



**COAL TO METHANOL PROJECT AT DANKUNI COAL
COMPLEX, WEST BENGAL ON BUILD OWN
OPERATE (BOO) BASIS, CIL**

DOC. NO.	REV
PNMM/ PC-176/E-4001	0
SHEET 1 OF 1	



COAL INDIA LIMITED, KOLKATA

TENDER DOCUMENT

FOR SETTING-UP OF

**COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-
OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA**

(TENDER NO.: PNMM/PC-176/E-4001 dated 24.09.2020)



PREPARED & ISSUED BY



**PROJECTS & DEVELOPMENT INDIA LTD.
(A Govt. Of India Enterprise)**

**PDIL BHAWAN, A-14, SECTOR-1,
NOIDA-201301 U.P. (INDIA).**



24.09. 2020

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(Tender No.: PNMM/PC-176/E-4001 DATED 24.09.2020)

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**COAL TO METHANOL PROJECT AT DANKUNI COAL
COMPLEX, WEST BENGAL ON BUILD OWN
OPERATE (BOO) BASIS, CIL**

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COAL INDIA LIMITED, KOLKATA

**TENDER DOCUMENT
(Volume-I , COMMERCIAL)**

FOR SETTING-UP OF

**COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-
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**PDIL BHAWAN, A-14, SECTOR-1,
NOIDA-201301 U.P. (INDIA).**

24.09. 2020

SECTION-1.0
"INVITATION FOR BID (IFB)"

Ref No: **PNMM/PC-176/E-4001**

24.09.2020

To,

PROSPECTIVE BIDDERS

SUBJECT : COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

NIT Ref No.: PNMM/PC-176/E-4001

Dear Sir/Madam,

1.0 INTRODUCTION

Coal India Limited (CIL) was incorporated on 01st November 1975 with nationalization of private coal mines by Govt. of India. With a modest production of 79 MT at the year of its inception, CIL today is the single largest coal producer in the world having produced nearly 607 MT.

Coal India Limited is a Schedule 'A' Maharatna CPSE under the administrative jurisdiction of Ministry of Coal, Government of India, with its Registered and Corporate office located at Kolkata (India). It operates through its subsidiaries spread over eight states (provinces) in India namely Jharkhand, West Bengal, Orissa, Chhattisgarh, Madhya Pradesh, Uttar Pradesh, Maharashtra and Assam. As on 01st April 2019, it operates 364 Mines through 83 Areas distributed in 7 Coal Producing subsidiaries namely, ECL, BCCL, CCL, SECL, WCL, NCL, MCL, and 1 consultancy company namely CMPDIL. In the Assam state (province), the coal mines are managed directly by CIL through NEC. Further, CIL also operates 16 coal washeries, and manages other establishments like workshops, hospitals, etc. CIL has 27 training Institutes. Indian Institute of Coal Management (IICM), the apex training institute, which operates under CIL and imparts multi-disciplinary management development programmes to the executives. The company has on roll 272,445 regular employees as on 01st April, 2020.

The shareholding of the Government of India in the company is 69.05%. The authorized and paid-up capital of the company is INR 80 billion and INR 61.62 billion respectively as on 31st March, 2019.

CIL has a foreign subsidiary in Mozambique namely, Coal India Africana Limited (CIAL). CIL has four subsidiary companies and one Joint Venture company. SECL has two subsidiary companies, and CCL has one subsidiary company.

During 2018-19, CIL & its subsidiaries produced 606.89 Million Tonnes (MT) of coal and achieved an off-take of 608.14 Million Tonnes (MT). During the FY: 2018-19, the gross sales, PBT and PAT of CIL were approximately INR 140.603 bn (USD 2.03 bn), Rs. 27.125 bn (USD 391 mn) and INR 17.462 bn (USD 251 mn) respectively.

CIL intends to diversify into a new "Coal to Chemical" business domain by converting the high calorific value, low ash thermal coal into synthesis gas (CO+H₂) and downstream chemicals. In pursuit of implementing this new strategy, the premises of the existing Dankuni Coal Complex

(DCC) have been identified as the geo-strategic location for setting up a Coal to Methanol Complex by using coal from Ranigunj Coalfield having ash content less than 20%.

2.0 COAL-TO-METHANOL PROJECT AT DANKUNI COAL COMPLEX(DCC)

Dankuni Coal Complex (DCC) is a Low Temperature Carbonisation (LTC) Plant of Coal India Limited (CIL) and is currently being run on lease by South Eastern Coalfields Limited (SECL), a wholly owned subsidiary of CIL. DCC was set up under the recommendation of the Fuel Policy Committee, to meet the growing needs of "Environmental Friendly Fuel" to meet requirements of domestic & industrial sectors. The commercial production of the plant started in May 1990. Today, DCC is engaged in processing and supplying of Coal gas and Coal products (coke) by using non-coking coal.

Coal India Limited intends to set-up a Coal (Indian Coal) to Methanol Plant at its existing premises of Dankuni Coal Complex at Dankuni West Bengal utilizing coal from Ranigunj coalfields as a basic raw material for the production of 2050 Metric Tonnes per Day (MTPD) Methanol. Pre-Feasibilities Studies have been completed. Currently, pre-project activities are under progress at the Project Site.

3.0 BRIEF SCOPE OF WORK:

Coal India Limited intends to setup a Coal-to-Methanol Plant on Build Own Operate (BOO) Basis for life of the plant (expected period 25 years). The scope shall be as defined in the Tender documents and shall broadly cover the following - Design, Build, Own, Lease, Operate & Maintain Production Plant(s), transfer required product(s) to storage in the proposed plant during its contracted period will be the responsibility of the BOO Operator.

The project shall broadly comprise the following plants and facilities:

- (a) Coal Handling System including Crushing-Milling-Drying Unit
- (b) Air Separation Unit
- (c) Coal Gasification Including Purification unit
- (d) Ash Handling
- (e) Methanol Plant (2050 MTPD) alongwith storage & loading facilities
- (f) Associated Offsite and Utilities Facilities

Projects & Development India Ltd. (PDIL) has been retained as Consultant for selection of (Build Own Operate (BOO) Operator for the project.

4.0 LOCATION OF THE PROJECT SITE

Coal India Limited intends to set up a Coal to Methanol Plant at its existing premises of Dankuni Coal Complex (DCC) at Dankuni, West Bengal (India).

The proposed project is situated by the side of Durgapur Expressway in the north and Janai Road railway station of the grand chord line in the south at Dankuni village of Hooghly District of West Bengal, India. The project site, adjacent to the Kolkata – Durgapur Expressway, is at a distance of about 25 km by road from Kolkata. Kolkata Airport is the nearest Airport to the proposed project site which is about 20 km.

5.0 Bidding Process

- (a) The "INVITATION FOR BID" and "Instruction to Bidders" is placed on the website of PDIL (www.pdil.in), CIL (www.coalindia.in), and CPP portal (<https://etenders.gov.in/e procure/app>).
- (b) This Invitation for bid briefly provides the Bidders with guidance, requirements and instructions for submitting a fully compliant and responsive bid. The Invitation for bid is an integral and inseparable part of the bidding document.

