and applicable codes

# Diesel Generator

* 1. **Applicable codes and standards**
     1. The DG set shall conform to the latest editions of the codes and standards listed under Clause
     2. below & other applicable standards. Nothing in this specification shall be construed to relieve the Concessionaire of this responsibility.

**2.1.2** The applicable Indian standards and codes shall be followed wherever applicable for the DG set. In all cases, the latest revision of the standards shall be referred to. In the event of conflict between any of these Specifications and the Codes referred, such specifications shall be defined, prepared by the Concessionaire and submitted to the Project Engineer for approval. The decis ion of Project Engineer in such case shall be final and binding on the Concessionaire. The following standards, unless otherwise specified herein, shall be referred to.

|  |  |
| --- | --- |
| IEC 34 | Rotating electrical machines |
| BS 5000 | Part 3 Reciprocating IC engines: Performance |
| IS 10002 | Performance requirements of Diesel Engines |
| IS 10000 (OR) Equivalent BS code | Method of tests for IC engines |
| BS 5514 / (ISP 3046) | Reciprocating internal combustion engines performance standard reference conditions, declarations of power, fuel and  lubricating oil consumptions and test methods |
| IS : 2147 | Degree of protection provided by enclosure for low voltage  switchgear and control gear |
| IS : 4722 | Rotating Electrical Machines |
| IS : 3043 | Code of practice for earthing |
| IS 8623 | Low voltage switchgear & control gear assemblies |
| IS 5578 | Marking of insulated conductors |
| IS 11353 | Uniform system of marking & identification of conductors  and apparatus |
| IS 2705 | Current Transformers |
| IS 7098 | Cross linked polyethylene insulated (XLPE) PVC sheathed |

|  |  |
| --- | --- |
|  | cables, Part 1: For working voltage up to and including 1100  V |
| IS 3156 | Voltage transformers |
| IS 5082 | Material data for aluminium bus bar |
| IS 1248 | Direct acting electrical indicating instruments |
| IS 9224 | Fuses with high breaking capacity |
| IS 13947 | Low voltage switchgear & control gear |
| IS 13364 | Specification for ac generators driven by Part 2,  reciprocating internal combustion engine rated above 20 kVA and up to 1250 kVA |
| IS 3231 | Specification for electrical relays for power system  protection |
| IS 8686 | Specification for static protective relays |
| IS/ IEC 60947 | Low-voltage switchgear and control gear |

# Construction & component specification

* 1. **Diesel Engine**
     1. The diesel engines shall be approved make, suitable for Prime power rating, direct injection, four stroke, multi cylinder, water cooled through base mounted radiator, turbo charged, water cooled type operating, acoustic enclosure & capable of developing requisite BHP rating to drive the Alternator
     2. The engine shall be designed to operate at 50° C ambient temperature without any de - rating factor
     3. The engine & the governing system shall conform to class -A1 governing as per BS 5514 and shall be suitable for Prime power rating generating application. The unit shall be suitable for operation on High Speed Diesel Oil without any modifications.
     4. The governing system of the engine shall be of the microprocessor based e lectronic type suitable to control frequency variation within +/-4% for a sudden load change up to 70% The governor shall ensure that the speed of the set is regulated within 1% of the nominal speed under normal operating conditions
     5. The engine shall be electric start and shall be suitable for battery assisted manual / auto

/ SCADA system starting. The design shall ensure that the starter will be automatically released when the engine picks up speed beyond 60% of the rated speed.

* + 1. All moving parts of the engine and other associated equipment shall be provided with guards to prevent accidental contact. The guard shall be designed to facilitate easy removal and reinstallation
    2. The engine fitments shall include but not be limited to the following: -
       1. Flexible coupling and flywheel with guard
       2. Air inlet system with Dry type air filter with clogged condition indicator & turbo charger
       3. Fuel system complete with Fuel Pump, flexible hoses, primary & secondary fuel filters with service indicator and manual priming pump.
       4. Exhaust system with dry manifold and residential silencer.
       5. Lube oil system with gear type oil pump, oil cooler, filter and crank case heater.
       6. Cooling system with engine coolant belt, fan, guard, radiator & low coolant level switch.
       7. 24V D.C. Starter and battery charging alternator with auto cut off.
       8. Acoustic enclosure suitable for outdoor operation

# Alternator

* 1. The Alternator shall be industrial type, 1500 RPM, 415V, 3 Phase, neutral, 50Hz, adequate size of DG set in KVA, 0.8PF, star connected, IP -23, horizontal foot mounted, continuous duty suitable for prime power alternator, double bearing, self -excited, self- regulated, brushless excitation machine with exciter and automatic voltage regulator (AVR). The exciter shall be rotating diode type and Class 'H' in sulated. The exciter shall be capable of forcing the field for 3 seconds (or duration as specified in the data sheet) in the event of short circuit fault at generator terminal. The exciter should be capable of building up voltage from residual magnetism, protection against low speed operation & high motor starting capability. The rectifier shall have in built protection for over voltage and rate of rise of voltage. The generator shall have on line greasing facility with grease nipple & relief device. All other parameters shall be as specified in the data sheet and conforming to codes and standards specified in the data sheet or relevant standards.
  2. Continuous damper winding fitted on each pole.
  3. Thermistor for Hot spot detection with control unit for mount ing in the control panel.
  4. Terminal box with separately mounted adopter box having bus bars and flexible wiring between Alternator terminals and adopter box drawn in PVC covered metallic flexible conduit. The adopter box shall be suitable for terminating adequate size of 2 runs x 3½ core XLPE armoured Aluminium cable.
  5. The Alternator shall further meet the following specification.
  6. The alternator shall conform to IS 4722 / BS standards.
  7. The alternator shall be suitable for 20% over speed for two minutes.
  8. The alternator terminal volt age for any load variation should be maintained within +/ - 2%.
  9. The transient and steady state frequency variation should be limited to +/ -4% for sudden load variation upto 70%. The generator TVD for sudden load variation of 100 % shall not be more than 15%.
  10. Both ends of each phase winding shall be brought to the terminal box.
  11. The alternator shall be capable of carrying 50% overload for a duration of one minute and 10% overload for one hour in 12 hours operation.
  12. The alternator shall withstand a 3 phase short circuit at the terminals for a period of 3 seconds
  13. The total harmonic distortion shall not exceed 3% and the design shall permit up to 30% unbalance between phases while in operation
  14. The efficiency shall preferably not be less than 93% in the normal operating range of 50% to 100% loading

Driven equipment - adequate size as required

Output - adequate size as required

Terminal voltage - 415 volts under full load conditions

Frequency - 50 Hz

No. of Phases - Three

Power Factor - 0.8 lag

Stator Connection - Star

Excitation - Brushless

Coupling - Direct

Operating duty - Continuous Place of Installation - Outdoor

Class of Insulation - Class 'F'

Impedance - Confirming to IS

Voltage Regulation - + / - 2.5% voltage regulation for a load

variation of full load to no load at 0.80 lag power factor with AVR

Over Speed - All rotating part of alternator suitable for 120% over speed for two minutes

Excitation - AC Brushless static exciter of suitable voltage and of adequate capacity to meet

the excitation current of the alternator at full load at 0.80 power factor

# Acoustic enclosure

* 1. The acoustic enclosure shall be of free standing, floor -mounting type integral with the DG set.
  2. The enclosure shall be provided with rugged heavy-duty structural steel base frame with chequered plate flooring on which the DG set is to be mounted. The enclosure shall be prefabricated factory-built and modular in construction.
  3. The enclosure shall consist of acoustically treated panels housed in rugged steel frames, which shall be bolted together to from the body of the enclosure.
  4. Hinged doors shall be provided, on either side, which shall also be acoustically treated, thereby providing easy access to the DG set while minimizing the operating space requirements.
  5. The construction of the acoustic enclosure shall be such that with both the acoustic doors open on the either side, full access is available to the engine and alternator .
  6. Fresh air inlet into the system a parallel baffle air inlet silencer shall be provided. Additionally, to augment the fresh air inlet requirements, a forced air ventilation duct with associated silencer shall be provided above the alternator.
  7. For hot air discharge, an acoustic discharge plenum shall be provided in front of the engine radiator, for discharge of hot air into the surroundings through a parallel baffle air outlet silencer. The enclosure shall have suitable openings in the roof module for exhaust piping.
  8. The acoustic panels shall be filled with a special grade high -density mineral wool retained on the inside by perforated GI sheets specially designed for optimum sound attenuation.
  9. The outer surface of the Acoustic Panels shall be fabricated of performed 16 G

corrugated CRCA sheet steel.

* 1. All structural members such as angles / channels used in the construction of the enclosure frame.
  2. All materials used for Acoustic Enclosure shall be fire resistant / fire retardant grade.
  3. The sheet steel treatment shall consist of degreasing, de -rusting and phosphating followed by two coats of zinc chromate primer, followed by two coats of Zinpholite surface for superior corrosion resistance and two coats of finish paint.
  4. For effective Acoustic sealing, necessary gasket material shall be provided.
  5. All hardware and fittings used shall be passivated with zinc.
  6. With the above Enclosure, the sound pressure levels when measured at a distance of 1 meter outside the Acoustic Enclosure shall be confirming to the CPCB / Tamilnadu state Pollution control Board regulation.
  7. It shall be ensured that at least 1000 mm (min.) clear space is available all around the Acoustic Enclosure to ensure free airflow for the Gen -set as required and to facilitate accessibility for generator operation and routine maintenance.
  8. The enclosure shall be provided with suction fans to ensure that the adequate cooling and combustion air is made available to the engine and the temperature within the enclosure is limited to 5° C above ambient.
  9. The fan shall be designed with sufficient static to draw the requisite quality of air from the duct provided for this purpose. Calculations shall be furnished to prove the adequacy of the ventilation system offered. The suction fans shall start auto matically when the temperature in the enclosure reaches 40°C and shall continue to run for 5 to 10 minutes after the load is disconnected. A temperature controller shall be provided for this purpose housed in sheet steel enclosure.
  10. Two light points controlled by a switch complete with 36W fluorescent Luminaries and lamps shall be provided. Provision shall also be made for fixing a heat detector inside the acoustic enclosure, which will be connected to the central fire alarm panel.
  11. Necessary openings shall be made for the entry of power cable and control cables, fuel piping, exhaust piping, air inlet pipe etc.
  12. With the installation of the acoustic enclosure, there shall not be any de -rating of the DG set. The maximum temperature of oil and water shall not exceed the limits prescribed by the manufacturer of the engine. The DG set shall give rated output continuously.
  13. The ventilation system shall be designed to provide an adequate air volume whenever the DG set is in operation.
  14. The ventilation fan shall be of the axial flow type designed to handle the static pressure estimated based on the inlet air duct size and length.

# Instrument / Control Panel

6.1 

the following

1. Auto Start / Stop control
2. Local / Remote / SCADA control
3. MCCB / ACB for power control
4. MCB for Control wiring
5. Lube oil pressure
6. Coolant temperature
7. Low Coolant Level
8. High Coolant Temperature
9. Over Speed
10. Engine start / stop key switch.
11. D.C Voltage.
12. Engine RPM
13. Operating Hours Meter
14. Over / Under Voltage
15. Over Current
16. Safety cutouts for low lube oil pressure high coolant temperature, over speed, emergency stop, low coolant level and fail to start
17. Indications for the above safety cutouts
18. Alternator Voltage and Amperage of all 3 phases
19. Wiring harness using temperature resistant insulation and flexible copper conductor wires. The wiring should be clamped at regular intervals and terminated using lugs.
20. Stainless steel flexible for engine exhaust
21. Stop solenoid.
22. Panel illuminating lights
23. Emergency stop
24. DG set controller with RS 485 Communication / Equivalent port to communicate to SCADA system (supplied by others) to control / monitor critical and essential system.

# Accessories

* 1. The following accessories shall be supplied with the DG set

1. Common base frame for the Engine and Alternator
2. Anti-vibration mounts of reputed make in requisite quantity
3. Protective guards for all rotating parts
4. 18 G galvanized sheet steel trays beneath the engine, day tank and overflow collection tank to collect the oil leakage

# Batteries

* 1. The batteries shall be of heavy duty, high performance & rated for continuous duty.
  2. Each battery shall be rated 24 V. The number and AH capacity shall be selected to suit the engine requirements.
  3. Battery shall be suitable for six successive starting attempts each of 10 seconds duration with a gap of 5 seconds between successive starts.
  4. The battery shall be supplied complete with electrolyte and accessories. The accessories shall include battery stand, battery leads with terminal ends, acrylic top cover and inter battery connectors. First charging of the batteries shall be included.

# Control cabling

* 1. The cables shall comply with all currently applicable Indian Standards & IEC standards and the following specific standards and codes:
  2. Copper/Aluminium control cables - PVC / XLPE insulated, PVC sheathed 650/1100V grade as per IS: 1554-I & IS: 7098 - I. Overall shielding if required with Aluminium Mylar tape with 100% coverage & 25% overlap on laid up cores for stat ic noise reduction.
  3. Flexible, chord cables and wiring cables - PVC insulated & sheathed upto 1100V as per IS: 694, single and multi core.
  4. Coaxial cables - RG and UR series as specified and as per MIL-C-17 / Bs: 2316 / IS

5068/ Is 11967 and suitable for 50/75/100/125 ohms

* 1. Signal cables as per BS:5308, DIN VDE 0815 & 816, IS: 1554, IEC: 189
  2. Conductor shall be stranded / solid, circular / shaped - electrical grade aluminium / copper as per IS: 8130 and IEC: 60228 / BS: 6360.
  3. Cable Insulation as per IS: 5831 / IS: 7098 and BS: 6746 / BS: 5467 / IEC: 60502
  4. Inner sheath & outer sheath shall be PVC / HR PVC / PVC FRLS / PVC FR as per ST 1

/ ST 2 / IEC 754 Part1 / IEC 60332 Part I & III / IEEE-383 / ASTM 2843 & 2863, EIL

Specs etc.

* 1. Armouring shall be G.S round wire / Flat strip or Aluminium wire / Flat strip over the inner sheath as per IS 3975

# Receipt of material at site

All material loading, unloading, transportation, (shifting and storage, safe keeping) etc., is under the scope of DG vendor.

# Testing, commissioning, training and approvals

Testing and commissioning shall be carried out based on the specifications, data sheets, BOQ and the latest requirements of the various statutory authorities.

After installation as per the final approved drawing, the site testing shall be carried out by the vendor as specified before commissioning the DG set system. After testing the entire system to the satisfaction of the Executing Agency and their represents.

A thorough training of the operation and maintenance procedures etc as required or necessary

-

ups and manuals / catalogues as reference for a minimum period of three months after handing over.

The documents / drawings required for obtaining the approval / sanction from the Electrical inspector, State Electricity board, State regulatory authority, Factory inspector, Pollution control board, Regulatory authority, and any other statutory agency appointed for the purpose by the state

/ central / municipal / local bodies shall be prepared by the DG set supplier.

# Guarantee

The performance figures specified shall be guaranteed within the tolerance specified or as permitted by relevant standards. In case of failure of equipment to meet the guaranteed

performance, the Executing Agency reserves the right to reject the equipment. However, the Executing Agency also reserves the right to use the rejected equipment until new equipment meeting the guaranteed performance requirements is supplied by the vendor at no extra cost. If any equipment supplied by the vendor fails at site during erection, commissioning or service (within guarantee period), the vendor shall repair and put back into successful operation the failed equipment within the time frame and procedure of repair agreed with the Executing Agency depending on nature of failure at no extra cost to the purchaser. The guarantee period shall be as specified in the commercial terms and conditions.

# Bar chart / Network

The Concessionaire to indicate following schedules: Manufacturing, Inspection & Testing at works Shipping

Pre - commissioning / testing Commissioning

Service kits with all filters and other consumables

List of recommended spares for three years satisfactory operation.

# Documentation and drawing requirements:

The following documents, drawings etc shall be submitted by the Concessioanire: Data sheet / Compliance and guaranteed particulars statement.

DG layout plan showing all dimensions, including operational and maintenance clearances with sections as required. The plan should also indicate ventilation requirement, civil foundations, loading data, wall openings, etc. & generator earthing requirement

Schematic diagram of control panel with accessories like AVR, AMF, and auxiliary power distribution details etc., along with cable schedule.

Terminal box drawing, literature, write-ups, description of DG set excitation system, voltage regulator, governor, & other auxiliaries, catalogues / brochures etc.

Component list with rating & ranges of all items

Single line diagram for the whole system - control and power

Technical specification sheet with brochures / catalogues and operational details for:

DG sets

Acoustic enclosure or Room sound proofing

Detailed specification sheet for all auxiliary components giving material specifications, make/model, capacity, ratings etc.

# Testing



to the Executing Agency. The Executing Agency reserves the right to inspect the above tests or waive the inspection.

# Tests on engine

Engine starting time

4 hour running at full load followed by 1 hour running at 110 % of load Fuel consumption test:

One hour running at 100% load One hour running at 75% load One hour running at 50% load

# Testing arrangement

Arrangement for loading DG by: Vendor Fuel charges for site testing by: Vendor

# Shop tests

All the tests required by the manufactures practice or by applicable standard during the manufacture stage.

Performance tests on the assembled diesel generator set. (With Voltage regulator) Check of fuel consumption at different loads.

Measurement of Generator Winding Temperature after stabilized condition at 10 % overload.

Measurement of cooling water temperature of engine at 10% overload as above Measurement of vibration

Measurement of sound level at 1 Meter Level and 10 Meter distance Functional tests on fuel transfer pump.

Dielectric and insulation tests Routine test on voltage regulator

Hydrostatic Pressure test on both fuel tanks (at 2 Bars) Simulation of all protection

Simulation of mains failure and mains return

# Load tests at 0.8 Power Factor

* 2 Hour at 100 % rated load
* 1 Hour at 110 % rated load
* 1 Hour at 75 % rated load.
* 1 Hour at 50 % rated load.

Starting tests to show time of starting and load acceptance

# Inspection, operation, maintenance Manuals

The supplier shall submit along with the delivery and/or on commissioning - as applicable, the Type & Routine test certificates / Guarantee certificates, etc.