(c) **Salient features of bidding document:**

A.	NAME OF WORK / BRIEF SCOPE OF SERVICE/JOB	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BOO BASIS					
B.	TENDER NO. & DATE	PNMM/PC176/E-4001, Date 25.09.2020					
C.	TYPE OF BIDDING SYSTEM	<table border="1"> <tr> <td>SINGLE BID SYSTEM</td> <td><input type="checkbox"/></td> </tr> <tr> <td>TWO BID SYSTEM</td> <td><input checked="" type="checkbox"/></td> </tr> </table>	SINGLE BID SYSTEM	<input type="checkbox"/>	TWO BID SYSTEM	<input checked="" type="checkbox"/>	
SINGLE BID SYSTEM	<input type="checkbox"/>						
TWO BID SYSTEM	<input checked="" type="checkbox"/>						
D.	TYPE OF TENDER	OPEN INTERNATIONAL COMPETITIVE BIDDING (ICB)					
	MODE OF SUBMISSION	E-TENDER, THROUGH CPP PORTAL					
E.	COMPLETION PERIOD	<table border="1"> <tr> <td>Mechanical Completion</td> <td>36 Months</td> </tr> <tr> <td>Commissioning</td> <td>41 Months</td> </tr> </table>	Mechanical Completion	36 Months	Commissioning	41 Months	
Mechanical Completion	36 Months						
Commissioning	41 Months						
F.	BID SECURITY / EARNEST MONEY DEPOSIT (EMD)	INR 550 million or equivalent USD					
G.	AVAILABILITY OF TENDER DOCUMENT ON WEBSITE(S)	PDIL (https://pdilin.com/tenders1.php) CIL (www.coalindia.in) CPP Portal (https://etenders.gov.in/eprocure/app)					
H.	LAST DATE OF RECEIPT OF BIDDER'S QUERIES	20.10.2020					
I.	DATE, TIME & VENUE OF PRE-BID MEETING	27.10.2020, 11:00 Hrs. (IST) at PDIL, Noida / or Video Conference through Google Meet					
J.	DUE DATE & TIME FOR BID SUBMISSION	17.12.2020, 15:00 Hrs. (IST)					
K.	DATE, TIME & VENUE FOR UN-PRICED BID OPENING	18.12.2020 at 15:00 Hrs. (IST) Venue: M/s Projects & Development India Limited, P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. Gautam Budh Nagar (UP). (India)					
L.	Address for Communication						
i)	PDIL	Projects & Development India Limited, (Materials Management Department) P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. Gautam Budh Nagar (UP). (India) Kind Attention: Mr.P.R.Sahu, Addl. General Manager (M.M) Fax no.: +91-120-2529801					

		<p>Tel no.: +91-120-2544063</p> <p>E-mail: prsahu@pdilin.com; anjali@pdilin.com; tanzin@pdilin.com</p>
ii)	CIL	<p>Mr. Sagar Sen</p> <p>Chief Manager (Min.)</p> <p>Coal Videsh & International Cooperation Divn. Coal India Limited, Coal Bhawan, Premise No. 04, MAR, Plot No. AF-III, Action Area - 1A, New Town, Kolkata - 700 156 (W.B.), India Office/ Fax: +91-33-7110 4656 / +91-33-2324 6546</p> <p>E-mail: ssen2.cil@coalindia.in</p>
M.	Original Documents to be submitted at	<p>M/s Projects & Development India Limited, P.D.I.L Bhawan, A-14, Sector-1, Noida, (PIN 201301) Dist. Gautam Budh Nagar (UP). (India)</p> <p>Kind Attention: Mr. P.R.Sahu, Addl. General Manager (M.M) Fax no. : +91-120-2529801 Tel no. : +91-120-2544063</p> <p>E-mail : prsahu@pdilin.com anjali@pdilin.com tanzin@pdilin.com</p>
N.	Contact Person for Site visit	<p>Mr. SRIBAS SARKAR</p> <p>Senior Manager (Coal Preparation),</p> <p>Coal Videsh & International Cooperation Division, Coal India Limited, "Coal Bhawan", Premise No. 04, MAR, Plot No. AF-III, Action Area - 1A, New Town, Kolkata - 700 156 (W.B.), India Tel No. Office/ Fax: +91-33-7110 4660 / +91-33-2324 6546</p> <p>E-mail: sribas.sarkar@coalindia.in</p>

In case the days specified above happens to be a holiday in CIL/PDIL, the next working day shall be implied.

- 6.0 Bids must be submitted strictly in accordance with Clause No. 13 of Instruction to Bidder (ITB) depending upon Type of Tender as mentioned at Clause no. 5.0 (D) of IFB. The IFB is an integral and inseparable part of the bidding document.
- 7.0 The following documents in addition to uploading the bid on CPP Portal (<https://etenders.gov.in/eprocure/app>) shall also be submitted in Original (in physical form) within 7 (seven) days from the bid due date provided the scanned copies of the same have been uploaded on CPP Portal (<https://etenders.gov.in/eprocure/app>) by the bidder along with e-bid within the due date and time to the address mentioned in Clause no. 5.0 (M) of IFB:-

- i) EMD/Bid Security
- ii) Power of Attorney
- iii) Pre-Signed Integrity Pact
- iv) Original Letter of TPI as per Annexure-1.15
- v) Letter of No Deviation as per Annexure-1.6

- 8.0 Bidder(s) are advised to quote strictly as per terms and conditions of the tender documents and not to stipulate any deviations/exceptions.
- 9.0 Any bidder, who meets the Pre-Qualification Criteria (PQC) enclosed at Section-2, Volume-1, Commercial and wishes to quote against this Tender Document, may download the complete Tender Document along with its amendment(s) if any, from websites as mentioned at 5.0 (G) of IFB and submit their Bid complete in all respect as per terms & conditions of Tender Document on or before the Due Date & Time of Bid Submission.
- 10.0 Bid(s) received from bidders to whom tender/information regarding this Tender Document has been issued as well as offers received from the bidder(s) by downloading Tender Document from above mentioned website(s) shall be taken into consideration for evaluation & award provided that the Bidder is found responsive subject to provisions contained in PQC and ITB.
- The Tender Document calls for offers on single point responsibility basis and in total compliance of Scope of Works as specified in Tender Document.
- 11.0 Any revision, clarification, corrigendum, time extension, etc. to this Tender Document will be hosted on the above mentioned website(s) only as per Clause No. 5.0 (G) of IFB. Bidders are requested to visit the website regularly to keep themselves updated.
- 12.0 The bidder shall submit the bid online through Central Public Procurement (CPP) Portal. Bids complete in all respects should be uploaded in the CPP portal on or before the Bid Due Date and time mentioned in at Sl. No. 5.0 (J) above. Bids through Post/ Fax / E-mail /CD/ any other mode other than that specified in ITB will not be accepted.
- 13.0 In the terms of the agreement the land will be provided on lease basis to the prospective bidder for the purpose of setting up the plant .The successful bidder will not have any perpetual right, title interest in the said land either as tenant or otherwise.
- 14.0 OWNER/PDIL reserves the right to reject any or all the bids received at its discretion without assigning any reason whatsoever.

This is not an Order.