# Make of DG set

The concessionaire to decide and get approval from the Executing Agency

# Guaranteed technical particulars for DG SET

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Requirement** | **Vendor's**  **confirmation** |
| **1** | **DG Sets** |  |  |
|  | Rating of sets | adequate size as required |  |
|  | Manufacturer: |  | Vendor to specify |
|  | Model No. & Type: |  | Vendor to specify |
|  | Quantity | 1 Nos. |  |
|  | Application: | Standby power generation - suitable for continuous full / part  load operation |  |
|  | Anti-vibration mounting | Required | Vendor to specify |
|  | Sound proofing | **Acoustic enclosure** |  |
|  | Total static weight with enclosure |  | Vendor to specify |
|  | Total Dynamic weight with enclosure |  | Vendor to specify |
|  | Exhaust line with silencer & chimney | Required | Vendor to specify |
|  |  |  |  |
| 2 | **Engine** |  |  |
|  | Make |  |  |
|  | Model no.: |  | Vendor to specify |
|  | Name plate rating: |  | Vendor to specify |
|  | BHP: |  | Vendor to specify |
|  | Engine speed: |  | Vendor to specify |
|  | Method of starting: | Electric |  |
|  | Aspiration: | Water cooled Turbo charged | Vendor to specify |
|  | Emission: | EURO III air emission norms or  CPCB norms. | Vendor to specify |
|  | Lube oil heater: | Required |  |
|  | Lube oil consumption: |  | Vendor to specify |
|  | Cylinder jacket heating (cooling water | Required |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Requirement** | **Vendor's**  **confirmation** |
|  | heating) with thermostat: |  |  |
|  | Lube oil priming facility: | Required |  |
|  | Lube oil pump: | Engine driven only |  |
|  | Engine noise level | Specify in db |  |
|  | Minimum operating time without cooling  water at full load | Specify in minutes | Vendor to specify |
|  | Combustion air flow | Meter cube / hour: | Vendor to specify |
|  | De rating under site conditions: | Specify - if any | Vendor to specify |
|  | No. of cylinders: | Specify | Vendor to specify |
|  | Turbo charger | Inter / after | Vendor to specify |
|  | Maximum time to start from cold &  attain rated speed & ready to take load | Specify in seconds |  |
|  | Short time overload capacity | 110% for 1 hr in 24 hrs of  operation | Vendor to specify |
|  |  |  |  |
| 3 | **Cooling system** |  |  |
|  | Method of Jacket cooling: |  | Vendor to specify |
|  | Heat Removal: |  | Vendor to specify |
|  | Radiator fan: | Engine driven |  |
|  | Total radiated heat: |  | Vendor to specify |
|  |  |  |  |
| 4 | **Fuel oil system:** |  |  |
|  | Fuel oil: | High speed Diesel |  |
|  | Fuel tank level indication | Required |  |
|  | Fuel tank gauge glass | Required |  |
|  | Fuel flow meter | Specify |  |
|  | Fuel transfer pump drive | If required: Engine driven |  |
|  |  |  |  |
|  | Fuel consumption at |  |  |
|  | a) Full load: | Specify in Litres/kWh | Vendor to specify |
|  | b) 75% load: | Specify in Litres/kWh | Vendor to specify |
|  | c) 50% load: | Specify in Litres/kWh | Vendor to specify |
|  | d) 25% load: | Specify in Litres/kWh | Vendor to specify |
|  |  |  |  |
| 5 | **Exhaust** |  |  |
|  | Exhaust silencer type | Heavy duty Residential / hospital  type | Vendor to specify |
|  | Exhaust noise level  (with silencer) | Confirming to CPCB / TNPCB  norms | Vendor to specify |
|  | Heat rejection to exhaust system | Specify in deg C over ambient | Vendor to specify |
|  | Max. Permissible back pressure | Specify in exhaust in kg /cm sq: | Vendor to specify |
|  | Exhaust gas flow: |  | Vendor to specify |
|  | Exhaust gas temperature: |  | Vendor to specify |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Requirement** | **Vendor's**  **confirmation** |
|  | Chimney height | Specify as required, building  height is around 4.50 M |  |
|  | Emission Limits (g/KW-hr) |  |  |
|  | NOX + HC | Confirming to CPCB / TNPCB  norms |  |
|  | CO | Confirming to CPCB / TNPCB  norms |  |
|  | IPM | Confirming to CPCB / TNPCB  norms |  |
|  | Smoke Limit absorption coefficient, WI  (at full load) |  |  |
|  |  |  |  |
| 6 | **Governor data:** |  |  |
|  | Make: | Specify | Vendor to specify |
|  | Model No: | Specify | Vendor to specify |
|  | Type: | Electronic only, give details |  |
|  | Adjustable droop provided: | Required |  |
|  | Speed raise / lower from panel | Required |  |
|  |  |  |  |
| 7 | **Alternator:** |  |  |
|  | Make: |  | Vendor to specify |
|  | Model No: |  | Vendor to specify |
|  | No. of phases: | 3 phase and neutral |  |
|  | Enclosure: | IP 23 |  |
|  | Terminal voltage & freq.: | 415 V AC & 50 Hz |  |
|  | Time permitted to build up rated voltage | 3 seconds max. | Vendor to specify |
|  | Permissible voltage dip | 10% for sudden loading of 50 % |  |
|  | Rating of biggest motor that can be started on DOL with permissible voltage  dip of 10% when the generator is |  |  |
|  | a) unloaded: |  | Vendor to specify |
|  | b) 80 % loaded: |  | Vendor to specify |
|  | c) 50 % loaded: |  | Vendor to specify |
|  | Power transfer: | Cable adopter box |  |
|  | Rating: | adequate size of DG set as required  at 0.8 P.F |  |
|  | Insulation class-Armature: |  | Vendor to specify |
|  | Field: |  | Vendor to specify |
|  | Inertia time constant: | Specify kW-Sec / kVA |  |
|  | Bearing type: |  | Vendor to specify |
|  | RFI suppression | Required |  |
|  | Short circuit withstand time: | Specify |  |
|  | Overload withstand capacity | Min. 150% for 15 Sec. |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Requirement** | **Vendor's**  **confirmation** |
|  |  |  |  |
|  | Neutral earthing: | Solidly Earthed |  |
|  | Type of Cooling: |  |  |
|  | Efficiency of Alternator |  |  |
|  | a) At 100% MCR & rated p.f.: |  | Vendor to specify |
|  | b) At 75 % MCR & rated p.f.: |  | Vendor to specify |
|  | c) At 50 % MCR & rated p.f.: |  | Vendor to specify |
|  | Max continuous & momentary  unbalanced load capacity: |  |  |
|  | Asymmetrical short circuit withstand  capability & duration: | Specify | Vendor to specify |
|  | Open circuit transient time constant: | Specify | Vendor to specify |
|  | Short circuit ratio: | Specify | Vendor to specify |
|  |  |  |  |
| 8 | **Exciter** |  |  |
|  | Type of excitation | Brushless |  |
|  | Capacity |  | Vendor to specify |
|  | Operating voltage & current: |  | Vendor to specify |
|  | Duration of field forcing: |  | Vendor to specify |
|  | Class of insulation: |  | Vendor to specify |
|  |  |  |  |
| 9 | **AVR** |  |  |
|  | Type of A V R: | Self-regulated |  |
|  | Mounting of AVR: |  | Vendor to specify |
|  | Dead band: % |  | Vendor to specify |
|  | Response time: |  | Vendor to specify |
|  | Voltage of operation: |  | Vendor to specify |
|  | Line drop compensator provided to  maintain bus voltage constant: | Required |  |
|  | Range of voltage adjustment: | Specify | Vendor to specify |
|  | Fine tuning adjustment: | Specify | Vendor to specify |
|  |  |  |  |
| 10 | **Set mounted panel** |  |  |
|  | The following analogue type indicators with 4 -20 mA output ports to be  provided: |  |  |
|  | Lube oil Temperature indicator: | Required |  |
|  | Make: | Specify | Vendor to specify |
|  | Type: | Specify | Vendor to specify |
|  | Accuracy: | Specify | Vendor to specify |
|  | Fuel oil Pressure Indicator: |  |  |
|  | Make: | Required |  |
|  | Type: | Specify | Vendor to specify |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Requirement** | **Vendor's**  **confirmation** |
|  | Accuracy: | Specify | Vendor to specify |
|  | Lube oil Pressure Indicator: | Required |  |
|  | Make: | Specify | Vendor to specify |
|  | Type: | Specify | Vendor to specify |
|  | Accuracy: | Specify | Vendor to specify |
|  | Engine Speed Indicator: | Required |  |
|  | Make: | Specify | Vendor to specify |
|  | Type: | Specify | Vendor to specify |
|  | Accuracy: | Specify | Vendor to specify |
|  | Any other indicator required for the  engine protection to be recommended by the vendor. | Specify | Vendor to specify |
|  |  |  |  |
| 11 | **Painting:** |  |  |
|  | Surface Pre-treatment: | Sand blasting / Chemical cleaning |  |
|  | Primer: | Two coats of primer |  |
|  | Final Paint Shade: | Siemens grey as per IS 5 or as  approved |  |
|  | Minimum Paint Thickness: | 100 microns |  |
|  |  |  |  |
| 12 | **Acoustic enclosure** |  |  |
|  | Make: |  | Vendor to specify |
|  | Model No: |  | Vendor to specify |
|  | Type: |  | Vendor to specify |
|  | Application | Outdoor / IP54 rating |  |
|  | Sound Level | Confirming to CPCB / TNPCB  norms |  |
|  |  |  |  |
| 13 | **Control & power panel** |  |  |
|  | Cabinet Construction: | Mounted inside the enclosure |  |
|  | Degree of protection: | IP54 |  |
|  | Access: | Front / Back |  |
|  | Cable entry: | TOP / BOTTOM and as per site  requirements |  |
|  | Controller: | Integrated Microprocessor: |  |
|  | Make: |  | Vendor to specify |
|  | Model No: |  | Vendor to specify |
|  | Type: |  | Vendor to specify |
|  | No. of starting commands in single  attempt in Auto position: min. | 3 minimum |  |
|  | Time gap between commands: | Specify in seconds |  |
|  | Auto stop on resumption of main supply: | Required with inbuilt time delay. |  |
|  | **Note** |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl.**  **No.** | **Description** | **Requirement** | **Vendor's**  **confirmation** |
|  | DG control & On, Off status to be  communication port with SCADA system |  |  |
|  |  |  |  |
| 14 | **Miscellaneous** |  |  |
|  | Guaranteed output in  KWH unit generated per litre of HSD |  |  |
|  | Alternator to care of 3RD, 5TH, 7TH  Harmonic distortion. |  |  |

1. **Earthing and lightning protection**

# General

The metallic body / enclosure of all electrical equipment shall be earthed with a minimum of 2 distinct earth connections of adequate size earth conductors.

Earthing shall be in conformation with IS 3043

# Earth station

**Pipe electrode earthing**

Earth electrode shall be of minimum   tapered bottom and with 12 mm dia holes at 75 mm c/c on all sides for bottom 2.0 m with top watering arrangement.

# Plate electrode

600 x 600 x 6 mm GI plates with 25 mm dia watering pipe with funnel buried at a depth of 2.5 m forms earth electrode. Earthing strip is directly brought to chamber/disconnecting link in protective pipe.

Earth electrode shall be back filled with alternate layers of charcoal and salt are provided through out height of electrode with overall 300 mm cover

# Inspection chamber

Brick masonry chamber of size 450 x 450 x 450 mm with heavy duty cast iron cover and frame with top at ground level are provided for watering arrangement.

# Soil treatment

In case of rocky soil or hard murrum, soil resistance is very high. Hence, for getting lower resistivity values, the Concessionaire shall carryout artificial soil treatment to achieve the required level of lower resistance as per IS.

The earth resistance shall not exceed 1.0 ohms in any case. The Concessionaire shall provide additional earth pits to get the desired earth resistance value of 1.0 ohm.

# Lightning protection

Lightning protection shall be in confirmation with IS/IEC : 62305.

The lightning protection to the buildings shall be effected by use of conventional vertical lightning air termination or horizontal faraday cage or by a combination of both. G.I tapes / strips or aluminium circular conductor shall be laid on all parapet walls and as down conductors.

Conventional spike type lightening arrestor shall be mounted at the highest point of the building and a supporting pole shall be used to achieve the desired height and angle of coverage.

The down conductors shall be brought down from parapet / terrace level to ground level duly ensuring that adequate side flashing distance is maintained between the down conductor and other metallic pipes, if any, running parallel from terrace to ground.

A Test and disconnecting link box shall be provided at a height of 1.0 mtr from G and the down conductor shall be terminated onto this link. Beyond this link 25 x 6 mm GI strip shall be run up to earth station.

Earth station for lightning protection system shall of 600 x 600 x 6 mm GI plate earthing.

# Inspection and testing

The consultant and the r inspect, expedite and witness shop tests. Any materials or works found to be defective or which does not meet the requirements of this specification will be rejected and shall be replaced at



All routine tests shall be carried out on the electrical equipment as per relevant Indian Standard Specifications. The delivery of the electrical equipment / electrical items shall be accompanied with copies of such routine test certificates clearly mentioning reference to the P.O No., Line item No. of P.O, quantity as per P.O, quantity inspected and passed, Governing IS for testing, test results and details of test equipment with their calibration details.

# Section - G5.3

**Erection, testing and commissioning**

# Section G5.3: Erection, testing and commissioning

1. **Equipment installation, testing and commissioning**

# Installation of equipment

* + 1. In accordance with the specific ins drawings or as directed by the Executing Agency, the Concessionaire shall unload, erect, install, wire, test and place into use of all electrical equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.
    2. The Concessionaire shall furnish all supervision, labour, tools, equipment, rigging materials and incidental materials such as bolts, wedges, anchors, concrete inserts etc. required to completely install, test and adjust the equipment.
    3. Drawings, instructions and recommendations shall be correctly followed in handling, settling, testing and commissioning of all equipment and care shall be exercised in handling to avoid distortion to stationary structures, the marring of finish, or damaging of delicate instruments or other electrical parts.
    4. The Concessionaire shall erect and commission the equipment as per the instructions of the Executing Agency and shall extend all co-operation to him.
    5. In case of any doubt / query as to correct interpretation of drawings or instructions, necessary clarification shall be obtained from the Executing Agency. The Concessionaire shall be held responsible for any damage to the equipment consequent to not following instructions correctly.
    6. The Concessionaire shall move all equipment into the respective buildings through regular doors or floors openings provided specifically for the equipment. The Concessionaire shall make his own arrangement for lifting of equipment.
    7. Where assemblies are supplied in more than one section, the Concessionaire shall make all necessary mechanical and electrical connections between sections including the connections between bus bars / wires. The Concessionaire shall also carry out the adjustments/alignments necessary for proper operation of the circuit breakers. All insulators and bushings shall be protected against damage during installation. Insulators or business chipped, cracked or damaged due to negligence or carelessness shall be replaced by the Concessionaire at his own expenses.
    8. The Concessionaire shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments or relays are supplied separately, they shall be mounted only after the associated control panels have been erected and aligned. The blocking material/mechanism employed for the safe transit of the instruments and relays shall be removed after ensuring that the panels have been completely installed and no further movement of the same would be necessary. Any damage to relays and instruments shall be immediately reported to the Executing Agency.
    9. Care shall be taken during handling on insulating oil to prevent ingress of moisture or foreign matter. In the testing, circulation, filtering, or otherwise handling of oil, rubber hose shall not be used. Circulation and filtering of oil, the heating of oil by regulated short- circuit current during drying runs and sampling and testing of oil shall be in accordance with the latest Code of Practice IS:10028 (Part II) shall be carried out.
    10. Inspection, storage, installation, testing and commissioning of transformers shall be in accordance with the latest Indian Standard Code of Practice IS:10028. All commissioning tests as applicable, vide Appendix B of IS:10028 (Part II) shall be carried out.
    11. Switchgear, relay and control panels shall be installed in accordance with the latest Indian Standard Code of Practice IS:10118. The switchgear panels shall be installed on finished surface or concrete or steel sills. The Concessionaire shall be required to install and align any channel sills which form part of the foundations. Tape or compound shall be applied where called for. The base of outdoor type units shall be sealed in approved manner to prevent ingress of moisture.
    12. After installation of all power and control wiring, the Concessionaire shall perform operating tests on all switchgear and panels to verify the proper operation of switchgear/panels and the correctness of the interconnections between various items of equipment. This shall be done by applying normal AC or DC voltage to the circuits and operating the equipment. Megger tests for insulation, polarity installation tests shall be carried out by the Concessionaire who shall also make all necessary for proper functioning of the equipment.
    13. Installation and testing of the battery and battery chargers shall be done in strict compliance with the applicable standards. Each cell shall be inspected for breakage and condition of cover seals as soon as received at site. The battery shall be set up on racks as soon as possible after receipt, utilizing lifting devices. The cells shall not be lifted by terminals. Contact surface of the battery terminals and inter cell connectors shall be cleaned, coated with protective grease and assembled. Each connection shall be properly tightened. Each cell shall be tested with an hydrometer and thermometer and the results logged. A freshening charge, if required, shall be added. When handed over to the Executing

Agency, the battery shall be fully charged and the electrolyte shall be at the full level of the specified specific gravity.

* + 1. Equipment furnished with finished coats of paint shall be touched up by the Concessionaire if their surface is spoiled or marred while handling.
    2. Foundation work and grouting-in of fixing bolts or channels for all transformer, switchgear, motors and control panels will be carried out by the Concessionaire.

# Installation work for earthing and lightning protection system.

The Concessionaire shall install aluminium / copper / steel conductors, braids, etc. required for the system and individual equipment earthing. All work such as cutting, bending, supporting, painting/coating, drilling, brazing/soldering/welding, clamping, bolting and connecting onto structures, equipment frames, terminals, rails or other devices shall be in

fixing cleats/clamps, anchor fasteners, lugs, bolts, nuts, washing, bituminous.

The quantities, sizes, materials of earthing conductors and electrodes to be installed as per requirement. Routes of the conductors and locations of electrodes shall be as shown on the project drawings.

The work of embedment of earthing conductor in RCC floors / walls along with provision of earth plate inserts / pads / earth risers shall be done by the Concessionaire when the

 installation shall include laying the conductors in position with 50 mm concrete cover, making welded connections to inserts/pad/risers above the floor near the equipment. The embedded conductors shall be connected to reinforcing rods wherever necessary.

If the tap connections (earthing leads) from the floor embedded main earthing grid to the equipment are more than 500 mm long then the same shall be embedded in floor by the Concessionaire where required, together with associated civil work such as excavation / chasing, concreting and surfacing, if not already done in the civil work. The concrete cover over the conductor shall not be less than 50 mm.

Installation of earth conductors in outdoor areas, buried in ground, shall include excavation of earth upto 600 mm deep 450 mm wide, laying of conductors at 600 mm depth, brazing / welding as required, of main grid conductor joints as well as risers of length 500 mm above ground at required locations and then backfiring material to be placed over buried conductor shall be free from stones and other harmful mixtures. Backfill shall be placed in layers of 150 mm, uniformly spread along the ditch and tampered utilizing pneumatic

tampers or other approved means. If the excavated soil is found unsuitable for backfilling, the Concessionaire shall arrange for suitable material from outside.

Installation of earth connection leads to equipment and risers on steel structures / walls shall include laying the conductors, welding / cleating at specified intervals, welding / brazing to the main earth grid risers, bolting at equipment terminals and coating welded / brazed joints by bitumen paint. Galvanized conductors shall be touched up with zinc rich paint where holes are drilled at site for bolting to equipment / structure.

Electrodes shall be installed (a) directly in earth, or (b) in constructed earth pits and connected to main buried earth grid. The scope of work shall include excavation, construction of the earth pits including all materials required for construction of earth pits, placing the rod and fixing test links on those pipe / rod / plate electrodes in test pits and connecting to main earth conductors.

Installation of lightning conductors on the roofs of buildings shall include laying, anchoring, fastening and cleating of horizontal conductors, grouting of vertical rods wherever necessary, laying fastening / cleating / welding of the down comers on the walls / columns of the building and connection to the test links to be provided above ground level.

Installation of the test links shall include mounting of the same at specified height on wall / column by suitable brackets and connections of the test link to the earth electrode.

Whenever main earthing conductor crosses cable trenches, they shall be buried below the trench floor.

Suitable earth risers shall be provided above finished floor/ground level. If the equipment is not available at the time of laying of the main earth conductors, the minimum length of such riser inside the building shall be 200 mm and outdoors shall be 500 mm above ground level. The risers to be provided will be marked in project drawings.

Earth leads and risers between equipment earthing terminal and the earthing grid shall follow as direct and short a path as possible.

Wherever earthing conductors passes through walls galvanized iron sleeves shall be provided for the passage of earthing conductor. The pipe ends shall be sealed by the Concessionaire by suitable water proof compound.

# Earthing connections

All connections in the main earth conductors buried in earth/concrete and connection between main earthing conductor and earth leads shall be of welded type.

Connection between earth leads and earthing terminal provided on the equipment shall be bolted type.

All bimetallic connections shall be treated with suitable compound to prevent moisture ingression.

Metallic conduits and pipes shall be connected to the earthing system.

Lightning protection system down conductors shall not be connected to other earthing conductors above ground level. Also no intermediate earthing connection shall be made to lightning arrestor and transformer earthing leads which shall be directly connected to plate electrode.

# Earth electrodes

Electrodes shall as far practicable, be embedded below permanent moisture level.

Test pits with concrete covers shall be provided for periodic testing of earth resistance. Installation of plate electrodes in test pits shall be suitable for watering. The necessary materials required for installation work shall also include civil work such as excavation and connection to main earth grid.

Earth pits shall be treated with salt and charcoal.

Soil, salt and charcoal placed around the electrode shall be finely graded, free from stones and other harmful mixtures. Backfill shall be placed in layers of 250 mm thick uniformly spread and compacted. If excavated soil is found unsuitable for backfilling, the Concessionaire shall arrange for a suitable soil from outside.

# Lightning protection system

The lightning protection of air termination rods and/or horizontal air termination conductors shall be fixed in such a way that they remain in their installed position even during severe weather conditions. The necessary accessories such as cleats, clamps, welding materials, bolts, nuts shall be supplied by the Concessionaire.

Air termination system shall be connected to earthing system by down conductors. The down conductors shall follow a direct path to earth. There shall not be any sharp bends, turns and kinks in the down conductors.

All joints in the down conductors shall be of welded type. All metallic structures within 2 metres of down conductors shall be bonded to lightening protection system.

level housed in a suitable G.I. enclosure made of adequate thickness steel sheet and hot-dip galvanised. The test joint shall be directly connected to the earthing system electrode.

The lightning protection system shall not be in direct contact with underground metallic service ducts, cables, cable conduits and metal enclosures of electrical equipment. However, all metal projections, railings, vents, tanks, etc. above the roof shall be bonded together to form a part of roof grid.

# Installation of cable racks and trays

* + 1. Lines and grade for trays may be measured from building steel and finished floor elevations. Changes in line or grade, or the addition of offsets by means of cutting standard tray sections and inserting additional tray fittings to match with the existing arrangement shall be considered as a normal part of the work.
    2. Where embedded steel inserts in concrete floors/walls for welding the supports for cable racks/trays are not available, Concessionaire shall provide suitable anchor fasteners at no extra cost.
    3. Cable shall be clamped to the cable trays at regular intervals.
    4. Flexible metallic conduits shall be used for termination of connection to equipment such as motors, limit switches and other apparatus.

# Installation of cables

* + 1. The Concessionaire shall install, test and commission the cables specified in the specification in accordance with drawings & instructions issued by the Executing Agency representative. Cables shall be laid directly buried in earth, on cable racks, in built-up trenches, on cable trays and supports, in conduits and ducts or bare on walls,

fixing, jointing, bending and termination of the cables. The Concessionaire shall also supply the necessary materials and equipment required for jointing and termination of the cables.

* + 1. All apparatus, connections and cable work shall be designed and arranged to minimise risk of fire and any damage which might be caused in the event of fire. Wherever cables pass through floor or wall openings or other partitions, suitable bushes of an approved type shall be supplied and put into position by the Concessionaire.
    2. Standard cable grips and reels shall be utilised for cable pulling. If unduly difficult pulling occurs, the Concessionaire shall check the pull required and suspend pulling until further procedure has been approved by the Executing Agency. The maximum pull tension shall not exceed the recommended value for the cable measured by the tension dynamometer. In general, any lubricant that does not injure the overall covering and does not set up undesirable conditions of electrostatic stress or electrostatic charge may be used to assist in the pulling of insulated cables in conduits and ducts.
    3. After pulling the cable, the Concessionaire shall record cable identification with date pulled neatly with waterproof ink in linen tags. Identification tags shall be attached securely to each end of cable with non-corrosive wire. The said wire must be non- ferrous material on single conductor power cable. Tags shall further be attached at intervals on long runs of cables on cable trays and in pull boxes. Cables and joint markers and RCC warning covers shall be provided wherever required. All cables shall be allocated a unique number which shall be fixed to each end of the cable using

corrosion resistant label. Cable of different categories shall be tagged with the following subscripts and three digit number.

* + - * HV power HV-P
      * LV power P
      * Control C
      * Instrumentation I
      * Protection PR
      * Telecommunication T
    1. Sharp bending and kinking of cables shall be avoided. The bending radii for various types of cables shall not be less than those specified below :
       - KV XLPE multicore armoured cables: 15 times the overall dia of the cable
       - 650 / 1100 V PVC insulated armoured cables: 12 times the overall dia of the cable

If shorter radius appears necessary, no bend shall be made until clearance and instructions have been received from the Executing Agency.

* + 1. Power, control and instrumentation cables shall be laid in separate cable racks / rays.
    2. Where groups of HV, LV and control cables are to be laid along the same route, suitable barriers to segregate them physically shall be provided.
    3. Cables of different categories shall be installed so as to maintain satisfactory clearances for safety and in order to reduce the possibility of electrical interference. The following table gives the distances in mm that shall be maintained between the different categories

/ voltage grade of cable.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Cable category** | **HV**  **Power** | **LV**  **Power** | **C&I**  **Protection** | **Telecommunication /**  **data network** |
| HV Power | - | 275 | 550 | 550 |
| LV Power | 275 | - | 275 | 275 |
| C&I Protection | 550 | 275 | - | 275 |
| Telecommunication | 550 | 275 | 275 | - |

* + 1. Where cables cross roads and water, oil, gas or sewage pipes, the cables shall be laid in reinforced spun concrete or steel pipes. For road crossings the pipe for the cables shall be buried at not less than one metre depth.
    2. Cables laid in ground shall be laid on a 50 mm riddled earth bed. The cables shall then be covered on top and at their sides with riddled earth of depth of about 150 mm. This is then gently filled up to a depth of about 100 mm above the top of uppermost cable to provide bedding for the protective cable covers which are placed centrally over the cables. The protective cable covers for LV cables may be of earthenware and for HV cables of reinforced concrete. The RCC covers shall have one hole at each end, to tie

them to each other with GI wires to prevent displacement. The trench is then backfilled with the excavated soil and well rammed in successive layer of not more than 300 mm depth, with the trenches being watered to improve consolidation wherever necessary. To allow for subsidence, it is advisable to allow a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench.

* + 1. In each cable run some extra length shall be kept at a suitable point to enable one or two straight through joints to be made, should the cable develop a fault at a latter date.
    2. Cables on cable racks, on cable trays and conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables shall be racked or laid directly into cantilevered cable trays where practicable, but in some cases it may be necessary that cables are pulled or threaded into trays. To facilitate visual tracing, cables in tray shall be laid only in single layers and unnecessary crossing of cables shall be avoided. Cables on trays shall finally be clamped in an approved manner.
    3. Cable splices will not be permitted except where permitted by the Executing Agency. Splices shall be made by Concessionaire for each type of wire or cable in accordance

splicing, insulated cables shall have conductor insulation stepped and bound or pencilled for recommended distance back from splices to provide a long leakage path. After splicing, insulation equal to that on the spliced conductors shall be applied at each splice.

* + 1. Jointing of cables shall be in accordance with relevant Indian Standard Code of Practice. Materials and tools required for cable jointing work, including cold setting bituminous compound shall be supplied by the Concessionaire. Cables shall be firmly clamped on either side of a straight through joint at a distance of not more than 300 mm away from the joints. Identification tags shall be provided at each joint at all cable terminations.
    2. At cable terminal points where the conductor and cable insulation will be terminated, termination shall be made in neat, workmanlike and approved manner by men specialised in this class of work.
    3. Control cable termination shall be made in accordance with wiring diagrams, using colour codes established by the Executing Agency for the various control circuit, by code marked wiring diagram.
    4. When control cables are to be fanned out and cabled together with cord, the Concessionaire shall make connections to terminal blocks, and test the equipment for proper operation before cables are corded together. If there is any question as to the proper connection, the Concessionaire shall make a temporary connection with sufficient length of cables so that the cable can be switched to another terminal without splicing. After correct connections are established through operating the equipment, cables shall be cut to their correct lengths, connected to terminals in the specified

manner, and corded together where necessary to hold them in place in a workmanlike manner.

* + 1. Cable seals shall be examined to ascertain if they are intact and that cable ends are not damaged. If the seals are found to be broken the cable ends shall not be jointed until after due examination and testing by the Executing Agency. Before jointing is commenced, insulation resistance of both sections of cables to be jointed shall be checked by megger.
    2. After installation and alignment of motors, the Concessionaire shall complete the conduit installation, including a section of flexible conduit between motor terminal box and trench/tray. The Concessionaire shall install and connect the power, control and heater supply cab



* + 1. For directly buried underground cables, Concessionaire shall install galvanised cast iron cable markers over ground, at all bends, loops, joints, crossing points and at every 25 meters interval on straight runs. The cable markers shall be anchored in the ground to a depth of minimum 500 mm. The cable markers for L.T. cables & HT cables shall be distinctly different in shape and marked as L.T. Cables and HT Cables as the case may be by 30 mm size letters.

# Lighting system installation

This covers the requirements of installation of the following :-

* + 1. Lighting fixtures complete with lamps and accessories
    2. Main Lighting distribution board
    3. Lighting panels
    4. Receptacles and lighting control switches
    5. Point wiring
    6. Street lighting poles and flood light towers
    7. Multicore cables for street and boundary lighting
    8. Maintaining equipment/materials during storage and being responsible for the equipment/material until they are handed over to the Executing Agency.
    9. Installation, testing and commissioning shall be carried out in accordance with the drawings and as stipulated in this specification.

# Applicable standards

Electrical wiring installations : IS:732 (system voltage exceeding 650 V)

Code of practice for interior illumination (Part-1) : IS:3646/BS:8206 Code of practice for street lighting installation : IS:1944

|  |  |  |
| --- | --- | --- |
| Code of practice for industrial lighting : | IS:6666 |  |
| Code of practice for fire safety of building | : | IS:1646 |
| Boxes for enclosure of electrical accessories | : | IS:5133 (Part I) |
| Guide for safety procedures and practices in electrical work | : | IS:5216 |
| Ceiling roses | : | IS:371 |
| **1.4.2 Lighting fixtures** |  |  |

* + - 1. The installation of lighting fixtures shall be based on the mounting arrangement shown in the drawings enclosed. Installation shall include all materials required to mount the fixtures in the manner as shown in the drawings. Installation of lighting fixtures shall include installation of control gear box wherever applicable.
      2. Installation of receptacles and switches shall be carried out suitably as per the lighting layout drawings prepared by Concessionaire and approved by Executing Agency. Switch shall be mounted in flush with the front cover plate. Supply and installation of necessary hardware shall be included in the scope for installation of receptacles/switches.
      3. Lighting distribution boards shall be installed at the location indicated in the layout drawings prepared by Concessionaire and approved by Executing Agency. Installation rates quoted for installation of lighting distribution boards shall include supply and installation of base channels, foundation bolts, etc.
      4. Outdoor lighting distribution boards shall be installed on a concrete plinth. The top of plinth shall be 100 mm (min.) above the ground level. Construction of concrete plinth shall be included in the installation of outdoor lighting distribution board. Installation cost of lighting distribution board shall include installation of earthing conductor from LDB to the nearest earthing grid.

# 1.4.3 Point wiring

**Supply and installation of conduit point wiring**

The point wiring shall include supply of necessary materials for the conduit wiring such as galvanised rigid steel conduit, galvanised M.S. fixing saddles with spacer plates, nylon/fibre plugs, galvanised M.S. fixing screws, 12 SWG galvanised steel earthing wire, PVC insulated copper or aluminium conductor wires, control switches and pulling, termination of the earthing/PVC insulated wires as required, installation of control switches, drilling holes in brick walls/RCC roof slabs for taking the wiring conduits and refinishing any other works/material necessary for making point wiring complete in all respects.

Wires used for conduit point wiring of lighting fixtures/ceiling fans and receptacles shall be 1100 V grade, PVC insulated, single core, stranded copper conductor wires of sizes not less than 1.5 sq.mm and 2.5 sq.mm respectively. Wires shall conform to IS:694 and shall bear the ISI mark.

Concessionaire shall take into consideration necessary galvanised MS fixing clamps when the wiring conduits are to be supported from steel roof truss/structural members.

# Point wiring shall also include/hold good for the following:

Supply and installation of lighting control switches and switchboxes complete with fixing accessories.

Drilling holes in brick/RCC wall & roof for taking cable or conduit, sealing and refinishing with cement plaster.

Testing, commissioning and handing over the lighting system in commercial working condition.

# Outdoor Lighting (Street and Flood Lighting)

The following shall be deemed to be included as part of the installation work for outdoor lighting point wiring.

Installation of multicore/single core cables between LDB and junction box mounted on street light pole/flood lighting tower, from junction box to metal enclosed control gear box.

Supply and installation of crimping type cable lugs, double compression type cable glands at each junction box and fixture, termination and testing and commissioning of cables.



Supply and installation of route markers, supply and installation of HDPE pipes for road crossing shall also be included.

Supply and installation of necessary cleating arrangement for cabling on flood light poles.

Concessionaire shall provide necessary foundation for erecting street light pole/flood light tower and install the same. Concessionaire shall prepare foundation drawings with necessary details to Executing Agency for approval.

Concessionaire shall plan and cut the cables in such a way that there is no wastage and no cable jointing is required in any run. However, should any joint become necessary, the same shall be provided by the Concessionaire and joint marker shall also be provided at no extra cost.

Earthing of street light pole/flood light tower, lighting fixtures, control gear boxes, junction boxes, etc. are also included in the scope of installation. Concessionaire shall earth street light pole/flood light poles and junction box with 25 x 3 mm G.S. flat tap off from the 25 x 3 mm

M.S. flat earthing grid along the street lighting included in the scope. The Concessionaire shall interconnect earthing grid to plant main earthing grid at first and last pole of each feeder circuit and at one intermediate pole.

# Installation of lighting poles & towers for outdoor lighting (Street and flood lighting)

Work includes supply and installation of street light poles and flood light towers including associated junction boxes with fuses, links and terminals for junction boxes and junction boxes near each flood light fixtures.

All street light poles and towers shall be painted with two coats of red oxide oil primer followed by two coats of aluminium alkyd paint.

# Installation of Lighting Distribution Board, Lighting Panels (AC & DC), 240 V, AC 1-Phase Distribution Boards

Installation of above items shall include necessary foundation channels, bolts/nuts, etc. for grouting lighting distribution boards, iron brackets/grouting brackets, bolts/nuts for wall/column mounted panels and associated civil works.

# Point wiring

* + 1. **Wiring**
       1. Wiring shall be carried out strictly as per project drawings and technical specification. All exposed conduit wiring shall have provision for easy inspection. Exposed wiring when run along wall shall be as near the ceiling as possible. Where cable wiring is specified cable shall be cleated on to the wall as close to the ceiling as possible. In all types of wiring due consideration shall be given for neatness and appearance.
       2. Wherever DC emergency lighting is provided, emergency lighting wires shall run in a separate conduit. Colour of the wires used shall be as follows; white for positive, black for negative.
       3. Wherever lighting system has three phase distribution, separate conduits shall be used for different phases. For easy identification of phases and neutral wires, the following colour wires shall be used.
          1. R - Phase - Red
          2. Y - Phase - Yellow
          3. B - Phase - Blue
          4. Neutral - Black
       4. There shall be a circuit breaker or a linked switch on each live conductor of supply mains at the point of entry. The wiring throughout the installation shall be such that there is no break in neutral wire in the form of switch or fuse unit.
       5. Conductors not arranged for connection to the same system or supply different phases of the same supply, shall be kept apart throughout their entire run.
       6. Receptacles and lighting fittings in general shall be fed from different circuits. Five amps receptacles for toilet or small rooms can be fed from the lighting circuit with proper isolating arrangement.
       7. Each final sub-circuit from a lighting panel shall be controlled by a single pole switch connected to the live conductor.
       8. For long conduit wiring runs, inspection/pull boxes shall be provided at intervals not exceeding 10 m. Such facilities shall also be provided at conduit bends.

# General practices

* + - 1. All receptacles and switches to be installed in offices and control rooms shall be flush mounted within the wall and those in other areas shall be wall or column mounted.
      2. Ceiling roses shall not embody fuse terminals as an integral part. For voltages exceeding 250 volts, a ceiling rose or any similar attachment shall not be used.
      3. A socket outlet shall not embody fuse terminals as an integral part of it. The switch controlling the socket outlet shall be on the live side of the line.
      4. All exposed metal parts of the plug, when the plug is in complete engagement with the socket outlet, shall be in effective electrical connection with the earthing pin.

# Earthing

* + - 1. Exposed conduits and fittings shall be earthed by 12 SWG GI wires run along the length of the conduit and secured by means of suitable clamps efficiently fastened to conduit tip. To achieve perfect electrical continuity, the conduits shall be bonded effectively on either end of a coupling and other joints. In case of concealed wiring 1.5 / 2.5 sq.mm PVC insulated wire inside the conduit shall be used for earthing.
      2. Conduits shall be earthed at the ends adjacent to switch boards at which they originate or otherwise at the earth clip, clamp or gland, in effective electrical contact with the conduit.
      3. For outdoor lighting poles the earthing conductor shall be terminated upto the junction box on the pole and 12 SWG wire shall be taken up to the pole fitting.

# Pre-Commissioning checks and commissioning



installation and commissioning check lists as given below :-

* + 1. Among other commissioning tests, the following shall be carried out at site after completion of installation. Concessionaire 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 Executing Agency.

# For Transformers

Dielectric strength of transformer oil. Operation of all protective equipment, voltage/turns ratio at all taps, winding resistance at all taps, vector group test, phase sequence test, buchholz relay operation (alarm and trip), OLTC control indicating and alarm circuits, lightning arrestor installation, test the bushing oil for dielectric strength.

# For Switchgear

Power frequency high voltage test, operation tests.

# For Relays

Check internal wiring, relay settings.

Satisfactory operation over their whole operating range by secondary injection. Check the minimum pick up voltage of D.C. coils, megger all terminals to body and AC to DC terminals.

# Relay and Control Panel

Switch development, check on relays, check on metres, functional checking of all

control circuit, e.g. closing, tripping, control, interlock, supervision, and alarm circuits including proper functioning of the component equipment.

# Circuit breakers

Manual operation of breakers, power closing/opening operation manually and electrically, breaker closing and tripping time, trip free and anti pumping operation, control wiring for correctness of connections, continuity and IR value, electrical and mechanical interlocks, all functional checks on CTS, checks on spring charging motor.

# Battery

Special gravity test, cell voltage check, capacity test as per IS, Initial charging cycle.

# Battery charger & D.C. Distribution Board

Functional check of auxiliary devices such as alarms, indicating etc., measurement of voltage regulation.

# Voltage transformers

Polarity  earthing connection.

# Current Transformer

Megger between windings and winding terminal to body, polarity test, capacitance and tan delta test.

# Cables

All new cables shall be tested for its insulation strength before terminating / jointing. After terminating / jointing is completed of all L.V. (i.e. 650/1100V) cable shall be tested by 1000V megger. All H.T. Cables (i.e. 11 KV) shall be tested by 2500 V motor operated megger.

Cable core shall be tested for

* + Continuity
  + Absence of cross phasing
  + Insulation resistance to earth
  + Insulation resistance between conductors

# Earthing and Lightning Protection System

The Concessionaire shall ensure the continuity of all conductors and joints. The Executing Agency 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 electricity rules. Earth resistance value should be not greater than one (1) ohm,

# Lighting System

Before putting complete system into service, commissioning tests stipulated in applicable standards and code of practice shall be carried out by the Concessionaire in the presence of the Executing Agency covering all lighting system equipment.

# The Concessionaire shall carry out insulation resistance tests by megger of following rating:

Control circuits upto 220 V : 500 V megger Power circuits upto 1.1 KV : 1000 V megger

# Safety procedure and practice

Following safety procedure and practice should be provided by concessionaire in switchgear room/sub-station as per latest edition of I.S. 5216.

# Rubber matting

1. In front of 11 KV switchgear.
2. In front of 415 V switchgear and other panel in switchgear room.

# Shock treatment charts

1. One chart near 11 KV switchgear room
2. One chart near 415 V switchgear room

# Caution/Danger Board

1. 11 KV switchgear
2. 11 KV capacitor panel
3. 415 V switchgear
4. Transformer near H.T. cable box
5. All power Distribution Board

# Fire Safety

The requirement of hand appliance in switchgear room, electrical equipment room shall be

provided as per Clause 4.0 of Fire Protection Manual by Regional Traffic Committee, 10th edition 1988.

# Section - G5.4 Instrumentation Works

**Section G5.4: Instrumentation Works**

# General

The Concessionaire is required to adopt the **latest technology with compatible automation system having fully automatic process control**,  provided by the Concessionaire as part of Basic engineering package. ON LINE to monitor and control the plant from a single location. The data collected through online monitoring shall be made available via the internet to authorities & officials in Executing agency,

{NATIONAL/STATE LEVEL AGENCY IF ANY}161, CPCB, SPCB, ULB and Project Engineer.

# General requirements

This part covers the general requirements for the design, supply, installation, inspection and testing of the instrumentation and automation solution proposed for flow measurement, monitoring of water quality and control of plant.

# Reference Standards

Unless otherwise approved, instrumentation shall comply with relevant quality standards test procedures and codes of practice collectively referred to as Reference Standards including those listed below in accordance with the requirements detailed elsewhere in this specification. IEC 60381-1:1982 Analogue signals for process control systems.

# Specification for direct current signals:

IEC 60947-4-1:2000 Specification for low-voltage switchgear and Control Gear. Contactors and motor-starters. Electromechanical contactors and motor-starters.

IS 15953 : 2011 ISA-5.1-2009 IEC 62443

IEC 61346

IEC 60870-6- all parts

IEC 61131-3 industrial control programming standard advancements IEC 61850 all parts ranging from 1 - 10

IEC 61850-10:2012 - Conformance testing 118

IEC TR 61850-90-3:2016 - Using IEC 61850 for condition monitoring diagnosis and analysis

+ IEC TR 61850-90 all parts

IEC 60947-4-2:1999 Specification for low-voltage switchgear and Control Gear. Contactors and motor-starters. A.C. semiconductor motor controllers and starters.

161 Contents in the flower parenthesis may be deleted if not applicable.

IEC 60947-4-3:1999 Specification for low-voltage switchgear and Control Gear. Contactors and motor-starters. Contactors and motor-starters. AC semiconductor controllers and contactors for non-motor loads.

IEC 60770-1:1999 Transmitters for use in industrial-process control systems. Methods for performance evaluation.

BS ISO 1217:1996 Displacement compressors. Acceptance tests. ISO 2112:1990 Specification for aminoplastic moulding materials.

ISO 6817:1997 Measurement of conductive liquid flow in closed conduits. Method using electromagnetic flow meters.

BS EN 837-1:1998 Pressure gauges. Bourdon tube pressure gauges. Dimensions, metrology, requirements and testing.

BS EN 1057:1996 Copper and copper alloys. Seamless, round copper tubes for water and gas in sanitary and heating applications.

BS EN 1092-1:2002 Flanges and their joints. Circular flanges for pipes, valves, fittings and accessories, PN designated. Steel flanges.

BS EN 1563:1997 Founding. Spheroidal graphite cast iron.

BS EN 60529:1992 Specification for degrees of protection provided by enclosures (IP code). BS EN 60534-1:1993 Industrial-process control valves. Industrial-process control valves. Control valve terminology and general considerations.

BS EN 60546-1:1993 Controllers with analogue signals for use in industrial-process control systems. Controllers with analogue signals for use in industrial-process control systems.

# Methods for evaluating performance

BS EN 60584-2:1993 Thermocouples.

# Tolerances

BS EN 60654:1998 Operating conditions for industrial-process measurement and control equipment. All relevant parts.

BS EN 60751:1996 Industrial platinum resistance thermometer sensors.

BS EN 60873:1993 Methods of evaluating the performance of electrical and pneumatic analogue chart recorders for use in industrial-process control systems.

BS EN 61000-6:2001 Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments.

BS 89:1990 Direct acting indicating analogue electrical measuring instruments and their accessories. All parts.

BS 90:1975 Specification for direct-acting electrical recording instruments and their accessories.

BS 476 Fire tests on building materials and structures. All parts.

BS 1042-1.4:1992 Measurement of fluid flow in closed conduits. Pressure differential devices. Guide to the use of devices specified in Sections 1.1 and 1.2.

BS 1041-2.1:1985 Code for temperature measurement. Expansion thermometers. Guide to selection and use of liquid-in-glass thermometers.

BS 1041-2.2:1989 Code for temperature measurement. Expansion thermometers. Guide to 119 selection and use of dial-type expansion thermometers.

BS 1041-3:1989 Temperature measurement. Guide to selection and use of industrial resistance thermometers.

BS 1041-4:1992 Temperature measurement. Guide to the selection and use of thermocouples BS 1042-1.4:1992 Measurement of fluid flow in closed conduits. Pressure differential devices. Guide to the use of devices specified in Sections 1.1 and 1.2.

BS 1123-1:1987 Safety valves, gauges and fusible plugs for compressed air or inert gas installations. Code of practice for installation.

BS 1203:2001 Hot-setting phenolic and aminoplastic wood adhesives. Classification and test method.

BS 1553-1:1977 Specification for graphical symbols for general engineering. Piping systems and plant.

BS 1571-2:1975 Specification for testing of positive displacement compressors and exhausters. Methods for simplified acceptance testing for air compressors and exhausters.

BS 1646-1:1979 Symbolic representation for process measurement control functions and instrumentation.

# Basic requirements

BS 1646-2:1983 Symbolic representation for process measurement control functions and instrumentation. Specification for additional basic requirements.

BS 1646-3:1984 Symbolic representation for process measurement control functions and instrumentation. Specification for detailed symbols for instrument interconnection diagrams. BS 1646-4:1984 Symbolic representation for process measurement control functions and instrumentation. Specification for basic symbols for process computer, interface and shared display/control functions.

BS 1794:1952 Specification for chart ranges for temperature recording instruments.

BS 2765:1969 Specification for dimensions of temperature detecting elements and corresponding pockets.

BS 3680 Measurement of liquid flow in open channels. All relevant parts.

BS 3693:1992 Recommendations for design of scales and indexes on analogue indicating instruments.

BS 4675-2:1978 Mechanical vibration in rotating machinery. Requirements for instruments for measuring vibration severity.

BS 4999-142:1987 General requirements for rotating electrical machines. Specification for mechanical performance: vibration.

BS 5169:1992 Specification for fusion welded steel air receivers.

BS 5728-3:1997 Measurement of flow of cold potable water in closed conduits. Methods for determining principal characteristics of single mechanical water meters (including test equipment).

BS 6004:2000 Electric cables. PVC insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring.

BS 6739:1986 Code of practice for instrumentation in process control systems: installation design and practice.

BS 7671:2001 Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition. Instrument Society of American Standards and Recommended Practices:

S 5.1 Instrumentation symbols and identification S 5.4 Instrument loop diagrams

S 7.3 Quality standard for instrument air

RP 16.1 Terminology, dimensions and safety practices for indicating variable 2, 3 area meters RP 16.4 Nomenclature and terminology for extension-type variable-area meters (rotameters) RP 16.5 Installation, operation, maintenance instructions for glass tube variable area meters (rotameters)

RP 16.6 Methods and equipment for calibration of variable area meters (rotameters) RP 18.1 Specifications and guides for the use of general purpose enunciators

S 26 Dynamic response testing of process control instrumentation

RP 31.1 Specification, installation and calibration of turbine flow meters S 37.1 Electrical transducer nomenclature and terminology

S 37.3 Specifications and tests for strain gauge pressure transducers

S 50.1 Compatibility of analog signals for electronic industrial process instruments S 51.1 Process instrumentation terminology

RP 60.08 Electrical Guide for Control Centers

Installation works shall comply with all relevant local Indian Regulations including the Code of Practice for Electrical Wiring Installations IS 732.

# Basic Features

Each instrumentation system shall be designed, manufactured and installed to achieve the following basic requirements:

To maintain the highest standards of availability, reliability and accuracy and to give clear warnings of any deterioration in performance

To suit the abilities of the staff who will:

* 1. Use the systems
  2. Service the systems

To measure, indicate, process, store and control the relevant parameters, as specified

To give clear warnings of dangerous and other abnormal conditions and to initiate plant safety procedures, shutdowns and corrective measures as specified to assure the safety of



as required

To derive, present and utilize, as required, such additional data to facilitate:

1. The most efficient operation of the plant
2. The routine maintenance of the plant

# Design requirements for instrumentation and control systems (I&C)

The instrumentation, control and automation installations shall fully comply with design standards, regulations and the material and workmanship requirements of the Specification. The instrumentation control and automation systems shall comply with the relevant Indian Standards being practiced as per the industry norms. All consumable items and spare parts shall be readily available within India.