Thanking You,

For & on behalf of
Coal India Limited



(P.R.Sahu)

Addl. General Manager (M.M)

Projects & Development India Limited

Tel No. : +91-120-2544063



E-mail : prsahu@pdilin.com

 पी डी आई एल PDIL	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS PRE-QUALIFICATION CRITERIA (PQC)	PNMM/PC- 176/E-4001/2.0	0	 कोयला इंडिया Coal India
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VOLUME-I, COMMERCIAL

SECTION 2.0

PRE-QUALIFICATION CRITERIA (PQC)

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC- 176/E-4001/2.0	0	
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PRE-QUALIFICATION CRITERIA (PQC)				

1.0 ELIGIBLE BIDDERS

1.1 SOLE BIDDER OR A JOINT VENTURE OR A CONSORTIUM

1.1.1 Bids may be submitted by a Bidder who is a sole Bidder or a joint venture company (JV) or a consortium of members along with a lead member (“**Consortium**”). However, [except in case of a sole Bidder], the successful Bidder emerged through tendering process should be a company incorporated in India prior to award of tender (LOA).

1.1.2 The Bidder which has completed 3 (three) financial years from the date of commencement of business shall fulfill each eligibility criteria as defined in Clause 2.0 below.

1.1.3 In case the Bidder is a newly formed JV which has not completed 3 (three) financial years from the date of commencement of business, then either the said JV shall fulfill each eligibility criteria or any one constituent member of such a JV shall fulfill each eligibility criteria. If the bid is received with the proposal that one constituent member fulfills each eligibility criteria then this member shall be clearly identified and it shall assume all obligations under the contract and provide such comfort letter/ guarantees as may be required by Owner. The guarantee shall cover inter alia the commitment of the member to complete the entire work in all respects and in a timely fashion, being bound by all the obligations under the contract, an undertaking to provide all necessary technical and financial support to the JV to ensure completion of the contract when awarded, an undertaking not to withdraw from the JV till completion of the work, etc.

The provisions of Cl. No. 1.1.3 above shall also apply for a Consortium bid. The leader of the Consortium shall fulfill each eligibility criteria and assume all obligations and guarantee as mentioned above.

1.1.4 A JV/Consortium once established at the time of submitting the Bid shall not be allowed to be altered with respect to constituting members of the JV/Consortium till the successful performance guarantee test run (PGTR). If during the evaluation of bids, a JV/ Consortium proposes any alteration/ changes in the orientation of JV/ Consortium or replacements or inclusions or exclusions of any partner(s)/ member(s) which had originally submitted the bid, bid from such a JV/ Consortium Company shall be liable for rejection.

1.1.5 The total number of Consortium members including their leader shall not exceed 4 (four).

All the members/shareholders of the JV and the members/shareholders of the newly incorporated company (in case of a Consortium) shall sign the contract and shall be jointly and severally liable for the entire assignment.



2.0 PRE-QUALIFICATION CRITERIA

2.1 TECHNOLOGY CRITERIA

2.1.1 Coal Gasification Technology:

The following 3 nos. of Coal gasification technologies had been shortlisted for Raw Syn-Gas from Coal feed stock:

- (i) M/s Shell Technology, Singapore (Now taken over by AirProducts)
- (ii) M/s GE (Power), the USA (Now taken over by Air Products)
- (iii) M/s Choren Industrietechnik GmbH, Germany

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PRE-QUALIFICATION CRITERIA (PQC)				

Any other Coal gasification technology suppliers who fulfill the eligibility criteria as per EOI, published in 2017 by M/s CIL may be licensed subject to approval of CIL/PDIL.

The Bidder either on his own or with the support from a reputed Gasification Process Licensor should be capable of providing/ arranging Process License and Basic Design Package of proven performance for Coal Gasifiers for gasifying Coal/feedstock (ash content ranging from 18% to 30.%) on commercial basis, for supply of Methanol Synthesis Gas.

The Coal Gasifiers / Gasification technology proposed by Bidder shall have reference of at least one plant having one or multiple (Max. 2 nos.) Coal Gasifiers with a total coal capacity of 1800 Metric Tonnes Per Day (MTPD) operating successfully on commercial basis with coal/feedstock, for at least one continuous year. However, it will be sole responsibility of the Bidder that the Coal Gasifier / Gasification technology proposed by him based on above criteria, is suitable for the quality of Coal to be specified in the NIT.

Bidder to note that Marketing of any by-product formation by selected Coal Gasification Technology apart from Methanol Synthesis Gas will be Bidder's responsibility.

Bidder has to submit letter of support / MOU from the Process Licensor for technology tie up for the proposed Coal Gasification technology. In case of his own technology, the Bidder shall submit a self- declaration.

Bidder shall submit documentary proof for Licensor's plant, issued by plant owner / Technology Licensor's certificate regarding the same.

Technology once selected and offered by the Bidder cannot be changed during the Construction Period including commissioning &PGT. However, innovations / modification / alteration in technology can be allowed during Operation Period, subject to acceptance of its proneness by CIL on the basis of availability of reference plants fulfilling aforesaid criteria.



2.1.2 Gas Cleaning, Purification, Methanol Synthesis Gas Generation and Methanol Production (Methanol Synthesis &Purification):

The Bidder either on his own or with the support from a reputed Process Licensor should be capable of providing/ arranging Process License and Basic Design Package for the proposed Gas cleaning, Purification, Methanol Synthesis Gas Generation and Methanol production (Methanol Synthesis &Purification). The Gas Cleaning, Purification, Methanol Synthesis Gas and Liquid Methanol (grade AA, i.e. above 99.85% purity) Generation technology proposed by Bidder shall have reference of at least one plant processing Methanol Synthesis gas from the gasifier and generating minimum 1200 MTPD of Liquid Methanol of grade AA, i.e. above 99.85% purity operated successfully for one continuous year in the last 10 years reckoned from the last day of the preceding month in which the bids are opened.

Bidder has to submit letter of support / MOU from the Process Licensor for technology tie up for the proposed Syn-Gas cleaning, Purification, Methanol Synthesis Gas Generation and Methanol Plant. In case of his own technology, the Bidder shall submit a self-declaration.

Bidder shall submit documentary proof for Licensor's plant, issued by plant owner / technology licensor's certificate regarding the same.

Technology once selected and offered by the Bidder cannot be changed during Construction Period including commissioning &PGT. However, innovations / modification / alteration in technology can be allowed during Operation Period, subject to acceptance of its proneness by

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PRE-QUALIFICATION CRITERIA (PQC)				

CIL on the basis of availability of reference plants fulfilling aforesaid criteria.

Bidder may tie up with any of the following commercially successful Methanol Process Licensors:

- Haldor Topsøe
- Casale
- Lurgi
- ICI
- Johnson Matthey

2.1.3 For establishing that the Technology to be adopted by the Bidder as per Clause Nos. 2.1.1 and 2.1.2 above is a proven one, the Bidder shall provide details of at least one latest commercial plant which has operated successfully for at least one continuous year in the last 10 years period reckoned from the last day of the preceding month in which the bids are opened. Bidder shall submit documentary proof for the Licensor's Plant issued by plant owner's / technology licensor's certificate / letter regarding the same

2.2 EXPERIENCECRITERIA

2.2.1 The Bidder should be an established BOO Operator and should possess experience of having successfully built Plants on BOO (Build, Own and Operate) basis in any one or more in the field of Coal gasification, Coal to Liquid, Coal to Chemical, Oil&Gas, Refinery, Hydrocarbon, Petrochemicals, Ammonia, Fertilizer and Methanol. Such plant should have been in satisfactory commercial operation for a continuous minimum period of one year in the last 10 years period reckoned from the last day of the preceding month in which the bids are opened.

2.2.2 In the aforesaid plant, the Bidder should have owned and operated for at least one year, a process unit with a minimum capacity to produce 100,000 Nm³/hr either Ammonia Syn-Gas or Methanol Syn-Gas or Pure H₂. Bidder to submit the documentary proof thereof.

2.2.3 Documentary proof consisting of detailed work order indicating scope of work, along with completion/ acceptance certificate and 1 year successful operation certificate issued by the owner will have to be submitted by the Bidder in support of fulfilling these criteria. The completion / acceptance certificate shall clearly indicate the LOA / work order number, Name of work, contract value, scope of work, contract period and actual date of completion. The certificate should clearly mention whether the Bidder was the sole party or a member of JV / Consortium who has carried out the assignment. Further, in cases other than sole party, the roles and responsibilities of the Bidder should be clearly indicated.

2.2.4 The Bidder, meeting the requirement as per Clause 2.2.1 above, must have owned or constructed atleast one Chemical Plant in any one of the field of Coal Gasification, Coal to Liquid, Coal to Chemical, Oil & Gas, Refinery, Hydrocarbon, Petrochemicals, Ammonia, Fertilizer and Methanol in last 10 (ten) years reckoned from the last day of the preceding month in which the bids are opened in the following manner:



Completed one work costing not less than INR 44 billion or equivalent foreign currency

Or

Completed two works each costing not less than INR 28 billion or equivalent foreign currency

Or

Completed three works each costing not less than INR 22 billion or equivalent foreign currency

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PRE-QUALIFICATION CRITERIA (PQC)				

Note: Wherever mentioned in the entire NIT, the “equivalent foreign currency” shall be arrived by using the conversion rate as per RBI reference rate or the rates published RBI authorised website, as on the date of opening of bids.

2.2.5 To meet the criteria at Cl. no. 2.2.4 above, Bidder shall submit documentary proof such as Copy of Work Order/ relevant Extract of Work Order and Completion / Acceptance Certificate. The Completion / Acceptance Certificate shall clearly indicate the LOA/Work Order No., ‘Name of Work’, ‘Contract Value’, Scope of Work, ‘Contract Period’ ‘Executed Value’ and actual date of completion.

2.2.6 For Cl. no. 2.2.1 and 2.2.4, a Job executed by a Bidder for its own plant/ project cannot be considered as experience for the purpose of meeting PQC of the tender. However, jobs executed for Subsidiary/Fellow subsidiary / Holding company will be considered as experience for the purpose of meeting PQC subject to submission of tax paid invoice (s) duly certified by Statutory Auditor of the Bidder towards payments of statutory tax in support of the job executed for Subsidiary/Fellow subsidiary/ Holding company. Such Bidders to submit these documents in addition to the documents specified to meet PQC.

2.3 FINANCIAL CRITERIA

2.3.1 Average Annual Financial Turnover

- a) The Average Annual Financial Turnover of the Bidder during the last 3 (three) preceding financial years i.e. 2019-20, 2018-2019, and 2017-2018 or calendar years 2019, 2018 and 2017 should be at least INR 17 billion or equivalent foreign currency.
- b) The Average Annual Financial Turnover of the each member of the Consortium/JV for the last 3 (three) preceding financial years i.e. 2019-20, 2018-2019, and 2017-2018 or calendar years 2019, 2018 and 2017 should be at least INR 8 billion or equivalent foreign currency.



2.3.2 Net Worth of the Bidder/each member of the Consortium or JV should be positive as on 31 March 2020 or calendar year 31 December 2019 as applicable.

2.3.3 The Bidder will submit Solvency certificate not more than 6 (six) months old from the last date of submission of tender from their Banker for a value not less than INR 19 billion or equivalent foreign currency OR financing/credit limits from bank of value not less than INR 19 billion or equivalent foreign currency valid as on date of issue of Tender OR minimum Credit ratings of “A” or equivalent from Rating Agencies registered with SEBI viz; ICRA/CRISIL/CARE/India Ratings(Fitch)/Brickwork Ratings/SMERA or Foreign reputed institutions like Moody, S&P, Fitch.

2.3.4 To meet the criteria (2.3.1 & 2.3.2) above, Bidder shall submit audited financial statements (balance sheet and profit & loss account) of the company for the last three (3) financial years i.e. 2019-20, 2018-2019, and 2017-2018 or calendar years 2019, 2018 and 2017 as applicable, along with the duly filled up form for ‘Pre- Qualification Criteria (PQC) in favour of Financial Criteria’ as set out in Exhibit 3.

Note:

- i. For PQ criteria in respect of Order value/Turn Over/ Net worth, in case PQ Criteria indicated by the BIDDERS is in foreign currency, RBI reference rate on the date of opening of technical bid shall be considered for conversion of the foreign currency into INR

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- ii. In case a Bidder does not satisfy the financial criteria w.r.t. Annual Turnover & Net worth as above, on its own, then the holding company would be required to meet the stipulated turnover requirements, provided that the net worth of such holding company as on the last day of the preceding financial year is at least equal to or more than the paid-up share capital of the holding company. In such an event, the Bidder would be required to furnish along with its bid, a letter of undertaking from the holding company, supported by board resolution, as per the prescribed format (Annexure 1.22), pledging unconditional and irrevocable financial support for the execution of the Contract Agreement by the Bidder in case of award.
- iii. In case a Consortium member does not satisfy the financial criteria w.r.t. Annual Turnover & Net worth as above, on its own, then the holding company of such member would be required to meet the stipulated turnover requirements, provided that the net worth of such holding company as on the last day of the preceding financial year is at least equal to or more than the paid-up share capital of the holding company. In such an event, the member would be required to furnish along with its bid, a letter of undertaking from the holding company, supported by board resolution, as per the prescribed format (Annexure-1.22), pledging unconditional and irrevocable financial support for the execution of the Contract Agreement by the member in case of award to the Consortium.
- iv. Further, the Bidder/any of the promoter of JV/ any consortium Member should not be on 'Holiday'/'Negative list' by CIL or Public Sector Project Management Consultant (like EIL, MECON, PDIL due to "poor performance" or "corrupt and fraudulent practices") or banned/blacklisted by Government department/ Public Sector on due date of submission of bid. Further Bidder has to submit declaration as per Annexure-1.13 Offer submitted by such Bidder shall not be considered for opening/evaluation/Award.