All equipment and materials incorporated in the system shall be selected, designed and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability. The instrumentation control and monitoring system equipment and materials shall have an operational life of not less than 15 years.

Unless otherwise specified, all functions shall be transmitted electrically and all analogue signal transmission systems shall be in accordance with IEC 60381-1:1982 or equivalent and shall use a signal of 4mA to 20mA dc. Where possible, measuring systems shall be designed so that any necessary power supply is taken from the appropriate instrument panel. Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter, and shall be capable of meeting the requirements specified in the appropriate part of IEC 60770-1:1999 or equivalent. Equipment mounted in enclosures shall be suitable for continuous operation at the maximum internal temperature possible in service, due account being taken of internally-generated heat and heat dissipated by other plant. All components shall be rated adequately and circuits shall be designed so that change of component characteristics within

l equipment shall be



designed to operate without forced (or fan) cooling.

All measuring instruments shall have zero and span adjustment. Instruments not mounted in panels shall be supplied complete with all brackets, stands, supporting steelwork and weatherproof enclosures (separate from the instrument cases) necessary for securing them in their working positions and affording complete protection at all times including periods of servicing, adjustment, calibration and maintenance. The installation arrangements for meters measuring conductivity, pH, dissolved oxygen, chlorine residual and ionic concentration shall include a sample bench and other facilities for operating portable test meters. Each installation shall incorporate a valve and pipework for obtaining a sample representative of the fluid at the position of the permanent meter, tundish and drain. If the measuring and sampling points are remote from each other, the test and sample facilities shall be provided at both points. Sample transport times shall be minimized by provision of a bypass and drain with control and isolating valves and a local flow meter to enable the correct sample flow to be adjusted. An automatic portable sampler shall be provided for collecting and transporting the samples from the sampling locations to the laboratory.

# Instrument Design Criteria

The design criteria to be applied to instrumentation system shall be as follows:

Instrumentation & Control (I&C) systems shall be selected, designed, manufactured, installed, tested and rated to operate under the defined performance duties and specified site conditions and to maintain a high level of operational reliability. Instruments mounted in field and on panels shall be suitable for continuous real time operation. All electronic components shall be adequately rated and circuits shall be designed so that change of component characteristics shall not affect the plant operation. All I&C equipment shall be new, of proven design, reputed make and have data logging facility. Unless otherwise specified, all instruments shall be tropicalized. The outdoor equipment shall be designed to withstand tropical rain and shall be suitable for the worst environmental operating conditions. Wherever necessary space heaters, heat dissipaters, dust and weather proof cabinets shall be provided. Instruments offered shall be complete with all the necessary mounting accessories & safety features.

No custom made hybrid type integrated circuits shall be used in any circuit in instrumentation and control equipment.

Instruments and loggers provided shall be able to carry out continuous real time monitoring and logging of selected water quality parameters.

All instrumentation shall be suitable for continuous real time operation and be powered through the UPS.

The signal/data from all field mounted instruments and skid mounted instruments shall be transmitted to the PLC through hardwired 4-20 mA / 0-10V DC linear having two/four wire system in the respective STP/FSTP/pumping stations/LS for local monitoring, control and automation.

The signal/data transmission from RTUs to central control room shall be GPRS/GSM based and preferably supported with alternate land based fibre communication link.After a power failure, when power supply resumes, the instruments and associated equipment shall start working automatically.

Unless otherwise specified, the normal working range of all indicating instruments shall be between 25% and 80% of the full scale range.

The field instruments i.e. the instruments mounted outside the control panel shall be mounted at a convenient height of approximately 1.2 m above grade platform.

Unless otherwise stated, field mounted electrical and electronic instruments shall be weatherproof to IP-65 or better.

The instruments shall be designed to work at the ambient conditions of temperature, humidity, and contamination that may prevail at site. The instruments shall be given enough protection against corrosion. All wetted parts of instrument sensors shall be non corrosive and suitable for use within sewerage environment.

The performance of all instruments shall be unaffected for the ±10% variation in supply voltage and ±5% variation in frequency simultaneously.

Unless otherwise specified, double compression glands shall be used for glanding the cable in field instruments and instrument control panel.

All digital outputs shall be volt free.

All probe type analyzers should be IP68 rated.

All displays shall be of the digital type with no moving parts and should utilize back lit liquid crystal diode LCD/ LED technology.

Instrumentation shall utilize solid state electronic technology and avoid the use where practical of any moving parts.

Minimum maintenance requirements. The instruments selected shall be rugged and not require any consumables / filling solutions. Systems should be able to work with minimum power requirements.

Lockable enclosure shall be provided for all the field mounted instruments.

All the instruments and cabinets shall have tag plates / name plates permanently attached to them.

All instruments to be used or installed within a corrosive sewerage environment shall be explosion proof and intrinsically safe.

The data obtained from the online quality monitoring system shall be conveyed back via suitable communications protocol, to web servers hosted by a service provider. The service provider shall have the data storage capacity for next 15 years.

Unless otherwise specified, all continuous online monitoring instruments shall be plug and play type.

Instrumentation system shall be provided to monitor the following parameters ***as required***

Online Continuous Dissolved Oxygen Measuring System Ultrasonic Level Measurement

Ultrasonic Differential Level Measurement Flow Measurement Instrument at Parshall Flume

Gas Flowmeter (Thermal Mass Flow Measurement System) Pressure Transmitter

Continuous Online Total Suspended Solids Analyzer Continuous Online pH Measuring System

Online Residual Chlorine Measuring System Conductivity Meter

Ammonia Analyzer Alkalinity Analyzer Indicative BOD Analyzer Indicative COD Analyzer Indicative TOC Analyzer

Measurement of CO2, CH4 and H2S Gas Concentration

Electro-Magnetic Flow Meter

Online Gas Calorific Value Measurement Total Phosphorus

Nitrate Analyzer

Total Nitrogen Analyzer

# Online Instruments

The online measurement at Inlet and outlet for continuous monitoring of the raw and treated sewage/faecal sludge/septage characteristics are specified below. However Concessionaire shall provide additional instruments to support their design.

At the Inlet Point and the Outlet Point

Electro-Magnetic Flow Meter/ Ultrasonic Open Channel Flow Measurement Continuous Online pH Measuring System

Continuous Online Total Suspended Solids Analyzer Indicative TOC Analyzer

Total Phosphorus

Total Nitrogen Analyzer

Online Residual Chlorine Measuring System





# Laboratory Laboratory instruments and sampling system

The laboratory shall be housed within the administrative building and shall be equipped with instruments, equipment, chemicals and other infrastructure that is necessary to perform the

ipment shall be supplied with all the accessories that are necessary to make the equipment functional for analyzing parameters and generating daily reports. In addition to these, Concessionaire shall also provide necessary chemicals, glassware and reagents required for sample testing in the laboratory along with calibration standards / solutions for calibrating the instruments.



The quality of the sewage/faecal sludge/septage entering, passing and leaving the treatment plant shall be monitored via online monitoring equipment as well as manual sampling systems and tested daily, at least from the following parameters:

# Table 2 Parameters to be monitored

|  |  |
| --- | --- |
| **Sl. No** | **Parameter** |
| 1 | BOD |
| 2 | pH |

|  |  |
| --- | --- |
| 3 | SS |
| 4 | Temp. |
| 5 | COD |
| 6 | TOC |
| 9 | Acidity, Alkalinity |
| 12 | MLSS/MLVSS |
| 13 | Dissolved Oxygen |
| 14 | SVI |
| 15 | Total Hardness, Calcium Hardness |
| 16 | Gas Analysis |
| 17 | Calorific Value Monitoring |
| 18 | Volatile Suspended Solids |
| 19 | Total Solids |
| 20 | Specific Gravity |
| 21 | Moisture Content |
| 22 | Total Coliform |
| 23 | Faecal Coliform |
| 24 | Total Dissolved Solids |
| 25 | Bacteria, Escherichia Coli |

Two portable samplers shall be provided to collect composite samples for monitoring from Inlet chamber for raw sewage/faecal sludge/septage and at outlet of STP(s)/FSTP(s).

The laboratory shall have the equipment, storage space and chemicals for all the chemical and bacteriological routine analyses. The area of laboratory shall be sufficient with sufficient length of working platforms and adequate no. of sinks. Area of laboratory shall be defined by Concessionaire as per the requirement of the Concession Agreement. At least the following equipment and all required laboratory chemicals / reagents given in Table 3 are to be provided by the Concessionaire within the scope of work and have to be replenished by him till the end of the O&M Period.

All lab based test instruments results shall be stored automatically and transferred to the PLC as well as web servers on real time basis for control and report applications.

# Table 3: Lab Instruments

|  |  |
| --- | --- |
| **Sl. No.** | **Parameter** |
| 1 | Comparator test set for residual chlorine or chloroscope |
| 2 | Single / Multi parameter meter for pH, Conductivity, DO, Ammonia |
| 3 | Mains operated pH meter completed with one calomel electrode and glass electrode |
| 4 | Turbidity meter - Bench Model |
| 5 | Turbidity meter - Hand held (Portable) |
| 6 | UV / VIS Spectrophotometer |
| 7 | Water bath with 6 to 8 concentric holes and discs, electrically heated |
| 8 | Hot plates 25cm |
| 9 | Ultrapure Water Plant |

|  |  |
| --- | --- |
| **Sl. No.** | **Parameter** |
| 10 | Conductivity with TDS meter |
| 11 | Refrigerator (280 litres capacity) double door / cooling cabinet for sample preservation |
| 12 | Muffle furnace |
| 13 | Electronic Burettes and Dispensers |
| 14 | Magnetic stirrer |
| 15 | Analytical balance (Electronic) with weight box Resolution up to 4 decimal places |
| 16 | Jar-Test apparatus 6 Stirrers |
| 17 | Centrifuge |
| 18 | Flame photometer with gas cylinder |
| 19 | Fume cupboard |
| 20 | Field Test kit for cations and anions |
| 21 | Depth Sampler |
| 22 | Total Organic Carbon Analyser |
| 23 | Sieve shaker with standard sieves and two pan balance weighing up to 200gm samples |
| 24 | Hot Air Oven |
| 25 | Autoclave |
| 26 | Binocular microscope |
| 27 | Automatic Portable Sampler |
| 28 | Pipette Box (Stainless Steel) |
| 29 | Wooden Racks/Aluminium Racks |
| 30 | Wire Baskets |
| 31 | Cotton/ Aluminium Foils |
| 32 | Burners (Bunsen) With Pilot Lamp |
| 33 | Suction Flask (1 Litre Cap) |
| 34 | Suction Pump |
| 35 | Sampling Bottles |
| 36 | Measuring Cylinders (1000 Ml, 500 Ml, 200 Ml, 100 Ml, 50 Ml, 25 Ml) |
| 37 | Vacuum pump |
| 38 | Soxhlet extraction unit |
| 39 | Kjeldhal digestion unit |
| 40 | Weighing Balance (max 10kg) |
| 41 | Laminar Air Flow chamber |
| 42 | M. Endo Broth (dehydrated) |
| 43 | Lactose or Lauryl Tryptose broth |
| 44 | Mac Conkey broth |
| 45 | Brilliant Green Bile Lactose Broth |
| 46 | Total Plate Count Agar |
| 47 | Peptone / Triyptone Water |
| 48 | BOD Analysis: Incubator, Reagents, etc |
| 50 | COD Analysis: COD Reactor 15 Vials, Reagents, etc |
| 51 | Filtration assembly for suspended solids |
| 52 | Incubator 44°C (Water/Air-Jacketed) |

1. **Online Instruments Specifications**

# Flow measuring system

* + 1. **Electromagnetic flowmeter**

Flow meters shall operate on the electromagnetic induction principle and shall consist of a measuring sensor and measuring transmitter complying with ISO 6817:1997. Measuring sensors shall have a full bore stainless steel metering tube and non-conductive, abrasion- resistant lining to suit the fluid being metered. The lining of material can be of polyurethane. No rubber lining will be allowed. The flow meter shall have flanged connection. Measuring sensors shall have factory sealed power and signal cables. Unless otherwise specified, the cable lengths shall be sufficient to permit termination external to the chamber, either at a junction box or at the measuring transmitter. Remote flow indicator cum integrator shall be provided on the control panel.

Measuring sensors installed within a chamber shall be suitable for indefinite submersion under a head of water equal to the chamber depth or 3 meters whichever is the greater. Measuring sensors shall be installed on a steel cradle or concrete plinth with upstream and downstream straight pipe lengths not less than those recommended by the manufacturer. When fitted in lined non-metallic or internally-coated pipe work, measuring sensors shall have an earthing electrode or corrosion resistant earthing rings. To ensure full electromagnetic compatibility the flow tube flanges and transmitter housing shall be connected earth.

Measuring sensors shall be bonded by tinned copper braid links at each end to the adjacent pipe work to ensure a good connection between the body and the metered liquid. Measuring sensors installed in a catholic protected pipeline shall have isolation and bonding in accordance with the recommendations of the manufacturer. The measuring transmitter shall provide a precise current input to the field winding of the measuring sensor and shall convert the resultant signal from the electrodes to analogue and pulse outputs in accordance with IEC 60381-1:1982. The signal processing facilities of the converter shall ensure that the output signals are unaffected by interfering voltages, stratified flow, changes in fluid electrical conductivity within the limit stated, non-homogeneity of the fluid and the presence of ferrous particles. The zero and output signals shall be unaffected by partly- fouled electrodes.

The following measuring transmitter features shall be provided as a minimum:

Measuring transmitter features:

Pulsed D.C. field excitation

Scaled pulse output for integration counter drive

Capability of bi-directional measurement with differing forward and reverse ranges and with local and remote indication of flow reversal

Contact operation at a programmable measured value

Integral display of flow and integrated quantity

Galvanic isolation between each output circuit and between the electrode circuit and output circuit

Output circuit isolation from earth within the instrument but suitable for earthing at any point in the external circuit

Key entry for basic parameters

Commissioning and re-scaling to require no special programming knowledge Adjustable low flow cut-off

Self-diagnosis

Continuously adjustable velocity and flow range settings

Terminals accommodated in a compartment separate from electronic components Outputs including: analogue - 4-20mA

Pulse - two programmable outputs

Alarms - two outputs programmable for high/low

Flow, polarity, forward/reverse, instrument fault, liquid sensing fault condition including partially empty pipe

# Technical specifications

Measuring Principal : Electromagnetic Type : Pulsed DC

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Metering Tube : SS 304

Sensor Housing : SS 304 fully welded Connection / Junction Box : SS 304 Lining Material : PTFE/Polyurethane Range : As per site requirement

Accuracy : ± 0.5% of flow rate at maximum mean velocity of 1.5 to 3.0 m/sec Electrode Type : Flush or bullet nose as recommended by the manufacturer Earthing Ring/Electrode Material: Type 316 stainless steel

Protection Category a.) Sensor : IP-68

b.) Transmitter / Controller : IP-65

Transmitter / Controller Type : Microprocessor Based Display : Indicating and totalizing

a.) Indicator : Digital 16-character display b.) Totalizer : Digital 16-character display Mounting : Pipe, wall, panel

Diagnostic : Inbuilt

Power Supply : 230 V AC ± 10%, 50 Hz

Analog Output : Isolated 4 20mA / 0-10VDC output based on the flow rate Zero & Span : Field Adjustable

Turndown Ratio : Minimum of 10 to 1 when flow velocity at minimum flow is at least

0.3 metres per second

Zero Stability Feature : Required to eliminate the need to stop flow to check zero alignment

Pressure Loss : Very Low Removable Electrodes : Required

Flange Material : Carbon steel, Epoxy Coated Empty Pipe Detection : Inbuilt

Operating Temperature : 0 to 50°C 129

Temperature Compensation: Inbuilt temperature sensors for automatic compensation for changes in air temperature

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc.

# Level measuring system

* + 1. **Ultrasonic level meters**

Ultrasonic level measuring devices applied for liquid level measurement shall comprise of level sensor / transducer, level transmitter, digital level indicator / remote indicator, control unit and any other items required to complete the level measuring system.

The transducer shall be suitable for flange or bracket mounting as required. To reduce the effect of sewage/faecal sludge/septage turbulence in wet wells / tanks, averaging facility should be provided in the transmitter unit for providing steady readings.

The design and application of the ultrasonic level measuring system shall take into account the vessel / sump / wet well / channel construction, the material, size, shape, environment, process fluid or material, the presence of foam, granules, size etc.

In case of ultrasonic level sensor, the installation shall avoid any degradation of instrument performance due to spurious reflections, absorption, sound velocity variations, sensor detection area, temperature fluctuations, specific gravity changes and condensation. For applications where spurious reflections are unavoidable the control unit shall be provided with facilities for spurious reflection rejection. If turbulence exists, shielding, stilling tubes or other measures shall be provided to avoid effects on the measurement.

# Technical specifications

Measuring Principal : Ultrasonic

Application : H2S laden atmosphere and other poisonous gases, corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : As required at site

Accuracy : ± 0.25% of measured value or better

Resolution : 2mm or 0.2 percent of range, whichever is greater Blanking Distance : As short as 0.3 meters

Beam Angle : 12 degrees or less Temperature compensation : Integral Mounting

a.) Sensor : Flange or bracket

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-68

b.) Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting 130 Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 3 SPDT contacts Zero & Span : Field Adjustable

Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Ultrasonic differential level measurement

The ultrasonic type differential level measuring system shall consist of ultrasonic type level sensors on upstream and downstream of screens, differential level computer / transmitter and indicator. The flow computer / transmitter shall be microprocessor based and shall have facility for programming (i.e. adjustment of set points) while the sensor shall be capable of adjustable datum setting facilities.

The differential level control shall be done by two ultrasonic sensors, one before and one after the screen to sense the differential level through the screen and give a signal to the control to start the screens operation as soon as a preset differential level is reached. After receiving the level signal the control shall start and operate the screen as long as the preset level difference appears.

# Technical specifications

Measuring Principal : Ultrasonic

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : As required at site

Accuracy : ± 0.25% of measured value or better

Resolution : 2mm or 0.2 percent of range, whichever is greater Blanking Distance : As short as 0.3 meters

Beam Angle : 12 degrees or less Temperature compensation : Inbuilt Mounting

a.) Sensor : Flange or bracket

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-68

b.) Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 3 SPDT contacts Zero & Span : Field Adjustable

Operating Temperature : 0 to 50°C 131

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Pressure measuring system pressure transmitter

Pressure measuring system shall measure pressure and transmit signal proportional to pressure.

The system shall consist of a combined pressure transducer and transmitter, digital panel indicator, connecting pipe work, diaphragm seal and valves. Pressure measuring system shall be rugged in construction and shall be capable for with standing surge pressures likely to occur in the monitored system. Pressure transmitters shall have over range protection up to 1.5 times the maximum line pressure and shall be capable of withstanding full line pressure on any side with the other side vented to atmosphere without damage or effect on the calibration. No plastic material shall be used in their construction. Internal parts shall be of stainless steel, bronze or approved corrosion-resistant material. Where necessary, a special diaphragm shall be used to segregate the corrosive fluid media. In ammonia applications, the diaphragm shall be in stainless steel. In chlorine applications, the diaphragm shall be in silver or tantalum. In Sulphur dioxide

applications, the diaphragm shall be in tantalum.

The zero and span of a pressure transmitter shall not change by more than ±0.1% of the span per

°C change in ambient temperature. After application for 10 minutes of pressure at 130% of maximum pressure, the change in zero and span shall not exceed ±0.1% of the span. Pressure transmitters shall be protected to BS EN 60529:1992, IP 65 standard or higher. For transmitters installed in locations liable to flooding or underwater applications, they shall be to IP 68 standard and shall operate up to a maximum submergence of 20 meters of water.

*Note: Explosion proof and intrinsically safe transmitters/instruments are required only for instruments/sensor/limit switches/solenoid valves located in the hazardous areas and not for instruments/sensor/limit switches/solenoid valves located in Safe Areas.*

*Instruments in hazardous area installation shall be intrinsically safe and in case of instruments where intrinsically safe option is unavailable, explosion proof shall be provided*

# Technical specifications

Parts : Transmitter and communicator

Type : Electronic variable capacitance; two-wire transmitter

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : As required at site

Accuracy : ± 0.25% of span or better Humidity : 0 to 100% relative humidity

Damping : Fluid or electronic type with adjustment Indicator : LCD with LED backlighting

Materials : Wetted parts including process flanges and drain / vent valves, Type 316 stainless steel otherwise specified

Wetted O-Rings : Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise specified

Fill Fluid : Silicone

Output : 4 20mA DC output proportional to the pressure range

Mounting : Pipe or wall as specified. Provide stainless steel brackets with stainless steel bolts

Housing : Modular with separate compartments for

electronics and field wiring termination. Epoxy coated aluminium, unless otherwise specified

Power Supply : 230 V AC ± 10%, 50 Hz Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc.

# Dissolved oxygen measuring system - DO analyzer

DO analyzers shall be installed to continually record the dissolved oxygen level at every grid within each aeration basin. The primary sensing device used for the dissolved oxygen level measurement, shall be a sensing probe mounted within the aeration basin and connected to a controller for displaying and transmitting the results

# Technical specifications

Measuring Principal : Optical

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 to 20.0 ppm, 0 to 20.0 mg/L Accuracy : ± 0.5% or better

Repeatability : ±0.5% of span Sensitivity : ±0.5% of span Pressure Limit : 4 - 6 bar Temperature Indication : Inbuilt

Calibration Method : Air Calibration: One point, 100% water saturated air;

Sample Calibration: Comparison to standard instrument, or comparison to Winkler Titration method

Cleaning : Air Blast Unit. Probe should be able to function with cleaning unit attached to it

Mounting

a.) Sensor : Inside aeration basin at each grid b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-68 for Sensor

b.) Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts 133 Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Total Suspended Solids Measuring System - TSS Analyzer

**Technical specifications**

Measuring Principal : Optical

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 50 mg/l, 0 - 1000 mg/l, 0 5000 mg/l Accuracy : <5% of reading or better

Pressure Limit : 6 bar

Flow Rate : Maximum 3m per second Temperature Indication : Inbuilt

Calibration Method : Single point or two point Cleaning : Inbuilt

Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-68 for Sensor

b.) Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement pH Measuring System pH Analyzer

# pH measuring system- pH Analyzer

**Technical specifications**

Measuring Principal : Combination / Differential Electrode

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 - 12 pH

Accuracy : ±0.02 pH or better Repeatability : ±0.05 pH Sensitivity : ±0.01 pH Pressure Limit : 4 - 6 bar

Flow Rate : Maximum 3m per second Temperature Indication : Inbuilt

Temperature Compensation : Inbuilt automatic temperature compensation Temperature Accuracy : ±0.5 °C

Calibration Method : Two point automatic, one point automatic, two point manual, one point manual

Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

For Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Residual Chlorine Measuring System Residual Chlorine Analyzer

**Technical specifications**

Measuring Principal : Amperometric or DPD Colorimetric

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 10 ppm

Accuracy : ±3% of the reference test or better Resolution : 0.001 ppm

Repeatability : 30 ppb or 3%, whichever is greater pH : Automatic

Temperature Compensation : Inbuilt temperature sensor Temperature Indication : Inbuilt

Pressure Limit : 0.5 bar

Flow Rate : Maximum 50 L/hour

Calibration Method : 1-point or 2-point calibration Mounting : Wall, Panel

Protection Category a.) Sensor : IP-65

b.) Transmitter / Controller : IP-66 (NEMA 4X)

Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20 mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Conductivity Measurement Conductivity Analyzer

**Technical specifications**

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 - 

Accuracy : ±0.5% or better Temperature Compensation : Inbuilt Temperature Indication : Inbuilt Pressure Limit : 6.9 bar

Flow Rate : Maximum 3m per second Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

For Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts

Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Ammonia Measurement - Ammonia Analyzer

**Technical specifications**

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 5 mg/l, 0 - 50 mg/l

Accuracy : 3% ±1mg/l or better Repeatability : 2% ±1mg/l or better Flow Rate : Maximum 20 L/h Cleaning : Automatic

Mounting

a.) Analyzer : Wall, Panel

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Analyzer : IP-55 or better

b.) Transmitter / Controller : IP-66 or better Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Cable Length : As per site requirement

# Alkalinity Measurement Alkalinity Analyzer

**Technical specifications**

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 500 mg/l

Accuracy : ±5% of reading or ±1.0 mg/L, whichever is greater

Repeatability : ±3% of reading or ±0.6 mg/L, whichever is greater Pressure Limit : 2 bar

Flow Rate : Maximum 2 L/m Mounting : Wall, Panel

Protection Category : IP-66 (NEMA 4X) Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C 137

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc.