2.4 AUTHENTICATION OF ALL DOCUMENTS SUBMITTED AGAINST PQC

2.4.1 Technical Criteria of PQC:

All documents in support of Technical PQC furnished by the BIDDERS shall be verified and certified by any one of the following independent third party inspection agency:

- a) Société Générale de Surveillance(SGS)
- b) Gulf Lloyds Industrial Services (India) Pvt. Ltd.(GLISPL)
- c) International Certification Services(ICS)
- d) Bureau Veritas (Ind.) Pvt. Ltd(BVIS)
- e) DNVGL
- f) UV Rheinland (India) Pvt. Ltd.
- g) TUV SUD South Asia Pvt. Ltd.
- h) TUV India Pvt. Ltd. (TUV Nord Goup)
- i) Intertek India Pvt. Ltd.
- j) Moody International (India) Pvt. Ltd.
- k) RINA India Pvt. Ltd.
- l) Competent Inspectorate and Consultants LLP

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m) ABS Industrial Verification (India) Pvt. Ltd.

All charges of the Third party for verification and certification shall be borne by the Bidder. TPIA will provide in addition a certificate towards verification and certification of documents pertaining to Technical PQC as per proforma attached as Annexure-1.15.

2.4.2 FINANCIAL CRITERIA OF PQC:

Bidder shall submit “Details of financial capability of Bidder” in prescribed format in prescribed format (Exhibit–3) of tender document, duly signed and stamped by a Chartered Accountant / Certified Public Accountant (CPA). Further:

- (a) For Indian Bidders, copy of audited annual financial statements submitted in bid shall be duly certified / attested by Notary Public with legible stamp.
- (b) For Foreign Bidders, copy of audited annual financial statements submitted in bid shall be certified true copies, duly signed, dated and stamped by an official, authorized for this purpose in Indian Embassy / High Commission in Bidder’s country. However, member countries of Hague Convention 1961, supporting document pertaining to financial PQC Apostille affixed by competent authorities designated by the government of Bidder’s country shall also be acceptable.

Note: In case, Bidder submits ‘details of financial capability of Bidder’ in prescribed format in support of financial criteria of PQC duly signed and stamped by its Statutory Auditor, authentication of audited financial statements as mentioned at Sl. No. 2.4.2 (a) and 2.4.2 (b) above may not be necessary.

 <p>पी डी आई एल PDIL</p>	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	DOC. NO.	REV	 <p>कोयला इण्डिया Coal India</p>
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SECTION 3.0

EXHIBITS

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LIST OF EXHIBITS

<u>EXHIBITS:</u>	
EXHIBIT – 1	In favour of Technology Criteria.
EXHIBIT – 2	In favour of Experience Criteria.
EXHIBIT – 3	In favour of Financial Criteria

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EXHIBIT-1A

PRE- QUALIFICATION CRITERIA (PQC) IN FAVOUR OF TECHNOLOGY CRITERIA

Bidder shall furnish details with reference to the work, which pre-qualify them in line with Technology Criteria mentioned under Clause 2.1.1 of Volume-1, Commercial, Section 2.0 'Pre-Qualification Criteria'.

1.0 REFERENCES OF PLANT WITH PROPOSED TECHNOLOGY

SL. NO.	DESCRIPTION	PROJECT – 1, 2 etc. (Separate sheets for each Project)
1.	Project name and description (Please Specify the name of Process licensor also)	
2.	The Bidder either on his own or with the support from a reputed Gasification Process Licensor should be capable of providing/ arranging Process License and Basic Design Package of proven performance for Coal Gasifiers for gasifying Coal / feedstock (ash content ranging from 18% to 30%) on commercial basis, for supply of Methanol Synthesis Gas.	
2..1	The Coal Gasifiers / Gasification technology proposed by Bidder shall have reference of at least one plant having one or multiple (Max. 2 nos.) Coal Gasifiers with a total coal capacity of 1800 Metric Tonnes Per Day (MTPD) operating successfully on commercial basis with coal/feedstock, for at least one continuous year. However, it will be sole responsibility of the Bidder that the Coal Gasifier/ Gasification technology proposed by him based on above criteria, is suitable for the quality of Coal to be specified in the NIT.	
3.	a) Date / month / year of award / commencement of Project	
	b) Date / month / year of commissioning of Project	
4.	Name of Owner	
	(a) Name and address of Owner's contact person	
	(b) Telephone and Fax No.	
5.	Documentary proof from the owner in support of successful operation of plant for last one year.	YES/NO
6.	Performance data of the qualifying plants/projects at least one continuous year (Attach relevant Plant performance Data sheets duly certified by owner)	YES/NO

Note:

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1. Bidder shall furnish the details as above of Projects which they consider suitable for their pre-qualification. CIL / PDIL reserve the right not to evaluate any other Project details.
2. Bidder to note that PQC form shall be filled as per the Proformas as stated, along with wherever applicable, copies of work order, completion certificates.
3. Bidder to note that non-submission of relevant supporting documents may lead to rejection of their PQ bid. It is to be ensured that all relevant supporting documents shall be submitted along with the PQ bid in the first instance itself. Pre-qualification may be completed based on the details so furnished without seeking any subsequent additional information.

STAMP & SIGNATURE OF BIDDER :
NAME OF BIDDER :
DATE :

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EXHIBIT-1B

PRE- QUALIFICATION CRITERIA (PQC) IN FAVOUR OF TECHNOLOGY CRITERIA (GAS CLEANING, PURIFICATION, METHANOL SYNTHESIS GAS GENERATION and METHANOL PRODUCTION (METHANOL SYNTHESIS & PURIFICATION):

Bidder shall furnish details with reference to the work, which pre-qualify them in line with Technology Criteria mentioned under Clause under Clause 2.1.2 of Volume-1, Commercial, Section 2.0 'Pre- Qualification Criteria'.

2.0 REFERENCES OF PLANT WITH PROPOSED TECHNOLOGY

SL. NO.	DESCRIPTION	PROJECT – 1, 2 etc. (Separate sheets for each Project)
1.	Project name and description (Please Specify the name of Process licensor also)	
2.	The Bidder either on his own or with the support from a reputed Process Licensor should be capable of providing/arranging Process License and Basic Design Package for the proposed Gas cleaning, Purification, Methanol Synthesis Gas Generation and Methanol production (Methanol Synthesis & Purification). The Gas Cleaning, Purification, Methanol Synthesis Gas and Liquid Methanol (grade AA, i.e. above 99.85% purity) Generation technology proposed by Bidder shall have reference of at least one plant processing Methanol Synthesis gas from the gasifier and generating minimum 1200 MTPD of Liquid Methanol of grade AA, i.e. above 99.85% purity.	
3.	c) Date / month / year of award / commencement of Project	
	d) Date / month / year of commissioning of Project	
4.	Name of Owner	
	(a) Name and address of Owner's contact person	
	(b) Telephone and Fax No.	
5.	Documentary proof from the owner in support of successful operation of plant for last one year.	YES/NO
6.	Performance data of the qualifying plants/projects at least one continuous year (Attach relevant Plant performance Data sheets duly certified by owner)	YES/NO

Note:

- Bidders shall furnish the details as above of Projects which they consider suitable for their pre-qualification. CIL/PDIL reserve the right not to evaluate any other Project details.
- Bidder to note that PQC form shall be filled as per the Proforma as stated, along with wherever applicable, copies of work order, completion certificates.
- Bidder to note that non-submission of relevant supporting documents may lead**

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to rejection of their PQ bid. It is to be ensured that all relevant supporting documents shall be submitted along with the PQ bid in the first instance itself. Pre-qualification may be completed based on the details so furnished without seeking any subsequent additional information.

STAMP & SIGNATURE OF BIDDER :

NAME OF BIDDER :

DATE :

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	DOC. NO.	REV	
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EXHIBIT-2

PRE- QUALIFICATION CRITERIA (PQC) IN FAVOUR OF EXPERIENCE CRITERIA:

Bidder shall furnish details with reference to the work, which pre-qualify them in line with experience criteria mentioned under Clause under Clause 2.2 of Volume-1, Commercial, Section 2.0 'Pre- Qualification Criteria'.

(MARK FOR APPLICABILITY IN BOX)

1.0 EXPERIENCE AS BOO Operator

SL. No.	Description	Details
1.	Name of Project, Location	
2.	Description of work	
3	Experience of having successfully Build Plants on BOO (Build, Own and Operate) basis in any one or more of the field of Coal gasification, Oil, Gas, Refinery, Hydrocarbon, Air Separation or Fertilizer and Methanol. Such plant should have been in satisfactory commercial operation for a continuous minimum period of one year in the last 10 years period. Bidder should have owned and operated at least for one year, a process unit with a minimum capacity to produce 100,000 Nm ³ /hr Either Ammonia Syn. gas or Methanol or Pure O ₂ or Pure N ₂ . Bidder to submit the documentary proof thereof	
4.	Name of Owner, Postal Address, Phone / Fax No. / E-mail	
5.	Name of Consultant / Postal Address, Phone / Fax No. / E-mail.	
6	Date of Commercial Operation of the Plant by BOO operator:	
7.0	Document Furnished	
8.1	Copy of work order / Contract Agreement enclosed	YES / NO
8.2	A certificate from the Owner that the Plant is put into commercial operation by the BOO Operator.	YES / NO

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2.0 DETAILS OF PROJECT REFERENCES

SL. NO.	DESCRIPTION	PROJECT – 1, 2 etc. (Separate sheets for each Project)
1.	Project name and description (In the field of Coal gasification, Coal to Liquid, Coal to Chemical, Oil & Gas, Refinery, Hydrocarbon, Petrochemicals, Ammonia, Fertilizer and Methanol in last 10 (ten) years)	
2.	(a) Awarded contract value (INR /equivalent foreign currency) Completed one work costing not less than INR 44 billion or equivalent foreign currency. Or Completed two works each costing not less than INR 28 billion or equivalent foreign currency, Or Completed three works each costing not less than INR 22 billion or equivalent foreign currency,	
	(b) Final executed contract value (INR / equivalent foreign currency)	
	(c) Exchange rate considered for contract	
3.	Name of Owner	
	(a) Name and address of Owner's contact Person	
	(b) Telephone and Fax No. (c) Mobile No. (d) Email	
4.	(a) Date / month / year of award / commencement of Project	
	(b) Date / month / year of scheduled Commissioning of Project.	
	(c) Date / month / year of actual commissioning of Project.	
5.	Basis of work	As a Single Bidder/JV/Consortium
6.	Whether document submitted in support viz. copies of work order and completion certificate identifying the successful commissioning of project for ascertaining BQC.	YES/NO

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Note:

1. Bidder shall furnish the experience details as above of Projects which they consider suitable for their pre-qualification. CIL/PDIL reserves the right not to evaluate any other Project details.
2. Bidder to note that PQC form shall be filled as per the Proformas as stated, along with wherever applicable, copies of work order and completion certificates.
3. **Bidder to note that non-submission of relevant supporting documents may lead to rejection of their PQ bid.** It is to be ensured that all relevant supporting documents shall be submitted along with the PQ bid in the first instance itself. Pre-qualification may be completed based on the details so furnished without seeking any subsequent additional information.
4. For PQ criteria in respect of Order value, in case PQ Criteria indicated by the bidders is in foreign currency, RBI reference rate on the date of opening of technical bid shall be considered for conversion of the foreign currency into INR.

STAMP & SIGNATURE OF BIDDER :

NAME OF BIDDER :

DATE :

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EXHIBIT-3

PRE- QUALIFICATION CRITERIA (PQC) IN FAVOUR OF FINANCIAL CRITERIA

FORMAT FOR CHARTERED ACCOUNTANT CERTIFICATE

We have verified the Annual Accounts and other relevant records of M/s.....(Name of the Bidder) and certify the following:

A. ANNUAL TURNOVER OF LAST 3YEARS:

Year	Amount (Currency)
Year 1:	
Year 2:	
Year 3:	

B. FINANCIAL DATA FOR LAST AUDITED FINANCIAL YEAR:



Description	Year _____
Amount (Currency)	
1. Current Assets	
2. Current Liabilities	
Working Capital (Current Assets-Current liabilities)	
NetWorth(Paid up share Capital and Free Reserves & Surplus)	

Name of Audit Firm:
Chartered Accountant
Date:

[Signature of Authorized Signatory]
Name:
Designation:
Seal:
Membership No.:

Instructions:



1. The financial year would be the same as one normally followed by the Bidder for its Annual Report.
2. The Bidder shall provide the audited annual financial statements as required for this PQ document. Failure to do so would result in the Proposal being considered as non-responsive.
3. This certificate is to be submitted on the letter head of Chartered Accountant.
4. For PQ criteria in respect of Turn Over / Net worth, in case PQ Criteria indicated by the bidders is in foreign currency, RBI reference rate on the date of opening of technical bid shall be considered for conversion of the foreign currency into INR.

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SECTION 4.0

SUBMISSION OF BID

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SUBMISSION OF BID				



From:

M/s.....

To:

**M/s COAL INDIA LIMITED,
Coal Bhawan, Action Area-1A,
New Town,
Kolkata - 700 156 (W.B.)**

1. I/We hereby tender for design, build, own, lease, operate and maintain Methanol Production Plant(s) on BOO basis, transfer required product(s) for storage and marketing of the entire quantity of methanol produced in the plant during the contracted period for CIL/or its subsidiary at Dankuni Coal Complex, West Bengal, India as per Terms and Conditions specified in **TENDER NO : PNMM/PC-176/E-4001** Price Format quoted by me/us are in accordance with Invitation for Bid, Instructions to Bidders, Schedule of Prices and other documents and papers, all as detailed in the Bidding documents.
2. It has been explained to me/us that the date of commencement of first delivery of Methanol is the essence of the Contract Agreement. I/We agree that in the case of failure on my/our part to strictly observe the Time Schedule, I/We shall pay compensation to CIL as per provisions and stipulations contained in the Contract Documents and I/We agree to recovery being made as specified therein.
3. I/ We acknowledge that Owner will be relying on the information provided in the Bid and the documents accompanying such Bid for the Project, and I/we certify that all information provided in the Bid is true, complete and correct; nothing has been omitted which renders such information misleading; and all documents accompanying such Bid are true copies of their respective originals.
4. I/ We shall make available to the Owner any additional information it may find necessary or require to supplement or authenticate my/ our Bid.
5. I/ We acknowledge the right of the Owner to reject my/our Bid without assigning any reason or otherwise and hereby waive, to the fullest extent permitted by applicable law, my/our right to challenge the same on any account whatsoever.
6. I/ We declare that:
 - a. I/ we have examined and have no reservations to the Tender Documents, including any addendum issued by the Owner;
 - b. I/ we are eligible to submit a bid and in particular, do not have any Conflict of Interest;
 - c. I/we have not directly or indirectly or through an agent engaged or indulged in any corrupt, fraudulent, coercive practice or restrictive practice, in respect of any tender or request for bid issued by or any agreement entered into with the Owner or any other public sector enterprise or any GOI/SG entity;