# Total Nitrogen Measurement Total Nitrogen Analyzer

**Technical specifications**

Measuring Principle : UV Absorption

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 30 mg/l, 0 - 80 mg/l

Accuracy : ± 3% of mean + 0.5 mg/l Resolution : 0.1 mg/L

Pressure Limit : 0.5 bar Cleaning : Automatic Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-68

b.) Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20 mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# BOD Measurement Indicative BOD Analyzer

**Technical specifications**

Measuring Principle : UV Absorption

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 50 mg/l, 0 - 500 mg/l

Accuracy : ± 5% or better Compensation : 550 nm Sample pH : 4.5 to 9 pH Pressure Limit : 0.5 bar Cleaning : Automatic 138 Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-68

b.) Transmitter / Controller : IP-66 (NEMA 4X) Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# COD Measurement Indicative COD Analyzer

**Technical specifications**

Measuring Principle : UV Absorption

Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 250 mg/l, 0 - 1000 mg/l Accuracy : ± 5% or better

Compensation : 550 nm Sample pH : 4.5 to 9 pH Pressure Limit : 0.5 bar Cleaning : Automatic Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-55 or better

b.) Transmitter / Controller : IP-55 or better Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# TOC Measurement Indicative TOC Analyzer

**Technical specifications**

Measuring Principle : UV Absorption / UV Pursulphate Application : H2S laden atmosphere and other poisonous gases, Corrosive Waste Water Environment

Safety : Explosion Proof or Intrinsically Safe Range : 0 - 1000 mg/l

Accuracy : ± 5% or better Compensation : 550 nm Sample pH : 4.5 to 9 pH Pressure Limit : 0.5 bar Mounting

a.) Sensor : Inside pipe / channel / tank

b.) Transmitter / Controller : Wall, Panel, Pole Protection Category

a.) Sensor : IP-55 or better

b.) Transmitter / Controller : IP-55 or better Transmitter / Controller Type : Microprocessor Based Diagnostic : Inbuilt

Display : LCD with LED backlighting Power Supply : 230 V AC ± 10%, 50 Hz Analog Output : Isolated 4 20mA

Relay Contacts : Minimum of 2 SPDT contacts Operating Temperature : 0 to 50°C

Communication Protocol : Open Protocol like MODBUS, PROFIBUS, etc. Sensor Cable : Integral to sensor

Cable Length : As per site requirement

# Surge Protection Devices

Surge protection devices (SPDs) shall be suitable for withstanding the surge arising out of high energy static discharge / lighting strikes and protect the instrument to which it is connected against damage. SPDs shall provide protection through the use of quick acting semiconductors like Tranzorb, zener diodes, varistors and an automatic disconnect and reset circuit. SPDs shall be passive and shall require negligible power for operation. During the occurrence of a surge it shall clamp on the allowable voltage and pass the excess voltage to the ground. The SPD shall be self resetting to minimize the down time of the measurement loop.

SPDs shall be provided to protect devices transmitting and receiving analogue and digital signals derived from field devices located outdoors.

The surge protection device shall be rated for surge rating of 10kA.

# Cabinets for field instruments

Wall mounted cabinets shall be provided for enclosing transducer unit and associated accessories which are mounted outside the main control panel. The cabinet shall be of die-cast aluminium; field provided not less than IP-65 protection and shall be lockable. The cabinet shall have facilities for earthing. A steel plate shall be provided inside the cabinet for mounting instrument and accessories.

# Panel Details

* 1. **Cabinet / Enclosure for Instruments**

Enclosures shall be any form of board, cabinet, panel, desk, box or case used to protect, contain or group instrumentation, telemetry or control equipment. Cabinets shall be fabricated from cold rolled steel with powder coating sheet of minimum 2 mm thick and shall be suitable for wall mounting or pedestal mounting as required. A steel plate/pipe, as per the requirement, shall be provided in the cabinet for mounting the instrument and accessories. The cabinet shall be properly painted from inside and outside and shall have built in locking facility. The cabinet shall also be earthed properly. All equipment in or on enclosures shall be arranged logically and, as far as possible, symmetrically, with projections kept to a minimum. Each enclosure shall be designed on ergonomic principles and shall permit in-situ and safe access for any normal adjustment,

maintenance and servicing. The tops of plant-mounted enclosures shall be sloped downwards from front to rear.

The minimum degree of protection shall be IP 54 for indoor locations and enclosures for use outside buildings or in places where splashing may occur shall have a minimum rating of protection to BS EN 60529:1992, IP 65 and have tops which project sufficiently to protect the vertical faces of the enclosure and any component mounted thereon from splashing, inclement weather and direct sunlight. Also, when enclosures for use outside buildings are located where exposure to direct sunlight will give rise to high top-panel surface temperatures such that the internal temperature rises above the manufacturer   enclosure shall include a sun shield fitted to the top of the enclosure and should have sufficient air ventilation for heat dissipation.

Fixing arrangements for surface-mounting enclosures shall be external to the enclosure and shall ensure that the rear face of the enclosure is not in contact with the surface to which it is fixed.

Enclosures shall have hinged access doors, fitted with recessed lockable handles. Doors shall be of rigid construction and provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Hinges shall be of the lift-off pattern and one hinge shall engage before the other for ease of fitting. Wherever necessary, removable access covers secured by quick-release fasteners shall be provided to ensure ease of maintenance for all installed apparatus. Mounting plates, brackets and racks shall be provided for all other internal equipment which shall be hinged or otherwise arranged with quick-release fasteners or captive screws to give quick and easy access to equipment, securing screws, terminals and wiring.

Enclosures for two or more devices with electrical circuits shall have gland plates and terminal blocks as specified elsewhere. Each enclosure shall be designed for the safe testing and servicing of equipment with the power on. Each part which may be live under any circumstances shall be so covered or shielded as to prevent inadvertent contact.

# Panel Design and Construction

Unless otherwise specified, all instrument panels, instrument cubicles, control panels, control consoles and desks, associated equipment and terminal racks, telemetry and electronic equipment racks and the like shall be free-standing, floor-mounted units and shall conform to the requirements of this part and will hereafter be referred to as panels. The design and dimensions of control consoles and desks shall be determined according to their intended function but shall be in accordance with the requirements of the Specification drawings. The height shall not exceed 1400mm above the finished floor level.

Unless otherwise specified as per the approved Design and Drawings, the height of panels shall be not greater than 2130mm overall (excluding lifting devices) above finished floor level. Front of-panel instruments and controls shall be mounted so that the height of their centers above the floor shall be generally between 1800mm and 900mm for indicators, 1400mm and 900mm for recorders and process controllers, 2000mm and 750mm for alarm facias and signal lamps and 1500mm and 750mm for manual controls. Controls, switches and push-buttons shall be positioned below or adjacent to any associated reading instrument. Panels for use in locations

such as pumping stations and machinery rooms shall have anti-vibration mountings. The clearance between the extremities of apparatus mounted on the internal walls shall allow safe and unobstructed access to all terminals and to parts requiring maintenance. Panel layout drawings shall normally include a list of all instruments, accessories and components contained therein. If the drawings have insufficient space for the list, a separate schedule of instruments, accessories and components shall be provided and the panel drawing shall contain a cross reference to the contents list and an indication of the panel location of each item on the list.

# Panels - major

Panels shall be constructed generally as specified in the preceding clause and as shown in the Specification drawings. Panel material shall be prime-quality, cold-rolled and annealed mild steel or zinc-coated mild steel sheet, suitably braced and stiffened as necessary with flat bar or angle to form a rigid structure.

Panel fronts shall be flat and free from bow or ripple. Exterior corners and edges shall be rounded or welded and ground to give a smooth overall appearance. Flanged edges shall be straight and smooth. Materials shall be chosen with due regard to the panel size, number of cut-outs, instrument weight and position of centre of gravity and method of fabrication, with the following:

minimum thicknesses

Instrument bearing surfaces, gland plates and pneumatic distribution plates: 3mm Internal mounting plates: 3mm

Doors, covers and filler panels: 2mm

No design involving the use of externally-visible assembly or fixing bolts and screws nor any design resulting in dust or water-collecting crevices will be accepted. Stiffeners and supporting frameworks shall be provided where necessary inside panels. Framework shall be hinged or fixed, suitable for the installation of instruments, components and internal equipment for which it is provided and located to give easy access to adjacent equipment.

When a panel is constructed in sections, the sections shall be designed for ease of assembly during installation and, in any case, shall not exceed 2 m in length. All necessary nuts, bolts, washers and the like shall be supplied and included in the same shipment as the relevant sections. Sections exceeding 1 m in length shall be provided with double doors. Unless otherwise shown in the Specification drawings, each panel shall be mounted on a self-draining base frame fabricated from 150 mm deep, steel channel section which shall be drilled or provided with clamps for bolting to the floor. The base frame shall be set back from the panel front face to give a toe space of not less than 25mm. The outside of the base frame shall be covered with an approved kicking strip.

Ceiling and other filler panels shall be fabricated from sheet steel and adequately stiffened. Each section shall have 50 mm returned edges along all four sides and shall be braced to the main steelwork of the panel. A chequered plate floor shall be provided inside and above the level of the base frame, having openings suitable for the bottom entry of cables when applicable. Sufficient

removable undrilled gland plates, in sections convenient for handling, shall be fitted close to the appropriate terminal blocks and not less than 230 mm above the panel floor or not less than 230 mm below the panel top. The gland plates shall have removable side covers giving access to both sides of the gland plate and ensuring vermin-proof and dust-proof construction. Gland plates of a surface-mounted enclosure may form a part of the base or top. Panels containing pneumatic or other instruments using a fluid as the transmission medium shall have distribution plates with bulkhead unions for the termination of internal and external pipework.

All doors shall open outwards and all doors in one panel assembly shall use the same lock and key combination. Panel design shall ensure adequate ventilation and air circulation without permitting the entry of vermin or dust. Panels installed in control rooms or other clean condition areas shall have louvres to allow air circulation. Temporary closures shall be provided to prevent the entry of dust and vermin during transit and installation. After commissioning has been completed, all entries except air-circulation louvres shall be sealed.

No equipment other than front-of-panel items shall be mounted on panel wall surfaces. If electrical and non-electrical instruments are mounted in the same panel, the panel shall be subdivided internally to separate the electrical and non-electrical sections. All connections shall be arranged to ensure that no accidental damage to cabling or electrical components can occur in the event of failure of any non-electrical component or connection. Provision shall be made for safe and easy handling during transit and installation. If lifting eyes are provided, they shall be reversible and panel tops shall be reinforced where necessary.

Where equipment is specified to be installed at a future date, space shall be allocated, and cutouts with removable masking plates, brackets, supports, wiring, terminals and piping and the like shall be provided. Panels shall be finish-coated at the place of manufacture before commencing the installation of apparatus and other fittings.

# Panels - Minor

Panels for installation on the Plant which contain relatively few items of equipment, or where so specified elsewhere, shall be provided s minor panels and shall be constructed generally as specified in the preceding clause and comply with this Clause. Panels shall be fabricated from sheet steel or other approved material less than 2.5mm thick suitably braced to form a robust and rigid structure. Exterior corners and edges shall be rounded to give a smooth overall appearance and assembly bolts, screws or rivets shall not be visible on the front face.

The design shall be such as to ensure adequate ventilation and air circulation where required, without permitting the entry of vermin. Openings for cables shall be made vermin-proof. Doors shall be hinged and shall be provided with close-fitting flexible seals in recesses to prevent the ingress of liquids, moisture, dust and vermin. Unless otherwise specified, panels shall be suitable for floor mounting and shall not exceed 2130mm in height. Where surface mounted panels are provided, the fixing shall prevent the ingress of moisture and the rear of the enclosure shall be not less than 10mm from the wall.

Lifting eyebolts shall be removed and replaced with bolts after installation. Panels shall be

extensible, and symmetrically arranged as far as possible with projections kept to a minimum. Where two or more panels are fitted together, they shall form a flush-fronted continuous panel of uniform height. Front door and top cover dimensions shall match. Instruments, relays, and control devices shall be mounted at a height not more than 2000mm and not less than 300mm from floor level.

The arrangement of equipment within each enclosure shall be such as to permit easy access for installation and maintenance. No instruments, relays or other components shall be mounted on rear access doors or removable covers.

# Panels - composite

In situations where space limitations preclude the use of separate instrumentation, control and automation (ICA) and switchgear panels and with prior approval of the consultant ICA equipment may be combined within a single enclosure subject to the following conditions:

***Enclosure***

The observance of all other clauses herein relating to enclosures, mounting boards and minor panels.

The written assurance of each supplier of ICA equipment that the proximity of the switchgear will have no detrimental effect on the life or performance of any ICA component

The total segregation of ICA equipment and switchgear including the glanding and termination facilities.

The absence of any voltage exceeding 250V ac or 50V dc from any compartment containing ICA equipment.

The use of the full height of the panel (excluding the busbar chamber and cable space) for any ICA equipment compartment.

# Panels - Glass Reinforced Plastic (GRP)

Any panel required to be installed outside buildings shall be manufactured from double-skin, resin-

plywood to BS 1203:2001 between the two skins to provide a rigid and vandal-proof enclosure. The environmental rating shall be IP 65 or better.

For any application in a non-temperate climate or where so specified elsewhere, the roof section shall be sloping and have a totally-encapsulated infill of end-grain balsa instead of plywood. Box section steel shall be encapsulated into door edges and door frames. Door locks, handles and hinges shall be of a high tensile strength, non-corroding alloy with stainless steel pins and through fixing bolts. Large plane surfaces shall have adequate reinforcing to ensure rigidity.

The doors shall be complete with latching handles and locks. All door catches and locks shall latch onto steel-reinforced surfaces. Threaded studs shall be incorporated into the design of the

panel for the mounting of sub frames within the panel. Any panel drilled to provide fixings for internal equipment will not be accepted. Each cubicle shall be provided with a floor or deck with a removable gland plate for cable entry.

The laminate material shall have flame-retardant characteristics in compliance with BS 476 Class

 -impregnated gel



-

finishes. The internal finish colour shall be white. The fronts of externally-visible instruments and windows shall be of glass. An air-gap of 100mm shall be provided between the top surface of the panel and its protective canopy. All internal equipment shall be mounted on supports built into the fiberglass structure. Fixing bolts through the skin will not be accepted.

# Panel protection

Adequate facilities for isolation and protection by miniature circuit breaker or fuse for each instrumentation and control circuit and sub-circuit shall be provided and shall be so arranged that any interruption causes minimum disruption of plant, operates the appropriate alarm and cannot result in any unsafe operating condition. All fuses shall be of the cartridge pattern and main fuses shall be of the high rupturing capacity type. Fuse and solid-link carriers and bases shall be of plastic-moulded insulating material as per best industry practices. Ceramic materials will not be accepted. Live connections shall be efficiently shrouded and it shall be possible to change fuses with power on without danger of contact with live metal. The fuses shall be rated to give maximum protection to the equipment in circuit and the rating shall be permanently inscribed on the fuse label and on the fuse carrier.

Unless necessary for the protection of particular equipment, miniature circuit breakers used for individual circuits in a panel or control desk shall not trip on over-voltage or under-voltage. Bases for solid links shall not be interchangeable with those for fuses. Fuses and links in the same circuit shall be mounted opposite each other in separate adjacent rows and shall not alternate in the same row. At least 10% and not less than two unallocated miniature circuit breakers or fuses and links shall be provided in each panel distribution board. Miniature circuit breakers and fuses of similar size and rating shall be of the same make and type. At least 10%, and not less than two, spare fuses and links of each rating shall be provided and fitted in clips inside the panel.

Each instrument requiring a power supply shall be individually wired and protected so that, in the event of a failure in one circuit, the remainder is unaffected. Power supply circuits shall be of sufficient rating that any protective device may operate without reducing the voltage at the terminals of any other component to an unacceptable level. Remote alarms shall be operated on failure of the electrical supply to a panel or to any internal sub-circuit. Clearly identifiable, switched socket outlets of 15A minimum rating to comply with IS 4615, supplied at the main cabinet operating voltages shall be fitted within the panel at the rate of one for each operating voltage per meter of panel length; for a panel whose length is less than one meter, one switched socket outlet for each main operating voltage shall be provided. Suitable socket outlets for portable tools and hand lamps shall be provided as specified elsewhere.

# Panel isolation

Clearly-labelled isolating circuit breakers shall be provided for each incoming power supply. Switches shall be of the quick make-and-break type with spring-loaded contacts that close fully without requiring full operation of the handle. The handle and cover shall be interlocked so that the handle cannot be operated when the cover is open and the cover cannot be opened unless the

clearly.

Circuit breakers for panel power supplies shall be mounted near an access point and in positions where they may be operated easily from a standing position. Plug-in isolating links or devices of an approved type shall be provided in any circuit that may still be alive when the power supply

xample, in circuits controlling equipment whose power supply is independent of the panel. Such links or devices shall be properly screened and, if not incorporated in or adjacent to their associated outgoing terminals, shall be labelled with suitable warning notices. Any item of panel equipment to which panel internal wiring is connected with a plug and socket instead of terminals shall be wired in flexible cable of adequate rating between

er supply connector shall be



a socket.

# Panel terminal blocks

External wiring for panel power supplies shall be terminated on the appropriate isolator. Signal cables from strain gauges, analyzers, resistance thermometers, re-transmitting slide wires and thermocouples may be terminated at their appropriate instruments. A terminal block shall be provided as the interface between the corresponding conductors of each internal and external wire and each internal and external connection except those listed above. The terminal blocks shall be mounted vertically where possible and not nearer than 230mm to the floor or less than 230mm from an incoming cable gland.

Terminal block rows shall be spaced apart by not less than 150mm and arranged to permit convenient access to wires and terminals and to enable ferrule numbers to be read without difficulty. Other circuits shall be grouped on the terminal blocks according to the classification

   along the corresponding section of each terminal board. Groups of different voltages on the same board shall be separated by insulated barriers.

All connections shall be made from the front of terminal blocks and no live metal shall be exposed at the back. All terminal blocks shall be of the type which clamps the wire securely and without damage between two plates by means of a captive screw and which permits removal of any terminal without disturbance to adjacent terminals. Pinch-screw type terminal blocks will not be accepted. Terminal mouldings shall be in melamine to ISO 2112:1990, polyamide or equivalent. Terminal rails shall be hot-dip galvanized. Current bars between the two connection points of each terminal block shall be of copper or brass with tin/lead alloy plating. All steel parts shall be zinc-plated and passivated with a yellow chromate layer.

Terminal blocks for input and output analogue signals and for circuits containing volt-free

contacts internal or external to the cabinet shall be of the Klippon type SAKC or equivalent which permit the connection of a test millimeter or continuity meter without disconnecting any wiring.

Terminal blocks for power supplies for equipment external to the panel shall permit the isolation of the item of external equipment without affecting the operation of any other circuit within or outside the panel.

No more than one core of external cables or one internal wire shall be connected to any terminal. If terminal blocks are used as common points for two or more circuits, individual terminals with the appropriate number of permanent cross-connections shall be provided. The lengths of exposed cable cores shall be sufficient to reach any terminal in the appropriate row or rows. The cores shall be formed into a neat loom and a separate loom shall be provided for each cable.



shall be fitted on each core of all external cables and on each internal wire. The size of the terminals shall be appropriate to the size and rating of the cable cores which will be connected to them but shall not be smaller than Klippon type SAK2.5 or equivalent.

Each row of terminal blocks shall contain at least 25% spare terminals over the number required for terminating all cores of external cables in that row. Unless otherwise specified or shown in the Specification drawings, each external cable shall contain at least 20% spare circuits, with a minimum of one spare circuit. Terminal blocks shall be numbered consecutively in a sequence different from that used for identifying wiring. The terminal numbers, voltage grouping and terminal board layout shall correspond precisely with wiring diagrams so that quick and accurate identification of wiring can be made. All the terminal boards shall be provided with covers of transparent insulating material that does not sustain combustion and shall be sectionalized where possible to give access to groups of terminals without uncovering all boards. Terminals which may be live when the panel is isolated from its main supplies shall be suitably labelled to minimize the risk of accidental contact.

# Panel internal wiring

Panel circuits shall be segregated into the following categories:

*Group 1: Power control and very-high-level signal wiring (above 50V):*

AC power supplies DC power supplies

DC current signals above 50mA (such as CT circuits)

AC voltage and control signals above 50V (such as PT circuits)

*Group 2: High-level signal wiring (6V to 50V dc):*

Signals from conventional electronic transmitters and controllers (such as 4mA to 20mA)

Circuits to alarm enunciators and other solid-state devices (excluding those in categories 2.1, 2.5, 3.1, 3.2 and 3.3)

Digital signals

Emergency shut-down and tripping circuits On / Off control circuits

Intrinsically safe circuits Speech-frequency circuits

*Group 3: Low-level signal wiring (5V dc and below):*

Signals from thermocouples

Signals from resistance thermometers and re-transmitting slide-wires Signals from analytical equipment and strain gauges

*For Group 3 wiring, internal connections to the instruments shall be made by one of the following methods:*

The twisted, screened conductors of the external cable shall be led direct to their appropriate instruments via ducting systems installed for this purpose during construction of the panel.