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SUBMISSION OF BID				

- d. My/ our Bid shall be valid for a minimum period of [180 (one hundred and eighty) days] from the Bid Due Date, as extended from time to time, in accordance with the Bidding Documents, and it shall remain binding upon me/ us and may be accepted at any time before the expiration of that period; and
- e. If my/ our Bid is accepted, we undertake to complete the Project in accordance with the Contract Agreement and other Tender Documents.
7. I/ We certify that in regard to matters other than security and integrity of the country, we/ any member or any of our/ their associates have not been convicted by a court of law or indicted or adverse orders passed by a regulatory authority which could cast a doubt on our ability to undertake the Project or which relates to a grave offence that outrages the moral sense of the community.
8. I/ We further certify that in regard to matters relating to security and integrity of the country, we/ any member or any of our/ their associates have not been charge-sheeted by any agency of the Government or convicted by a court of law.
9. I/ We further certify that no investigation by a regulatory authority is pending either against us/ any member or against our/ their associates or against our chief executive officer or any of our directors/ managers/ employees.
10. I/ We undertake that in case due to any change in facts or circumstances during the Bidding process, we are attracted by the provisions of disqualification in terms of the provisions of the Tender Document, I/ we shall intimate the Owner of the same immediately.
11. I/We agree to pay the Earnest Money Deposit and Security Deposit (if awarded the job) and accept the terms and conditions laid down in the memorandum below in this respect.

MEMORANDUM

- (a) General Description of Work: Installation of Coal Gasification and Methanol Plant on Build, Own & Operate (BOO) Basis for CIL at Dankuni Coal Complex, West Bengal, India and Supply & marketing of Methanol to third party consumer.
- (b) Earnest Money Deposit (EMD): INR 550 million or equivalent USD The Earnest Money is payable in the manner set out in para 5 below.
- (c) Security Deposit (SD) : As per Clause 23.0 of Sec 5.0, Instruction To Bidder.
12. Should this tender be accepted, I/We hereby agree to sign the Agreement(s) with CIL and abide by and fulfill all terms and conditions referred to above and in the Agreement and in default thereof, to forfeit and pay to CIL or its successors or its authorized nominees such sums of money as are stipulated in conditions contained in Bidding Documents.
13. I/We hereby pay the Earnest Money Deposit (EMD) of Rs. _____ (Rupees _____) in Bank Guarantee No. _____ issued by _____ (name and office of the State Bank of India or any Nationalised Bank) in favour of Coal Indian Limited, Kolkata.

OR

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC- 176/E-4001/4.0	0	
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SUBMISSION OF BID				

I/We hereby pay the Earnest Money Deposit(EMD) of Rs. _____
 _____(Rupees _____) Crossed Demand Draft No.,
 _____ issued by _____(name and address Bank) in favour of Indian
 Coal Indian Limited, Kolkata.

14. If I/We fail to commence the work specified in the Memorandum in Para (3) above, or I/We fail to deposit the amount of Security Deposit (SD) specified in the Memorandum in (3) above, I/We agree CIL or its successors without prejudice to any other right or remedy be at liberty to forfeit the said Earnest Money Deposit(EMD) in full. CIL shall also be at liberty to cancel the Notification of Award if I/We fail to deposit the Security Deposit (SD) as aforesaid or to execute an Agreement or to start WORK as stipulated in the Bidding Documents.
15. I/ We hereby authorise the Owner to seek reference/clarifications from my/our bankers.
16. I/ We hereby irrevocably waive any right or remedy which we may have at any stage at law or howsoever otherwise arising to challenge or question any decision taken by the Owner in connection with the selection of Bidders, or in connection with the selection/ bidding process itself, in respect of the Project and the terms and implementation thereof.
17. I/ We agree and undertake to abide by all the terms and conditions of the Tender Documents.
18. I/ We undertake to execute the Contract Agreement within 60 (sixty) days from the date of issue of the LOA, if the Project is awarded to me/ us.
19. **I/We enclose herewith complete technical and commercial details as per the requirement of this Bidding Document as well as other supporting documents to facilitate evaluation of the bid.**

Dated the _____ day of _____ 020



Witness:

Name in Block Letters:

Address:

Yours faithfully,
 Signature of Bidder(s) with the
 Seal of the Firm.



Name and Designation of authorised person
 signing the tender on behalf of the Bidder(s).

 <p>पी डी आई एल PDIL</p>	<p>COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS</p> <p>INSTRUCTIONS TO BIDDERS</p>	PNMM/PC-176/E-4001 /5.0	0	
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SECTION 5.0

INSTRUCTIONS TO BIDDERS

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PREAMBLE

Coal is the most important and abundant fossil fuel in India. It accounts for 55% of the country's energy need. The country's industrial heritage was built upon indigenous coal. Indian coal offers a unique eco-friendly fuel source to domestic energy market for the next century and beyond. Hard coal deposits, spread over 27 major coalfields, are mainly confined to eastern and south central parts of the country. The lignite reserves stand at a level around 36 billion tonnes, of which 90 % occur in the southern state of Tamil Nadu.

Coal deposits in India are mainly distributed along the present day river valleys. Major coal deposits are confined to south and south eastern quadrant of the country. Coal deposits are of drift origin and high in extraneous ash content.

There are 44 known coalfields located in the peninsular India containing 95% of total resources. Total estimated geological resource of coal, as on April 01' 14 is 302 billion tonnes, out of which about 114 billion tonnes is of 'proven' category.

The Ministry of Coal has the overall responsibility of determining policies and strategies in respect of exploration and development of coal and lignite reserves, sanctioning of important projects of high value and for deciding all related issues. Under the administrative control of the Ministry, these key functions are exercised through the Public Sector Undertakings, namely, Coal India Ltd. and its subsidiaries and Neyveli Lignite Corporation Limited. Other than Coal India Ltd. and Neyveli Lignite Corporation Ltd., the Ministry of Coal has also a joint venture with Government of Andhra Pradesh called Singareni Collieries Company Limited. Government of Andhra Pradesh holds 51% equity and Government of India holds 49 % equity.

Coal India Limited has decided to venture into a vertical integration of business initiatives other than its conventional coal business with necessary approval of the Board and has come up with the intention of setting up of "Coal to Methanol plant of 2050 MTPD capacity at its Dankuni Coal Complex (DCC)"



The objective of such ventures is to explore additional utilization of Indian coal, which is available in abundance. In pursuit of implementing one of such initiatives, the premises of Dankuni Coal Complex (DCC), at a distance of 25 km from Kolkata, has been identified as a strategic location for initially setting up a 2050 MTPD capacity Coal to Methanol (C2M) plant by utilizing the low ash, high Calorific Value thermal coal from Ranigunj coalfields. The Plant is proposed to operate as two separate units, a Coal Gasification Island

1.0 INTRODUCTION

- 1.1 Coal India Limited (CIL) was incorporated on 01st November 1975 with nationalization of private coal mines by Govt. of India. With a modest production of 79 MT at the year of its inception, CIL today is the single largest coal producer in the world having produced nearly 607 MT.