The conductors of the external cables shall be terminated on terminals segregated from all other categories and the connections to the appropriate instruments shall be made using twisted pairs with individual screening installed for this purpose during construction of the panel.

Internal wiring for all circuits in Group 2 except those sharing a common connection shall be multi-stranded, twisted pair, 0.75mm² minimum copper conductors with HPDE or PVC insulated cable of adequate grade and rating in accordance with BS 6004:2000. Wiring for circuits in other Groups or sharing a common connection shall be run in stranded, 1.0mm² minimum copper conductors with 250V grade, PVC-insulated cable of adequate grade and rating. Wiring sheath colours shall be black for AC circuits, and grey for DC circuits (excluding thermocouple circuits) and blue for Group 2.6 circuits. Circuits supplied at 240V, between 240V and 110V dc shall also be physically segregated from each other and from other circuits. Access to wiring and components of circuits having voltages exceeding 240V shall not be possible unless and until the circuit has been isolated.

Separate ducts, trunking, cable looms, tray work and the like shall be provided within the panel for each category with at least 150mm between parallel paths of Group 1 and those of any other Group. Intrinsically-safe circuits and their terminals shall be segregated from other circuits and terminals. All wiring shall be neatly and securely fixed by insulated cleats, bunched and secured by approved plastic strapping or run in approved insulated wiring trunking or non-corrodible flexible tubing. Not more than 75% of the capacity of trunking, ducts, looming, or tubing shall be used. Insulated earth wiring shall be so arranged that access to any equipment or connection point or the removal of any item of equipment is unimpeded. Wiring for future equipment shall be secured and terminated on terminal blocks. Lacing for wiring looms shall be of rot-proof cord or

plastic strips. Inter-section wiring in multi-section cabinets shall be via a terminal block in each section.

# Panel wiring identification and termination

Identification ferrules shall be fitted at both ends of each wire. The numbers or letters used shall correspond with the appropriate wiring diagram. The ferrules shall be of plastic insulating material with permanent black characters on a colour-coded background for numbers and on a white background for letters, unaffected by oil or water. They shall be so arranged that they can be read logically from left to right when viewed normally. The system of wire identification shall be such that wires in the same circuit on opposite sides of a terminal shall have the same reference, and this system shall be continued through all external cabling. Terminal ferrules (spade, tongue, crimped connections) shall be provided on each conductor.

# Panel earthing

A continuous copper earth bar of not less than 25mm % 6mm cross section shall run the full length of each panel and shall be securely fixed and bonded electrically to the main frame. The cable gland-plates and the earth bar shall be provided with suitable brass terminals of not less than 6mm diameter for connecting the metal cladding or armouring of all incoming and outgoing cables to the station earthing system.

A second continuous copper earth bar of not less than 25mm % 6mm cross section, electrically isolated from the steelwork of the panel and metal cladding and armouring of cables, shall be provided for earthing the signal earth connection of each instrumentation and control device and the screen(s) of each instrument cable not earthed elsewhere to the station instrumentation earth plate. The earth bar shall have sufficient brass terminals as specified above for each instrumentation and control device and the screen of every shielded cable plus 25% spare terminals. In multi-section panels, each earth bar shall be electrically bonded to the corresponding bars in the adjacent section(s). Instrumentation and instrument cable screen earthing shall comply with BS 6739: 1986, Section 10, unless otherwise stated in this clause.

# Panel Heating

Each panel shall have one or more thermostatically-controlled tubular or ribbed panel heaters to prevent condensation and assist ventilation and which shall be adequate for ambient temperatures down to 5°C. The heater rating shall not exceed 0.2W/Sq.mm and the surface temperature of any part which could be contacted accidentally shall not exceed 60°C. Heaters shall be so situated that no deterioration can be caused to any equipment or wiring in the panel. The heating circuits shall be switched and fused independently of the instrumentation and control equipment and manually controlled by an enclosed switch mounted in an accessible position within the panel. Thermostats shall be mounted remote from the heaters and other sources of heat and shall be fully adjustable over a range of not less than 0°C to 50°C. Thermostats shall cut out each heater when the internal temperature of the panel exceeds a preset value; differential thermostats shall be used to maintain the panel internal temperature at a pre-set value above the external ambient temperature. If the permanent power supply is not available at the time of installation of the panel and condensation

is detected, a temporary power supply shall be connected to the panel of sufficient rating to operate the heaters.

# Panel lighting

Each panel shall be adequately illuminated internally, as evenly and as free from dazzle as possible, by fixed fluorescent lighting controlled from totally-enclosed light switches and by totally-enclosed door-operated switches positioned so as not to interfere with access. There shall also be one installed inspection lamp per three meters of panel length or part thereof with adequate flexible connection cable to reach any point in the panel. The control switch for an inspection lamp shall form part of the lamp assembly. Lighting circuits shall be fused independently of any instrumentation and control circuit and designed to allow lamps to be replaced safely and shall be fed from a distribution board and circuit breaker connected on the live side of the main panel ac supply circuit breaker.

# Panel ventilation

Each panel shall be provided with ventilation fans as required to ensure that equipment within the

in which the panel will be mounted. Fans shall be controlled by a suitably labeled enclosed switch mounted internally in an accessible position. Fans shall be mounted with their axes horizontal and shall be arranged to draw clean air into the panel. Air entries shall have filters which can be renewed from outside the panel and shall be designed to prevent the entry of rain, spray, injurious fluids, sand or dust.

# Panel piping and tubing

Panels containing equipment using a supply of compressed air shall have a common air pressure reducing station with duplicate pressure-reducing valves and filters. The pressure reducing station shall also include isolating valves upstream and downstream of each filter/reducing-valve set, pressure-relief valve, pressure indicator and low-pressure alarm unit for the low-pressure header and a pressure indicator for the high-pressure pipework. The pressure-reducing station components shall be mounted in a clear space inside the panel, supported on a suitable framework between the lower horizontal row of instruments and the main low-pressure header. All piping, fittings and valves downstream of the pressure-reducing station shall be of brass, copper or plastic. PTFE tape shall not be used downstream of the main filters. The low-pressure header shall be brass and shall be near the panel floor with drain valves and tundishes piped to a drain. Branch air headers shall be of brass (15mm diameter minimum) and shall run vertically from the header to the instrument. The low pressure header and each branch shall have a 6mm minimum, non-ferrous shut-off valve for each instrument requiring an air supply and a compression coupling for each air-purge connection. At least 10% spare connections for possible future instruments shall be provided in each panel section. Any header dismantled before shipment shall have brass unions or flanges at each panel-section junction. Panel-mounted instruments shall be

shall be colour-coded in accordance with

Instrument Society of America and shall be segregated from wiring so that any leakage is

harmless. Each panel-mounted pressure gauge shall have a stainless steel flush-mounted shut-off and fine-regulating valve mounted vertically below. A drip tray shall be provided below each row of gauges. Exhaust and de-pressurizing pipework shall be routed out of the panel.

# Panel labels

Labels shall be provided for every panel to describe the duty or otherwise identify the panel and its sections and every instrument, component and item of equipment mounted internally and externally. Where applicable, front-of-panel labels shall be as shown in the Specification drawings. Each label shall be permanently secured to the surface near the item to which it refers. Externally-fitted labels shall be of perspex or other approved transparent plastic, with letters and numbers rear-engraved and filled with black. The rear surface of each perspex label shall be finished with a coat of paint of the same colour as the panel external finish. Instrument duty labels fitted externally shall be below the item to which they refer. Embossed tape or similar adhesive labels will not be approved.

Laminated materials or rear-engraved and filled plastic shall be used for internally-fitted labels, which shall be white with engraved black letters. Labels conforming to the requirements of the preceding paragraphs or other approved means shall be provided:

Labels

To describe or identify circuits or circuit components To identify DC polarity

To warn or remind about dangerous or potentially-dangerous circumstances Wherever elsewhere specified

Unless otherwise specified, all engraving shall be in plain block letters, 4mm high. The minimum practicabl  shall not be fitted on panel external surfaces.



# Panel finish

For control and instrument panels, desks and cubicles a hard, smooth, durable finish, free of blemishes, shall be provided. Before painting, all external welds and any rough areas shall be smoothed, and all surfaces shall be thoroughly cleaned and free from scale, contaminates corrosion or grease. If rust-proof or Zintec steel has not been used in the construction, the panel shall be treated with a passivating agent such as phosphoric acid. All internal surfaces shall have a minimum of three coats of paint of which the first shall be an approved antirusting priming coat and the final coat shall be opaque gloss white enamel. All external surfaces shall have not less than five coats of paint of which the first shall be an approved etch priming coat, and the second and third suitable undercoats, all of which shall be rubbed smooth when dry before application of the next coat. The undercoats shall be easily distinguished in shade or colour from the priming and finishing coats. The two final coats shall be of stove enamel paint, gloss or semi-matt finish, to a colour and finish. Stoving shall be carried out in accordance with the recommendation of the paint manufacturer. The overall dry film thickness (DFT) shall be between 85 and 120 microns.

Nuts, bolts, washers and other fixing devices which may have to be removed for transit or maintenance purposes shall be galvanized or otherwise finished to an approved standard. A 500ml tin of matching touch-up paint shall be provided and packed with each panel.

# Electrical Indicators and Integrators

Indicators for use with analogue signal-transmission systems shall comply with BS 89:1990 or equivalent and have an accuracy class index of 1.0. Indicator movements shall be critically damped (dead-beat). Indicators for use on more than one circuit shall have rotary switches to select the circuit, with engraved plates to show the circuit selected. Indicators shall have circular scales or shall be of the vertical edgewise type and shall be designed to avoid parallax error.

Scales shall be clearly marked in SI units and shall comply with BS 3693:1992 or equivalent. All instruments mounted on one panel or board, or in adjacent groupings, shall have similar styles of figures and letters. Dials shall be white with black scales and lettering not subject to fading.

The material for scales shall be such that no peeling or discolouration will take place with age under any environmental conditions. Major scale marks and numerals shall be of the same size and thickness and shall be separated by not more than twenty-five minor marks. Pointers shall taper to the width of the scale marks. Integrators shall be of the multi-digit cyclometer type. Integrators operating in conjunction with an electromagnetic or ultrasonic flow meter shall use the pulse output from the flow transmitter. Any integrator operating from a device without a pulse output shall have an integral or separate current-to-pulse converter with sufficient adjustment of the pulse rate to avoid the use of any multiplying factor except in integer power of 10. Each integrator shall incorporate an adjustable limiter whereby any input below a pre-set value is inoperative. Unless otherwise specified, integrators shall have a minimum of eight digits with a decimal point where applicable.

# 17.1. Alarm System

Alarms shall be initiated by the opening or closing of volt-free contacts which shall remain unchanged throughout the periods in which the alarm conditions exit. Alarm circuits shall be capable of conversion from open-healthy to open-alarm or vice versa by a simple modification after installation requiring no additional parts or special equipment.

Each alarm shall initiate the operation of both visual and audible devices. The sound intensity of each audible device shall be suitable for the maximum sound level of its environment.

Audible devices in the same room or area shall have distinguishable sounds and adjustable sound levels.

# Matrix Type Alarm Annunciators

The alarm annunciator shall be microprocessor based, modular, split type unit with alarm windows mounted on the front door and electronic modules inside the panel. The weather protection class for alarm annunciator shall be IP-54 of IS 13947, Part-I. Each alarm shall initiate a visible and audible indication of the specified condition. Unless otherwise specified, alarm

indicators shall be grouped together in annunciator units each having at least 20% spare ways. Alarm indicator lamps (Cluster LED type) shall have transparent screens engraved with appropriate legends as approved in the Designs and Drawings. The legend area of each indication shall not exceed 40mm high and 75mm wide. When any alarm condition occurs, a condition device common to an alarm annunciator system shall sound and the appropriate indicator shall flash on an off. The flashing rate shall not be less than 2 Hz and shall not exceed 5 Hz. On pressing an accept pushbutton, the audible device shall be silenced and the flashing light shall become steady. The alarm indicator shall remain illuminated until the alarm condition ceases and a reset pushbutton has been operated.

The operation or acceptance of one alarm shall not inhibit the operation of the audible device or the flashing of the appropriate alarm indicator if a further alarm condition occurs.

At unmanned locations alarms operated on two or more annunciators shall require acceptance at each annuciator. Alarms shall be accepted automatically and the appropriate audible device silenced after an adjustable period of 1 to 5 minutes.



and to operate the audible device but shall not cause a spurious alarm condition on any other annunciator.

Alarm circuitry shall be arranged so that spurious or transient alarm states persisting for less than

0.5 seconds do not initiate any action.

Alarm annunciator / indicator legends or labels shall be arranged with three lines of text as follows:

Top Line: Location; example: sludge blanket level Middle line: parameter; Level

Bottom line: status. High

# Push-Buttons and Indicator Lights

Push-buttons in control circuits shall have shrouds, guards or other suitable means for preventing inadvertent operation. Status-indicator lights shall be of the high-intensity LED type. Indicator lights shall be of a design which allows easy LED replacement from the front. Indicator lights shall be easily visible above the ambient light level when viewed from within an included angle of 120 degrees. LEDs shall be chosen to ensure clear discrimination between the energized and de-energized states and to ensure an average working life of not less than 3000 hours. A -button shall be provided for each group of indicator lights. The colours of push-buttons and indicator lights on instrument panels shall be as follows:



INDICATOR LIGHTS ON INSTRUMENT PANELS

Start or on (energize) - Green Stop or off (de-energize) - Red

Open valve - Black\* Close valve - Black\* Accept - Black Lamp test - Black Reset - Black

Motor running (energized) - Red Motor stopped (de-energized) - Green Valve open - Red

Valve closed - Green Urgent alarm - Red

Non-urgent alarm - Yellow

Plant healthy or ready for use - White

\*Panel-mounted push-buttons for valve operation shall be coloured black, or as per the approved Design and Drawings, with the duty clearly defined by legend on an associated label.

# Analogue Signal Transmission

Unless otherwise specified, analogue signal-transmission systems shall be in accordance with BS EN 60546-1:1993 and shall use a signal of 4mA to 20mA DC. Transmitting devices shall have integral indicators to monitor the output signal or connections suitable for use with a portable test meter. Transmitters shall be capable of meeting the requirements laid down in the appropriate part of IEC 60770-1:1999.

# Analogue Process Controllers

Analogue controllers shall use solid-state components and shall have outputs containing three terms with negligible interaction. The controller fascia shall have measured value, set value and output indication, manual set-value and output controls, auto/manual switch for control mode and remote-local transfer switch for set-value control. Manual control stations shall have measured value and set-value indication, local/remote switch and control available lamp indicator. Each controller shall have the means to restrict its output signal to a predetermined, fully adjustable band so that the regulating device is not moved to unsafe positions. The adjustment of these safe operating limits shall be by means of accessible, clearly marked, internal components. A continuously adjustable proportional band of not less than 5 to 500% shall be provided. Integral and derivative action times shall be adjustable over ranges which shall not be narrower than 6 seconds to 25 minutes and 0-to 10 minutes respectively. If the integral or derivative action times' adjustments are in steps, the ratio of successive steps shall not exceed 2. The controls used to set the P, I and D values may be at the front of the instrument or mounted internally in an accessible position.

Each controller shall be designed so that in the event of failure, it shall be possible to plug a portable manual station into the controller case and to control the regulating device manually.

Controller design shall ensure automatic procedure-less, bump less transfer whenever the

instrument is switched from "auto" to "manual" or vice versa. Controller action shall be adjustable from direct to reverse and vice versa by the operation of an internal switch. Analogue process controllers shall be capable of meeting the requirements laid down in the appropriate part of BS EN 60546-1:1993.

# Section G5.5

**SCADA (Online Monitoring System) for STP(s)/FSTP(s) and LS/ PS**

# Section G5.5: SCADA (Online Monitoring System) for STP(s)/FSTP(s) and LS/ PS

1. **General**

One of the key requirements forming part of Operation and Maintenance requirement of STP(s)/FSTP(s), LS/PS, and I&D is REAL TIME ONLINE MONITORING of various data & details by authorities & officials in Executing agency, {NATIONAL/STATE LEVEL AGENCY IF ANY}, CPCB, SPCB, ULB and Project Engineer.

In order to facilitate this requirement, the concessionaire shall design and implement an SCADA concept based ONLINE MONITORING SYSTEM for real time monitoring of various parameters of the STP(s)/FSTP(s) and LS/ PS including mechanical equipment (pumps, motors, valves, etc.), process instruments and power network.

The SCADA based REAL TIME ON LINE MONITORING SYSTEM (hereinafter referred to as RTOLMS) should be such that it has feature as per generic requirements to enable transmission of real time data of all the monitored parameters over Internet networks, leased and phone lines, wireless communication etc., or a mix of these as appropriate and as feasible at the respective site(s). The indicative list of such parameters which are to be logged and monitored / communicated on line are given in the table below.

# Typical parameter and relayed to control monitoring station

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter s** | **Descripti on of soft signal** | **Main pumping station** | | ***[LOCATION]* STP/FSTP** | | | **I&D & distribution chamber** | **Bio gas generation** | **Septage handling system** | **Bio gas DG set** |
| **Sump / collection well** | **Pumps** | **Sump / collection well** | **Pumps** | **Other equipment's** |
| Date &  Time | Real time |  |  |  |  |  |  |  |  |  |
| Liquid  Level | High |  |  |  |  |  |  |  |  |  |
| Low |  |  |  |  |  |  |  |  |  |
| Liquid flow | Inlet flow  measure ment |  |  |  |  |  |  |  |  |  |
| Sewage/Fa ecal Sludge/Sep  tage quality | pH, TOC  bases BOD and COD, |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter s** | **Descripti on of soft signal** | **Main pumping station** | | ***[LOCATION]* STP/FSTP** | | | **I&D & distribution chamber** | **Bio gas generation** | **Septage handling system** | **Bio gas DG set** |
| **Sump / collection well** | **Pumps** | **Sump / collection well** | **Pumps** | **Other equipment's** |
|  | TSS, TP,  TN and  residual chloride |  |  |  |  |  |  |  |  |  |
| Pump status for individual  pumps | On, OFF,  Trip |  |  |  |  |  |  |  |  |  |
| Flow rate  in common header | Flow rate, head |  |  |  |  |  |  |  |  |  |
| Electrical parameter for individual pumps & main switch  board | Voltage, Current, KWH, PF, KVA |  |  |  |  |  |  |  |  |  |
| No of  operating personnel |  |  |  |  |  |  |  |  |  |  |
| Temperatur e -  Ambient,  liquid |  |  |  |  |  |  |  |  |  |  |
| Bio gas monitoring | Online status for various  activity |  |  |  |  |  |  |  |  |  |
| Gas generation | Cum / day,  cumulati |  |  |  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameter s** | **Descripti on of soft signal** | **Main pumping station** | | ***[LOCATION]* STP/FSTP** | | | **I&D & distribution chamber** | **Bio gas generation** | **Septage handling system** | **Bio gas DG set** |
| **Sump / collection well** | **Pumps** | **Sump / collection well** | **Pumps** | **Other equipment's** |
|  | ve gas generatio n, gas  quality |  |  |  |  |  |  |  |  |  |
| Septage handling monitoring | Online status for various  activity |  |  |  |  |  |  |  |  |  |
| Septage treatment | Cum / day, cumulati ve septage received,  quality |  |  |  |  |  |  |  |  |  |
| DG set running  hours |  |  |  |  |  |  |  |  |  |  |
| Electrical parameter for individual Bio gas- based engine generator, DG set  pumps & main switch  board | Voltage, Current, KWH, PF, KVA |  |  |  |  |  |  |  |  |  |

*Note: For flow measurement at I&D, the Concessionaire is free adopt any available flow measuring instruments with compatibility for online monitoring*

# System architecture

The schematic representation of the required RTOLMS architecture to be provided by the Concessionaire as part of Basic engineering package to meet the KPI requirements as per schedule 1 and 11.

# Scope of work

The scope of work, as a minimum shall include.

Supply, installation, testing and commissioning of all necessary Hardware and Software for RTOLMS System including LAN switches, Modems, UPS, central work station, HMIs, data / fibre cabling between various sensing devices to the PLCs in the respective STP(s)/FSTP(s), and LS / PS

Supply, installation, testing and commissioning at STP(s)/FSTP(s),and LS & PS of all necessary isolating and interface modules and RTUs, potential free auxiliary NO/NC contacts etc., required for making the existing / new Electrical power system components compatible for monitoring the voltage, current, PF, kVA, KWh, KVAh, pump ON/OFF status etc., besides interfacing of data on levels, pressure, flow rate and various other parameters of raw water and treated water.

Supply, installation, testing and commissioning of al Networking Equipments (Router, firewall etc.) for the central unit at STP(s)/FSTP(s).

Interface / Integration of PLC & RTU of STP(s)/FSTP(s), and LS & PS with RTOLMS System.

Integration of Field Instruments Hardware with RTOLMS System. Testing, Erection & Commissioning of supplied system.

# Features Required in RTOLMS System

RTOLMS system will have many extra features and the proposed system should support multiple PLC/ RTU Protocol like Modbus, Profibus, DNP (Serial/TCPIP), OPC etc.

## System components

The system shall consist of a modular controller (including control, I/O, and communications functions) and software modules that facilitate open systems connections.

The system shall include a full complement of modular supporting equipment (including mounting racks, power supplies, termination strips, equipment enclosures, prefabricated cables, furniture, etc.), all of which shall be designed to simplify construction.

## Open Communications

The control system shall be open to enable easy integration with OPC (OLE for Process Control) [where OLE stands for Object Linking and Embedding (OLE)] server so as to collect the data from the remote housing station.

## Reliability and redundancy

The system must be designed for maximum reliability and minimal downtime and work satisfactorily under harsh and dusty ambient conditions. This should be achieved through a fault- tolerant design with minimal common cause failures and state-of-the-art redundancy schemes. The main system should offer 100 % redundancy for both hardware and software. The offered system shall offer highest possible MTBF within the service period of 15 + years.

* 1. ***Hardware Details***

# SCADA CUM COMMUNICATION SERVER, WEB SERVER, ISR SERVER

|  |  |  |
| --- | --- | --- |
| **Qty** | **Hardware Component** | **Remarks** |
| 1 | RTOLMS SCADA cum  Communication Server | The interfaces for each server are connected to Ethernet  networks to collect data from field. |
| 1 | WEB server | Interface with Internet to remote client |
| 1 | ISR server | Databases server with Oracle/SQL for Alarm and MIS  Report |

**USER INTERFACE SUBSYSTEM**

|  |  |  |
| --- | --- | --- |
| **Qty** | **Hardware Component** | **Remarks** |
| 2 | Workstation Console | The console is provided with TFT Monitor  The interface is connected to the Ethernet networks. |
| 1 | Remote access terminal | LAPTOP connected through a serial link and a modem. |

# LOCAL AREA NETWORK SUBSYSTEM

|  |  |  |
| --- | --- | --- |
| **Qty** | **Hardware Component** | **Remarks** |
| 1 | LAN Switch | Ethernet switch 14 ports (10/100 Base TX) + 2 Fibre Port |
| 6 | Remote Location LAN switch | Ethernet switch 14 ports (10/100 Base TX) + 2 Fibre Port |
| 1 | Router | Port 2 LAN+2 WAN, all are 10/100 with 2 V.35 |
| 2 | Firewall | 4LAN+2 WAN, all Wan are 10/100Mbps and LAN are  10/100/1000 Mbps |
| Lot | 12C Single armored cable Mode  Fibre | For Connectivity |

* 1. ***Peripheral Subsystem***

# PRINTERS

|  |  |  |
| --- | --- | --- |
| **Qty** | **Hardware Component** | **Remarks** |
| 1 | Laser Printer(Colour) | Each laser printer is connected to Ethernet network. |

**UPS**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Qty** | **Hardware Component** | | | | | **Remarks** |
| 1 | UPS of  STP/FSTP | appropriate | kVA | rating | for | The UPS shall be with two hours battery  autonomy. |
| 2 | UPS of appropriate kVA rating for LS &  PS | | | | | The UPS shall be with 2 hours battery  autonomy |

Note : This UPS shall be independent of that to be provided for the PLC system at STP/FSTP, and LS/PS locations

## Hardware Components Description

This section describes the common hardware components.

# Communication cum SCADA Server, Web Server, ISR Server\* Characteristics \*

|  |  |
| --- | --- |
| Intel® Xeon® Quad-Core Processor E5606 2.13 GHz, 8MB L3 Cache | 1 |
| Integrated Two Broadcom dual-port Gigabit Ethernet with TOE enabled | 1 |
| 8GB Memory (4x2GB), 1333MHz, DDR3 RAM | 1 |
| 2nd Intel® Xeon® Quad-Core Processor E5606 2.13 GHz, 8MB L3 Cache | 1 |
| 300GB 15K RPM,6Gbps SAS 3.5 Hot Plug Hard Drive " With RAID5 | 3 |
| DVD+/-RW ROM, SATA, Internal for Ms 2008 R2 | 1 |
| High Output Power Supply, Redundant, 460W | 1 |
| Power Cord, GType, 230V (Nepal, Sri Lanka, India) | 2 |
| 2U Cable Management Arm | 1 |
| 2U Sliding Rail | 1 |
| Windows Server | 1 |

\* The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

# Workstation Console Monitor\*

|  |  |
| --- | --- |
| Motherboard | Intel® Xeon® Dual-Core Processor W3503 (2.40 GHz, 4 MB cache, 1066  MHz memory) |
| Video Card | ATI FirePro 2270 (512 MB) |
| RAM Memory | 4GB (2x2GB) DDR3 SDRAM Memory, 1333MHz, ECC 1 |

|  |  |
| --- | --- |
| HDD | 500 GB SATA (7200 RPM) HDD |
| Input Power Supply | 220 to 240 VAC (+/- 10%), 50 Hz (+/- 2 Hz) |
| Power Cord | Indian Style |
| CD Drive | 16X DVD + /-RW Combo Drive |
| Keyboard | USB Entry Keyboard |
| Mouse | USB Optical Scroll Mouse (2 buttons) with Mouse Mat |
| LAN (Ethernet port) | Dual Broadcom RJ45 10/100/1000 BASE on board Ethernet NIC |
| I/O Cards | One serial RS-232 port, 4 USB port and one parallel port |
| Indicator & Switch | Power on/off x 1, HDD x 1. Power on/off x 1, System reset x 1 |

\*The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

# LAN Switch\*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Specification** | | **Managed Industrial Ethernet switch** | | | |
| Ethernet Standards | | IEEE 802.3  IEEE 802.3u for IEEE  802.3x for Flow Control | for 100BaseT(X) | and | 10BaseT 100BaseFX |
| Design Standard | | FCC Part 15, CISPR (EN55022) class A, Shock- IEC60068-2-27, Vibration-IEC60068-2-6, EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS),  EN61000-4-8, EN61000-4-11 standards | | | |
| Input Voltage | | 9.6-60 VDC | | | |
| Operating temperature: | | 0 to 60°C | | | |
| Ambient  Humidity: | Relative | 5% to 95% Non-condensing | | | |
| Overload  Protection | Current | Present | | | |
| Mounting | | DIN Rail Mounting | | | |
| No. of Ports | | 12 Nos. (10 CU + 2 FO) | | | |
| Interface | | | | | |
| Ethernet ports | | 10 no. RJ45 Ports with 10/100BaseT(X) auto negotiation speed, Full/Half  duplex mode, and auto MDI/MDI-X connection | | | |
| Fiber Port | | Two 10/ 100BaseFX port SC Type Single-Mode, 1310 nm Supports Ring,  and Self-Healing | | | |

The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

# Router \*

|  |  |
| --- | --- |
| **Memory** | **RISC @ 533 MHz** |
|  | Flash Memory:256M Bytes |
|  | SDRAM: 256M Bytes |
| Interface | 2 x 10/100/1000 Mbps Ethernet Port |
| 2 Serial Ports (V.35) |
| 2 X 10/100 Mbps WAN Interface |
| 1 Console port |
| 1 Auxiliary port |
| Performance |  |
| Throughput | 300 Kpps (64-byte packets) |
| Routing table size | 30000 entries |
| Network Management | IMC - Intelligent Management Center; command-line interface; Web browser; SNMP Manager; Telnet; RMON1; FTP;  IEEE 802.3 Ethernet MIB |
| Operating Temperature | 0° to 40° C (32° to 104° F) (Relative Humidity: 5% to 90% non-  condensing) |
| Non-Operating Temperature | -40° to 70° C (Relative Humidity: 5% to 90% non-  condensing) |
| Power | 100-120/200-240 VAC |

\*The system (hardware, software, accessories, etc.) being provided during installation would be of latest configuration.

# 12C Single Mode Fibre Cable\*

|  |  |
| --- | --- |
| **Configuration** | **Multitube double sheath armoured cable** |
| Nos. of Core | 12 |
| Maximum Tensile Loading | 1361 x 1021 |
| Installation | 2700N |
| Long Term Installed | 900N |
| Operating Temperature | -30°C to +60°C |
| Normal Dia | 14.8 mm |
| Nominal weight | 200 KG/KM |
| Mode | Single Mode |
| Single mode Fiber: | (G.652.B) |

## Server Panel

The equipment can be of any Standard make which can comply with the following standards:

|  |  |
| --- | --- |
| **Type** | **SERVER RACK 42U/600W/1000D** |
| Specification | Captive Front Panel Hardware, Pkt of 20 |
| Castors (Plain) |
| Server Rack, 19"/42U |
| consisting of High quality extruded Aluminium vertical profiles 4 Nos.  Top and Bottom steel end |
| frames with bottom Panel having gland plate for cable entry, Top cover  with FHU provision, Side |
| Panels with latches and venting slots at bottom 1/3 area and 2 pairs of  19" Mounting Angles |
| Dimension: 2150 x 600W x 1000D Powder Coated BLACK |
| Front CRCA steel single door with Perforation |
| Rear CRCA steel single door with Perforation |
| Component Shelf, Universal, 19"W/575mmD, Load cc 50 kg. |
| Top Mounting, Fan Housing Unit with 4 fans 230 V / 90CFM |
| Rotary Keyboard Tray with slides |
| Castors (with brake) |
| Earth Continuity straps (kit) |

## Power Supply

Redundant power supplies shall be available for card rack mounting to form as an integral part of the system. The module rack must provide two individual power supply buses that to be driven by two independent power sources for high availability placed in the rack in current sharing mode. Each module shall be capable of using power from any of the two buses.

## Enclosures

The racks shall be mounted in an industrial enclosure with a front & rear -access design, with all frequently accessed items (such as modules, connectors, status indicators, switches, and termination assemblies) located in the front of the enclosure. For maximum flexibility, the enclosures shall be modular, with the ability to be stacked, joined side to side, or joined back to back. To provide the degree of environmental security required, enclosures shall be available in sealed and vented versions.

Enclosure shall be i) for Indoor IP 44 and ii) for Outdoor IP 65

## Input / Output Devices

Input/output Modules shall be intelligent I/O modules. Each module should be able to communicate with the CPU in a dedicated fashion without requirement of any additional interfacing hardware so as to reduce the common cause of the Failure. Each module should have its own microprocessor to execute its input/output function, maintain its configured data, and

perform module diagnostics.

All process I/O shall be electrically isolated from both computer common and communications common. Isolation shall meet be min 1500 VAC requirements. Modules shall automatically determine their physical address and report this information to the controller. No range jumpers or user- configurable physical address jumpers should be necessary.

All configurable data shall be set via software, with no hardware jumpers used. Configurable data should include channel tag.

All the I/O modules shall have max 8 channels for the Analog and 16 channels for the Digital modules. Special modules like Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum. More numbers per channel may be accepted if the overall reliability factor of MTBF within the service period of 15 + years is achieved.

## Field Termination for I/O Modules

hall be wired into the system such that an I/O module can be removed at any time without disturbing the field wiring.

The field wiring should be separate from the I/O module(s). The extension from the module(s) shall be accomplished via a marshalled I/O cable assembly. This assembly should be a multi- conductor cable that attaches to the module rack (and the back of the I/O module) on one end and a finished termination end.

The marshalled termination assemblies shall be DIN rail-mounted PCB-based fixtures that include terminal blocks and two receptacles for accepting the interconnect cable plug. These receptacles must be female to eliminate the possibility of power from the terminal block being exposed on pins.

# Detailed functional Specification of RTOLMS System Components

## Data Acquisition

The RTOLMS system shall perform data acquisition from PLC of all treatment plants, all LS / PS and field equipment. PLC is to be located at each location of the treatment plant and LS/PS. PLC communications with central system shall utilize the Open protocol like Modbus, Profibus and Ethernet TCP/IP.

## Data Exchange

The RTOLMS systems shall be able to exchange various types of data with the other application software using ActiveX Data Objects (ADO) or Dynamic Data Exchange (DDE).

## Data Processing

* + 1. Analog data

Analog data processing shall be performed according to the requirements listed below.

* + - * Conversion to measurable Units as required by ULB / {NATIONAL/STATE LEVEL AGENCY IF ANY}
      * Reasonability limits checking
      * Limit monitoring
    1. Digital/Status Input Data

The following status input data types shall be accommodated as a minimum: Two-state points: The following pairs of state names shall be provided:

1. Open/Closed
2. Tripped/Closed
3. Alarm/Normal
4. On/Off
5. Auto/Manual
6. Remote/Local
   * 1. Calculated Data

It shall be possible to define the calculations on real-time data and historical data, periodically and on request. The results shall be incorporated into the database as calculated data available for display & report generation.

The user shall be able to define calculated analog values using database points as the arguments and mathematical functions as the operations. Functions such as addition, subtraction, multiplication, division, maximum value, minimum value, average, count, square root, exponentiation, trigonometric functions, logarithms and other statistical functions shall be provided.

The RTOLMS system shall be capable of analyzing the open/closed status of switching devices, such as Motor, PUMP etc. The configuration shall be updated whenever a switching device status change is detected.

## Sequence-Of-Events Recording

The Sequence-of-events (SOE) data shall be collected by the RTOLMS system from PLCs. The description of each event shall include the database description name, device state, the date, and

the time (to the nearest millisecond) of each event.

## Information Storage and Retrieval

Information Storage and Retrieval (ISR) system shall collect and store analog data (telemetered and calculated) periodically at every 5 minute (configurable) and status data by exception. Associated quality codes shall be included. It shall be possible to perform calculations on the stored data, and the results of these calculations shall be collected and stored. Other information such as alarms, events, SOE and reports shall also be stored. The data shall be stored on hard disc with date tag on daily basis for easy retrieval. Subsequently, the data shall be retrieved for analysis, display, trending, and report generation.

## Extensive Use of Standard

The RTOLMS Software should be such that it uses an extensive use of standards, achieved by a corporate commitment to comply with all standards that are recognized on the RTOLMS market, and in particular:

* Intel (or compatible) based hardware;
* Operating system options of WNT 4.0, Windows 2000 or Windows 2003;
* Uses Microsoft Foundation Class (MFC) Object Oriented Database;

- 

* Installed using Microsoft Install Shield utilities;
* Component Based Architecture;
* Interfaced using Active X controls (OCX);
* TCP/IP for Local and Wide Area Networks (LAN & WAN);
* Web-enabled Operator Consoles;
* Control Center Application Programming Interface (CCAPI) Initiatives

## System Sizing & Extensibility

The hardware and software openness of RTOLMS allows the Executing Agency / concessionaire to smoothly upgrade the proposed system with great facilities. Common upgrading needs include (but not limited to) the following items:

* Additional measurement points (analog and digital);
* Additional protocol-compliant IEDs;
* Additional protocol-compliant PLCs;
* Additional operator consoles;
* Additional printers;

## Graphical User Interface (GUI)

The GUI shall operate within a window environment, the system shall use displays which mimic the existing control panels so that the operators working in conventional control room environment are comfortable while working on the new system. Concessionaire shall develop control panel display generally similar to the one existing in conventional control room.

The GUI shall allow the personnel to monitor and control the equipment through the control panel displays and Tabular displays. The control panel displays shall be dynamically updated for measurands, device positions, annunciations. To have better visibility of control panels, it shall be possible to iconise each control panel separately. Operator shall select that icon to zoom/view that panel display & carry out operations such as alarm annunciation accept/reset, device close/open operations etc.

## Trending

Trend displays shall enable the user to select real-time and historical data for trending on graphical displays and for tabular displays. It shall be possible to take print of these trends.

## Alarms

Alarms are conditions that require user notification when detected. Audio, visual alarm shall be generated for all such conditions. It shall be possible to accept & reset all trip & non-trip alarm annunciation appearing on control panel facia from control panel display itself. Alarm annunciation on control panel shall have following characteristics:

|  |  |  |
| --- | --- | --- |
| **Condition** | **Facia** | **Sound** |
| Alarm initiation by relay contact | Flashing Glow | On |
| Accept PB pressed | Steady Glow | Off |
| Reset | Off (if relay contact is reset)  Steady Glow (if relay contact is not reset) | Off |

Other alarm conditions shall be acknowledged from respective alarm list displays. Other alarm conditions shall include, but not be limited to the following:

1. Telemetered or calculated value limit violations
2. Un-commanded changes of a power system device state
3. Data source communication errors resulting in loss of data
4. SCADA hardware and software element failures.

The standard products for advanced alarm management shall also be provided. Regardless of the alarm management technique used, all alarm messages shall be recorded with time & date tag on auxiliary memory for review and printing on demand by the user.

Displays shall highlight alarm condition using a combination of colour, intensity, inverse video and blinking. Alarm messages shall be a single line of text describing the alarm that has occurred with date & time of occurrence.

## Events

Events are conditions or actions that shall be recorded by the SCADA system but do not require user action. Events shall be recorded in the form of an event message. The event message format shall be similar to the alarm message format. Events shall include but not be limited to the following:

Values returning to normal from a limit violation State Device status change on manual operation.

## Hardcopy Printing of Display

A means shall be provided to produce a copy of a display. The display printout shall be initiated from user friendly push buttons/pull down menus. The options for printing mode shall include at least selection for orientation, background colour, page size, colour or black & white print and print preview. It shall also be possible to print selected portions of display and direct printing on any of the connected printer.

## Report Generation

The user shall be able to schedule periodic reports generation, direct a report to a display, print a report, and archive a report. Hardcopy report formats shall be handed over to Concessionaire for generation of report formats in the system. It shall also be possible to define and generate the additional user configurable reports. The generation and printing of any report shall not effect normal scanning of data from PLC. The report scheduling display shall enable entry of the following parameters, with default values provided where appropriate:

1. Report name
2. Report destination (printer or archiving device)
3. Time the system should produce the report.

## RTOLMS System Access Security

A mechanism for defining and controlling user access to the SCADA system shall be provided.

## Alarm Summary Displays

Displays that list or summarize all unacknowledged and acknowledged alarms shall be provided. The user shall be able to select between viewing alarms in chronological and reverse chronological order. The default shall be most recent alarms. The summary shall separate acknowledged and unacknowledged alarms. To facilitate identification of unacknowledged messages the time field shall blink or entire row shall blink. It shall be possible to sort alarms by user defined text, date, time.

## Event Summary Displays

Event summary displays shall list the most recent events. The user shall be able to select between viewing events in chronological and reverse chronological order. The user shall be provided with a convenient and efficient means of selecting an event summary display. It shall be possible to sort events by user defined text, date, time.

## Operating Information Summaries

The operating information summaries defined below shall be provided. Summary items will be listed in reverse chronological order with the most recent item shown on the first page. The user shall have the ability to sort summary items by device.

## Abnormal Summary

The summary display shall list devices and values that are found to be abnormal, i.e., are not in their normal state. Telemetered, calculated, and manually entered status and data values shall be included.

## Out-Of-Scan Summary

The out-of-scan summary display shall list device status and data values that are not currently being processed by the system.

## Alarm Inhibit Summary

This display shall list devices and data values for which the user has suspended alarm processing.

## Tag Summary

This display shall list and describe all active device tags.

* 1. *Help Displays*

Help displays shall be provided to aid the user in interpreting displayed information and to guide the user through a data entry or control procedure.

* 1. *Alarm Beeper Services*

The Alarm Beeper service audibly notifies the operator of recent alarms by playing a wave file. customized wav files can be used.



* 1. *Alarm Pager Services*

The Alarm Pager service allows the user to configure the system to issue various pages in response to specified alarms.

# Section G5.6

## Section G5.6 :

All inspection and testing shall be carried out in accordance with the Specification and in absence of Specification relevant Indian Standard or internationally approved equivalent standard. After award of contract, Concessionaire shall furnish QA plan, which will be mutually discussed with the Executing Agency and finalized QA plan shall include test, and incoming supply of raw materials and bought out items, stage inspections and tests on finished products at manufacturer's works / appropriate testing station. QA plan shall clearly indicate tests which are intended to be witnessed by the Concessionaire alone and those by both Concessionaire and Project Engineer and Executing Agency.

The Concessionaire shall carry out wherever practical, at the place of manufacture tests of the Plant / Equipment.

The Executing Agency shall be entitled to attend the aforesaid inspection and / or tests by his own duly authorized and designated representatives.

The Executing Agency and his duly authorized representative shall have access to the Concessionaire's premises at all suitable times to inspect and examine the material and workmanship of the mechanical and electrical plant and equipment during its manufacture there. If part of the plant and equipment is being manufactured on other premises, the Concessionaire shall obtain permission for the Executing Agency or his duly authorized representative, to inspect as if the plant and equipment was manufactured on the Concessionaires own premises. Testing (including testing for chemical analysis and physical properties) shall be carried out by the Concessionaire and certificates submitted to the Executing Agency who will have the right to witness or inspect the above mentioned inspection / testing at any stage desired by him. Where inspection or testing is to be carried out at a sub-contractor's works, a representative of the Concessionaire shall be present.

The procedure for the testing and inspection to be carried out during or following the manufacture of the materials to ensure the quality and workmanship of the materials and to further ensure that they conform to the Contract is whatever place they are specified shall be as described below.

The Concess  the date and the place at which any plant or equipment will be ready for inspection/testing as provided in the Contract. The Executing Agency or his duly authorized representative shall thereupon at his discretion notify the Concessionaire of his intention either to release such part of the plant and equipment upon receipt of works test certificates or of his intention to inspect. The Executing Agency shall then give notice in writing to the Concessionaire, and attend at the place so named the said plant and equipment which will be ready for inspection and/or testing. As and when any plant shall have passed the tests referred to in this section, the Executing Agency shall issue to the Concessionaire a notification to that effect.

The Concessionaire shall forward to the Executing Agency duly certified copies of the test certificates and characteristics performance curves for all equipment.

If the Executing Agency fails to attend the inspection and/or test, or if it is agreed between the parties that the Executing Agency shall not do so, then the Concessionaire may proceed with the inspection and/or test in the absence of the Executing Agency and provide the Executing Agency with a certified report of the results thereof as mentioned above

If any materials or any part of the works fails to pass any inspection / test, the Concessionaire shall either rectify or replace such materials or part of the works and shall repeat the inspection and/or test upon giving a notice as mentioned above. Any fault or shortcoming found during any inspection or test shall be rectified to the satisfaction of the Executing Agency before proceeding with further inspection.

Where the plant and equipment is a composite unit of several individual pieces manufactured in different places, it shall be assembled and tested as one complete working unit, at the maker's works or at site as mutually agreed by the Executing Agency and Concessionaire.

Neither the execution of an inspection test of materials or any part of the works, nor the attendance by the Executing Agency, nor the issue of any test certificate shall release the Concessionaire from any other responsibilities under the Contract.

The test equipment, meters, instruments etc., used for testing shall be calibrated at recognized test laboratories at regular intervals and valid certificates shall be made available to the Executing Agency's at the time of testing. The calibrating instrument used as standards shall be traceable to National / International standards. Calibration certificates or test instruments shall be produced from a recognized Laboratory for the Executing Agency's consent in advance of testing and if necessary instruments shall be recalibrated or substituted before the commencement of the test.

Items of plant or control systems not covered by standards shall be tested in accordance with the details and program agreed between the Executing Agency and Concessionaire.

Tests shall also be carried out such that due consideration is given to the Site conditions under which the equipment is required to function. The test certificates shall give all details of such tests.

The Concessionaire shall establish and submit a detailed procedure for the Inspection of materials or any part of the works to the Executing Agency for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following:

1. Applicable code, standard and regulations
2. Fabrication sequence flow chart indicating tests and inspection points
3. Detailed tests and inspection method, indicating tests and inspection points
4. Acceptance criteria
5. Test report forms and required code certificates and data records
6. Method of sampling, if any sampling test to be conducted
7. Concessionaire's or Executing Agency's witness points.

The Concessionaire shall not pack for shipment any part of the Plant until he has obtained from the Executing Agency or his authorized representative his written approval to the release of such part for shipment after any tests required by the Contract have been completed to the Executing Agency's satisfaction.

# Part-C Testing and Commissioning

**Part C**

# Testing and Commissioning

**Requirements Inspection and Testing During Construction**

# General

Inspection and testing of all Facilities shall be carried out in accordance with the relevant Indian Standard or internationally approved equivalent standard. QA plan shall clearly indicate tests which are intended to be witnessed by the Concessionaire alone and those by Concessionaire and Project Engineer.

Inspection and tests schedule shall be as follows;

* + 1. Manufacturer tests
    2. Acceptance Inspection / Quantity checking
    3. Install /Site Inspection
    4. Site Acceptance Test
    5. Tests on Completion
    6. Process Wet Tests (by Raw Sewage/Faecal Sludge/Septage)
    7. Operation Test (Tests After Installation)

The Concessionaire shall establish and submit a detailed procedure for the inspection of materials or any part of the Facilities to the Project Engineer and Executing Agency for approval within the date indicated in the Programme Details. The detailed procedure shall indicate or specify, without limitation, the following:

Applicable code, standard, and regulations.

Fabrication sequence flow chart indicating tests and inspection points.

Detailed tests and inspection method, indicating the measuring apparatus to be used, items to be measured, calculation formula, etc.

Acceptance criteria.

Test report forms and required code certificates and data records. Method of sampling, if any sampling test to be conducted.

 points.

The witness testing shall be carried out for all the Mechanical, Electrical, Instrumentation, PLC, SCADA and Associated Equipment.

# Testing on Construction Completion

For all the subject Facilities, prior to the commencement of Trial Operations on respective Construction Completion the Concessionaire shall submit the following to the Executing Agency:

1. As-Built Drawings
2. Operation and Maintenance Manuals
3. Site test results

The initial charges of oil, grease, generator fuel / oil, chemical, disposal of cake, etc. necessary for Trial Operation shall be borne by the Concessionaire.

# Manual Commissioning Tests

Manual commissioning tests shall be such preliminary trials, tests and retests on subject Facilities prior to subject Facilities COD respectively, in order to demonstrate that the subject Facilities as a whole are ready to undergo the manual operation tests and that these will take place with a minimum of interruption.

# Manual Operation Tests

When the manual commissioning tests have been completed so that the subject Facilities have been demonstrated to the satisfaction of the Project Engineer and Executing Agency, the Concessionaire shall commence the manual operation tests.

These tests shall demonstrate the correct operation of the subject Facilities whilst using the minimum quantity of automatic control and monitoring equipment. Such equipment shall be at least that required for the maintenance of safety and for the normal mode of operation of such Facilities.

The subject Facilities will be required to demonstrate satisfactory operation at all design flow rates.

# Automatic Commissioning Tests

The Automatic Commissioning Tests shall be such preliminary trials, tests and retests on subject Facilities in order to demonstrate that the subject Facilities as a whole ares ready to undergo the tests of completion and that these will take place with a minimum of interruption.

# Dry Test Requirements

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

1. A general inspection to check for correct assembly and quality of workmanship
2. A check on the presence of lubricant, cooling medium, electrolyte, etc.
3. A check on adequacy and security of Facilities fixing arrangements.
4. A general check to ensure that all covers, access ladders, water proofing, guard railings etc. are in place.
5. A check on damp-proofing, rust-proofing and vermin-proofing and particularly the sealing of apertures between building structures, chambers etc. and the outside.

# Civil and Building Works

As a minimum requirement, check for the presence of foreign bodies in pipe work and structures shall be carried out on the civil and building works.

# Mechanical Works

As a minimum requirement, preliminary running checks as far is permitted by circumstances in order to ensure smooth operation of Facilities shall be carried out on the mechanical systems.

# Electrical Works

As a minimum requirement the following dry tests shall be carried out on the electrical systems:

* 1. Check phasing and polarity.
  2. Carry out point to point check on cables.
  3. Check on security of cable terminations.
  4. Check on completeness and adequacy of earthing systems.
  5. Check setting on protection relays, sizes of fuses and motor overload settings.
  6. Carry out checks on cabling systems in accordance with the requirements of the relevant standards.
  7. Check operation of main circuit breakers by secondary injection methods.
  8. Check rotational direction of Plant.
  9. Check instrument loop integrity, functionality and calibration.
  10. Check operation of standby generator installation and mains / generator changeover procedures; a 4 hour load test (using the normal load of the Works) shall be carried out on the generator when the load is available.
  11. Check plant functionality.
  12. Check functionality of the central MMI and its power supply.

# Process plant item / equipment

All process plant items / equipment shall be tested to ensure they meet the requirements for quality of workmanship, construction and performance as laid down in the Concession Agreement.

# Hydraulic Wet Test Requirements

Hydraulic wet tests shall be carried out on completion of dry tests.

Clear water shall be used for hydraulic wet tests. The purpose of the tests is to prove the hydraulic performance of the Works. In order to demonstrate this, the Concessionaire 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 water to carry out these tests the Concessionaire shall provide all required facilities, including but not limited to any temporary facilities that may be required for storage and recycle of clear water or facilities for the disposal of the water off Site in an approved manner.

The following tests inter alia shall be carried out:

* + - 1. Pressure testing of all piped systems laid direct in ground in accordance with the relevant standards.
      2. Fill all structures and check for leaks.
      3. Filling of all storage vessels to check for leaks and distortion.
      4. Running of all pumped systems in order to check for.
      5. Correct functionality.
      6. Absence of leaks.
      7. Correct running temperatures.
      8. Smoothness of running and the absence of undue vibration or stress.
      9. Check drive running currents.
      10. Carry out calibration of instruments where appropriate.
      11. Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.
      12. Demonstrate correct functionality of electrical, control and instrumentation systems.

# Process Wet Tests (with Raw Sewage/Faecal Sludge/Septage)

On approval by the Project Engineer the Concessionaire shall carry out process wet tests.

Raw Sewage/Faecal Sludge/Septage 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 Concessionaire 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

erating period

of not less than 48 hours.

The Concessionaire shall provide all required facilities for the disposal off Site in an approved manner. The following tests inter alia shall be carried out:

* + - 1. Check for leaks on vessels, structures, pumps and pipework.
      2. Running of all pumped systems in order to check for. Correct functionality.

Absence of leaks.

Correct runningtemperatures.

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.

* + - 1. Carry out calibration of instruments.
      2. Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.
      3. Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing.

On completion of the tests on the various parts of the works the Concessionaire shall run all subject Facilities as a whole in order to demonstrate the full functionality and performance of the subject Facilities at various throughput rates for a continuous period as specified in Concession Agreement.

# Trial Operations

The Trial Operations shall be used to prove the operation of the subject Facilities are in compliance with the KPIs at varying flows and with varying Influent Standards.

1. The quality of Treated Effluent produced
2. Guaranteed Energy Consumption
3. Quality of Digested Sludge
4. The quality of Treated Water produced

Raw Sewage/Faecal Sludge/Septage shall be used as the main feed stock for Trial Operations. These tests shall be carried out to demonstrate the process performance of the Facilities. In order to demonstrate this, the Concessionaire shall ensure that each part of the Facilities are loaded to rated throughput.

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

1. Check for leaks on vessels, structures, pumps and pipe work.
2. Running of all pumped systems in order to check for. Correct functionality.

Absence of leaks.

Smoothness of running and the absence of undue vibration or stress.

Check drive running currents where the solution pumped is different from that pumpedduring hydraulic wet tests.

1. Carry out calibration of instruments.
2. Carry out valve operation, diversions etc. to fully hydraulically load each process element (or where there is a requirement to withstand an over load), overload each process element.
3. Demonstrate correct functionality of electrical, control and instrumentation systems not checked during dry or hydraulic wet tests or which may have changed as a result of the different operating conditions now prevailing.

# Trial Operation & minimum performance standards test record

The Concessionaire shall maintain two copies of Trial Operation test reports for documentation of the following information on daily basis.

Print outs of data logs from SCADA system.

Samples collected for assessment the quality of Treated Effluent Samples collected for assessment the quality of Treated Water Electricity consumption.

Stabilized Digested Sludge characteristics

Log sheets required for noting down readings / results of various tests shall be prepared.

# PART D

**Specifications for Operation and Maintenance**

**Part D : Specifications for Operation and Maintenance**

* 1. **General**

The Facilities and Associated Infrastructure shall run 24 hours every day and 365 days each year continuously under normal operation.

# The O&M manual

The Concessionaire shall submit an O&M Manual as per the Concession Agreement before COD. The O&M of the Facilities and Associated Infrastructure shall be done as per the approved O&M Manual, any approved updations to it as agreed by the Executing Agency and the EHS Plan.

# Guidelines of operations

## Inventory control

Throughout the O&M Period, the Concessionaire shall provide and maintain tools and spare parts in accordance with the Concession Agreement.

The current stock levels shall be updated on-line by monitoring signals of the SCADA system (e.g. level of chemical tanks). All delivery of spare parts and consumables shall be recorded as appropriate.

The Concessionaire shall carry out inventory checks every six months. The inventory checks shall be scheduled to avoid disturbance to the O&M.

## Chemicals, Dangerous Goods and Hazardous Materials

The Concessionaire shall provide and maintain storage of chemicals, dangerous goods and hazardous materials required for the O&M. Dangerous goods include any of the goods or substances to which the Dangerous Goods Ordinance applies.

# Guidelines for Maintenance

The Concessionaire shall carry out corrective and preventive maintenance of the Facilities and Associated Infrastructure in accordance with the Design and Drawings, O&M Manual, Scheduled Maintenance Programme and EHS Plan to ensure the facilities and equipment perform to the specific standards.

The maintenance of all civil structures shall be done for a period of 15 years as per the frequency as per CPWD maintenance manual 2012 as approved by Executing Agency.

# Maintenance Management

A Computerized Maintenance Management System (CMMS) shall include functions for the creation and upkeep of work orders and maintenance records. The database shall include the following information:

Preventive maintenance programmes of systems, equipment, building and infrastructure of the Facility, which are used to generate work orders for preventive maintenance automatically;

Logs of system or equipment fault / breakdown and automatic generation of work orders for corrective maintenance;

Date of inspection / maintenance (preventive or corrective) carried out;

Logs of manual alterations of any operations records, etc; Details of inspection / maintenance carried out including:

Causes of maintenance Maintenance procedures Special gears / equipment used Spare parts used

Equipment / parts replaced

Any follow-up actions / recommendations (e.g. change of operational procedures, etc.)

The CMMS shall have functions to organise, sort and filter the maintenance records in the database as required and perform statistical analysis and generate reports for performance monitoring. The CMMS database shall be archived on a monthly basis. One electronic copy of the entire database shall be stored on the Site for retrieval as necessary.

## Calibration of Instruments and Measuring Equipment

The Concessionaire shall maintain accuracy and reliability of all measurement facilities throughout the O&M Period to enable correct and effective monitoring and control of the Facilities and Associated Infrastructure.

The Concessionaire shall be responsible for the calibration and re-calibration as necessary of all measurement facilities. All calibration work shall be carried out so as not to delay or disrupt the O&M. Calibration frequency shall not be less than that recommended by the manufacturers of the instruments or measuring equipment and in any case no longer than 12-month intervals.

## Tools and Spare Parts

During the O&M Period, the Concessionaire shall provide and maintain tools and spare parts in accordance with the Concession Agreement.

The storage of special tools and inventory of spare parts shall be recorded and monitored.

At the expiry of the O&M Period, the Concessionaire shall handover to the Executing Agency all special tools and spare parts in accordance with the Concession Agreement. The stock level of spare parts shall be sufficient for 1 year operation from the end of the Concession Term.

# Records and Reporting

## Archiving of SCADA and CMMS Data

The Concessionaire shall maintain all operation and maintenance records, including SCADA, throughout the O&M Period in a safe and secure manner. Any amendment to the records shall only be made in accordance with proper checking and authorization procedures, which shall be included as part of the O&M Manual.

The Project Engineer shall be allowed to check the above mentioned data and records described at any time.



facilities with backup security. If the computer facilities fail, then appropriate paper records shall be produced and filed.

## Site Diary

The Concessionaire shall maintain a Site Diary which shall include, as a minimum, the following information on a daily basis:

Date and weather; Operation hours; Labour on the Site;

Flow and quality records of influent and effluent; Disposal records of treatment by-products; Accidents and incidents;

Instructions to the Concessionaire; Comments by the Concessionaire; Complaints received and action taken; Authorized visitors to the Site; and

The Site Diary shall be checked and signed by authorized personnel of the Concessionaire in accordance with the O&M Manual.

The Concessionaire shall keep appropriate records of all personnel employed at the Site. These records shall be available for inspection by the Project Engineer at any time.

## Safety and Health Records

The Concessionaire shall keep records on all safety and health matters as per the requirements of the Concession Agreement, O&M Plan and the EHS Plan and update such records daily for inspection by the Project Engineer.

## Daily report

The Concessionaire shall provide details in the form of daily reports, of operational data and information in relation to the O&M of the Facilities to the Executing Agency in a systematic and concise manner, which shall include the following. The frequency of testing must as per the Table: Testing Methodology and Frequency

Availability of the Facilities

Characteristics of the Treated Effluent and deviations from the KPIs, if any Characteristics of the Digested Sludge and deviations from the KPIs, if any

## Monthly Report

The Concessionaire shall provide details in the form of monthly reports, of operational data and information in relation to the O&M of the Facilities to the Executing Agency in a systematic and concise manner. Monthly reports shall be submitted to the Executing Agency by the 7th day of the subsequent month and shall include the following:

Availability of the Facilities

Characteristics of the Treated Effluent and deviations from the KPIs, if any Characteristics of the Digested Sludge and deviations from the KPIs, if any Summary of energy consumption (fuel and electricity) of the Facility; Quantities of chemicals, reagents, fuel and spare parts consumed;

Stock level of chemicals, reagents, fuel and spare parts;

Programme showing the scheduled maintenance (including planned and ongoing) work in the following month.

## Quarterly Report

The Concessionaire shall provide details in the form of monthly reports, of operational data and information in relation to the O&M of the Facilities to the Executing Agency in a systematic and concise manner. Quarterly reports shall be submitted to the Executing Agency within 7 days of end of a quarter and shall include the following:

Availability of the Facilities

Characteristics of the Treated Effluent and deviations from the KPIs, if any Characteristics of the Digested Sludge and deviations from the KPIs, if any Summary of energy consumption (fuel and electricity) of the Facility;

Quantities of chemicals, reagents, fuel and spare parts consumed; Stock level of chemicals, reagents, fuel and spare parts;

Programme showing the scheduled maintenance (including planned and ongoing) work in the following quarter.

## Annual Report

The Concessionaire shall submit Annual Reports to the Executing Agency within 30 days of end of the year and the report shall include the following:

Summaries of quantities and characteristics of Sewage/Faecal Sludge/Septage received and treated at the STP(s)/FSTP(s) during the reporting year;

Overall performance of the STP(s)/FSTP(s) with highlights on non-compliance with KPIs as reported in each quarter;

Summary of expiry dates for licences, permits and certificates for the O&M;

Summary of major equipment breakdown, repair, overhaul, renewal, replacement, modification, performance tests, condition surveys carried out;

Summary of incidents related to safety and health, environmental issues, security and complaints;

Scheduled maintenance, overhaul, renewal, replacement, modification of major plant and equipment, Performance Tests and Condition Surveys in the forthcoming 12 months;

List of Changes ordered by the Executing Agency, with details and status;

## Monthly Environmental Monitoring Report

The Concessionaire shall submit Monthly Environmental Monitoring Reports to the Executing Agency providing overview of compliance with EHS Plan.

## Testing Methodology and Frequency

The raw sewage/faecal sludge/septage and treated effluent shall be tested and checked for compliance with KPIs as defined below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters to be measured** | **Frequency** | **Methodology** | | | | | | |
| Raw sewage / faecal sludge / septage and treated effluent (pH  ,TOC based BOD & COD, TSS,  TP, TN and Residual Chloride) | It should be every 2 hours | Analysing the average of periodical values at every  5 minutes (configurable) and status data by exception of respective online  instruments/analyzers | | | | | | |
| Raw sewage / faecal sludge / septage and treated effluent (pH  ,BOD, TSS, COD, TP, TN and  Fecal Coliform) | One composite sample a day | 24-hour composite be collected and analysed. These samples shall be stored in a refrigerator at a temperature between 1°C and 4°C. The sample  shall not be allowed to freeze. | | | | | | |
| Raw sewage / faecal sludge / | One Composite | The | sample | shall | be | tested | in | National |

|  |  |  |
| --- | --- | --- |
| **Parameters to be measured** | **Frequency** | **Methodology** |
| septage and treated effluent (pH  ,BOD, TSS, COD, TP, TN and  Fecal Coliform) | sample of a day  every month | Accreditation Board for Testing and Calibration  Laboratories (NABL) accredited laboratory recognised by CPCB and SPCB. |
| Digested/dewatered Sludge |  |  |
| Outlet Concentration of dewatered sludge , and volatile suspended solids | At time of disposal | Seven samples of sludge shall be collected at the time of disposal and analyzed for Outlet concentration of dewatered sludge , and volatile suspended solids,. The geometric mean of the Outlet concentration of dewatered sludge, and volatile suspended solids of these seven samples shall not exceed the prescribed standards/ limits as mentioned in the KPI. |
| Fecal coliform, Salmonella, viruses and helminth egg | At time of disposal | Seven samples of sludge shall be collected at the time of disposal and analyzed for faecal coliforms. The geometric mean of the these seven  samples shall not exceed the fecal coliform limits. |
| Outlet Concentration of dewatered sludge, Fecal coliform, Salmonella, viruses  ,helminth egg and volatile suspended solids. | Once in month | The Outlet Concentration of dewatered sludge, volatile suspended solids, and fecal coliform of any one sample every month shall be tested in National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited  laboratory recognised by CPCB and SPCB |

## Staffing

For all operation and maintenance works, the Concessionaire shall provide skilled staff which has adequate qualifications and sufficient experience of similar works.

The Concessionaire shall appoint an overall Facilities Manager to be responsible for managing the Operation of the Facilities. The detailed staffing schedule shall be approved by Executing Agency. No staff / labour below the age of 18 years shall be employed. The Concessionaire shall make appropriate arrangements for maintenance of items like road work, buildings, horticulture, patrolling and maintenance of civil structures, vehicle operations and other activities defined to fulfill its obligations under O&M Contract.

# PART E

**Electrical Load List**

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**Part E : Electrical Load List**

**List of Electrical Drives**

This information requested for each proposed STP(s)/FSTP(s), and PS and LS is to consider the Bidders load calculations for Transformer Sizing Calculation and for communication to the Electricity Board and for assessment of Emergency Load requirement. The Bidders shall include any particular additional equipment anticipated for the running of the facilities. The bidders shall fill in the requisite information as per the technology considered.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Sl. No***  ***.*** | ***DESCRIPTION*** | ***QTY.*** | ***W*** | ***S*** | ***q = flow capacity (m3/h)*** | ***h = different i al head (m)*** | ***Ph***  ***/ (3.6 106)*** | ***pump efficien cy*** | ***Ps =***  ***Ph*** | ***Motor efficiency*** | ***motor KW*** | ***KW of the Motor with relevant margin in case of raw sewage/faecal sludge/septage pumps with 25% over shaft***  ***power)*** | ***KW of Motor / Unit selecte d (each)*** | ***Type of feede r*** | ***V*** | ***DUTY HOURS*** | ***Total KW*** | ***Total energy consumptio n per day, kWH*** | ***LOAD FACTOR*** | ***correct ed P.F.*** | ***KW ABSRB E D*** | ***KVA INPUT*** |
| ***g = gravity (9.81 m/s2***  ***=***  ***density of fluid (kg/m3)*** | ***Ps = shaft power (kW)*** |
|  | **STP/FSTP** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **1.** | Fine Screens |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **2.** | Conveyor  System |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **3.** | Vortex Grit  Mechanism |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **4.** | Primary Clarifier  Mechanism |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **5.** | Primary Sludge  Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **6.** | Scum pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **7.** | Mixers in  Anoxic Tank |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **8.** | Air Blowers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **9.** | EOT for  Blowers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **10.** | Secondary  Clarifier Mechanism |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **11.** | Return Activated  Sludge Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **12.** | Waste Activated  Sludge |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **13.** | Decanters ( If  SBR provided) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **14.** | Motorized Gates |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |



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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Sl. No***  ***.*** | ***DESCRIPTION*** | ***QTY.*** | ***W*** | ***S*** | ***q = flow capacity (m3/h)*** | ***h = different i al head (m)*** | ***Ph***  ***/ (3.6 106)*** | ***pump efficien cy*** | ***Ps =***  ***Ph*** | ***Motor efficiency*** | ***motor KW*** | ***KW of the Motor with relevant margin in case of raw sewage/faecal sludge/septage pumps with 25% over shaft***  ***power)*** | ***KW of Motor / Unit selecte d (each)*** | ***Type of feede r*** | ***V*** | ***DUTY HOURS*** | ***Total KW*** | ***Total energy consumptio n per day, kWH*** | ***LOAD FACTOR*** | ***correct ed P.F.*** | ***KW ABSRB E D*** | ***KVA INPUT*** |
| ***g = gravity (9.81 m/s2***  ***=***  ***density of fluid (kg/m3)*** | ***Ps = shaft power (kW)*** |
| **15.** | Thickened  Sludge Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **16.** | Dilution Water  Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **17.** | Digester Feed  Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **18.** | Digester Mixers |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **19.** | Air Compressor |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **20.** | Biogas Scrubber |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **21.** | Dewatering  equipment Feed Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **22.** | Dewatering  equipment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **23.** | Poly dosing  Agitator |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **24.** | Poly dosing  Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **25.** | Centrate return  Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **26.** | Plant Water  Pumps |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **27.** | Analytical  Instruments |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **28.** | Lighting and Miscellaneous  Works |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **29.** | Any other equipment anticipated  by bidders |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

# SCHEDULE 13: TERMINATION COMPENSATION

In case of termination of the Agreement for a Concessionaire Event of Default, the Capex Annuity payable as termination compensation under Clause 18.1(b), Clause 18.2(b) and Clause 18.3(b) will be in accordance with the table below:

|  |  |
| --- | --- |
| **Termination in Year post relevant COD** | **% of Capex Annuity** |
| 1 | 65 |
| 2 | 65 |
| 3 | 65 |
| 4 | 70 |
| 5 | 70 |
| 6 | 70 |
| 7 | 75 |
| 8 | 75 |
| 9 | 75 |
| 10 | 80 |
| 11 | 80 |
| 12 | 80 |
| 13 | 85 |
| 14 | 85 |
| 15 | 85 |

# SCHEDULE 14: SITE LAYOUT

**[map/layout/google image of the site to be inserted here]**

# SCHEDULE 15: LIST OF DRAWINGS

|  |  |
| --- | --- |
| **S.No.** | **Content** |
| 1. | ***[please add the relevant drawings related to the project zonal***  ***plan, city maps, site layout, discharge point, indicative drawing for pumping station (if any)etc.]*** |

(Note: All drawings provided are indicative only)