CIL is a Schedule 'A' Maharatna CPSE under the administrative jurisdiction of Ministry of Coal, Government of India, with its registered and corporate office located at Kolkata (India). It operates through its subsidiaries spread over eight states (provinces) in India namely Jharkhand, West Bengal, Orissa, Chhattisgarh, Madhya Pradesh, Uttar Pradesh, Maharashtra and Assam.

CIL has a foreign subsidiary in Mozambique namely, Coal India Africana Limited (CIAL). Mahanadi Coalfields Limited has four subsidiary companies and one JV company. South Eastern Coalfields Limited has two subsidiary companies, and Central Coalfields Limited has one subsidiary company.

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During 2019-20, CIL and its subsidiaries produced 602.15 MT of coal. During the FY 2019-20, the gross sales about 17.8 bn, PBT and PAT of CIL were approx. INR 240.713 bn and 167.003 bn respectively.

CIL intends to diversify into a new “Coal to Chemical” business domain by converting the high calorific value, low ash thermal coal into synthesis gas (CO+H₂) and downstream chemicals. In pursuit of implementing this new strategy, the premises of the existing Dankuni Coal Complex (DCC) have been identified as the geo-strategic location for setting up a Coal to Methanol Complex on Build Own Operate basis (BOO) by using the good quality Indian coal from Raniganj coalfields.

1.2 COAL-TO-METHANOL PROJECT AT DANKUNI COAL COMPLEX (DCC)

Dankuni Coal Complex (DCC) is an existing Low Temperature Coal Carbonisation (LTC) Plant of CIL and is currently being run on lease basis by South Eastern Coalfields Limited (SECL), a wholly owned subsidiary of CIL. DCC was set up under the recommendation of the Fuel Policy Committee of 1974, to meet the growing needs of “Environmental Friendly Fuel” to meet requirements of domestic & industrial sectors. The commercial production of the plant started in May 1990. Today, DCC is engaged in processing and supplying of Coal gas and Coal products (coke) by using non-coking coal.

CIL intends to set-up a Coal (Indian Coal) to Methanol Plant at its existing premises of Dankuni Coal Complex at Dankuni West Bengal utilizing coal from Raniganj coalfields as a basic raw material for the production of 2050 Metric Tonnes per Day (MTPD) Methanol. Pre-Feasibilities Studies have been completed (Project). Currently, pre-project activities are under progress at the Project Site.

1.3 Owner has retained Projects & Development India Ltd. (PDIL) as Consultant for selection of Build Own Operate (BOO) Operator for the project.



1.4 Project execution Philosophy: Coal to Methanol Complex shall be set up on Build Own Operate (BOO) basis with storage of the entire quantity of methanol produced in the proposed plant during its contracted period. The Bidders shall be responsible for selecting / sourcing of coal gasification technology, basic and detail engineering, procurement, installation, commissioning and operating the Coal to Methanol Complex for the entire life of the project.

1.5 SOLE BIDDER OR A JOINT VENTURE OR A CONSORTIUM

1.5.1 Bids may be submitted by a Bidder who is a sole Bidder or a JV or a Consortium. , [except in case of Sole Bidder], the successful Bidder emerged through tendering process should be a company incorporated in India prior to award of Work.

1.5.2 The Bidder which has completed 3 (three) financial years from the date of commencement of business shall fulfill each eligibility criteria of PQC.

1.5.3 In case the Bidder is a newly formed JV which has not completed 3 (three) financial years from the date of commencement of business, then either the said JV shall fulfill each eligibility criteria or any one constituent member of such a JV shall fulfill each eligibility criteria. If the bid is received with the proposal that one constituent member fulfills each eligibility criteria then this member shall be clearly identified and it shall assume all obligations under the contract and provide such comfort Letter/ Guarantees as may be required by Owner. The Guarantee shall cover inter alia the commitment of the member to complete the entire work in all respects and in a timely fashion, being bound by all the obligations under the contract, an undertaking to provide all necessary technical and financial support to the JV to ensure completion of the contract when awarded, an undertaking not to withdraw from the JV till completion of the work, etc.

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The Provisions of Cl. No. 1.5.3 above shall also apply for a Consortium bid. The leader of the Consortium may fulfill each eligibility criteria and assume all obligations and guarantee as mentioned above.

1.5.4 A JV/Consortium Company once established at the time of submitting the Bid shall not be allowed to be altered with respect to constituting members of the JV/Consortium till the successful PGTR . If during the evaluation of bids, a JV/ Consortium proposes any alteration/ changes in the orientation of JVC/ Consortium or replacements or inclusions or exclusions of any partner(s)/ member(s) which had originally submitted the bid, bid from such a JV/ Consortium Company shall be liable for rejection.

1.5.5 The total number of Consortium members including their leader shall not exceed 4 (four).

1.5.6 All the members of the JV shall sign the contract and shall be jointly and severally liable for the entire assignment.

1.6 ONE BID PER BIDDER

1.6.1 A Bidder shall on no account submit more than one bid either directly or indirectly.

1.6.2 A Bidder shall be deemed to have submitted an indirect bid if (i) the Bidder is a JV/Consortium member in an another independent bid or (ii) a group/subsidiary (partly or wholly owned) of the Bidder is participating as a direct or JV / Consortium member in an another independent bid.

Also, in case of several subsidiary companies of a single holding/parent company, then the participation may be allowed in the following cases:

1.6.2.1 Only one of the holding/subsidiary / group companies shall be allowed to bid whether as a Sole Bidder or as member of a JV /Consortium,

1.6.2.2 Two or more group companies may be allowed to participate if they are Partners in the same and single JV/Consortium.



1.6.3 If a Bidder makes more than one bid and/or directly or indirectly participates in another bid (in the manner set out in Clause 1.6.1 and 1.6.2), all the bids of the Bidder, including the bid of the Bidder in whose bid the first named Bidder has directly or indirectly participated, may be considered as cartel bids and may be rejected. If the factum of such bid(s) is discovered after the notification of award, the resultant contract shall be liable to be terminated.

1.7 GENERAL INSTRUCTIONS

1.7.1 Bidders must review the Bidding Documents as a whole, and ensure that their Bids are as per the terms of the Bidding Documents. CIL/Owner retains the right to modify the terms of the Bidding Documents and/ or any of the sections/ attachments/ formats thereto at any time prior to the Bid Due Date.

1.7.2 Once a Bid is submitted no changes will be permitted to be made by the Bidder except as permitted under the Bidding Documents.

1.7.3 Words and expressions beginning with capital letters used in this NIT without being defined shall have the same meaning as assigned to them in the Contract Agreement or the other Bidding Documents.

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2.0 SCOPE OF WORK:

2.1 CIL intends to setup a Coal-to-Methanol Plant on Build Own Operate (BOO) Basis for life of the plant (expected period 25 years). The scope shall be as defined in the Tender documents and shall broadly cover the following - Design, Build, Own, Operate & Maintain Production Plant(s), transfer required product(s) , storage of the entire quantity of methanol produced in the proposed plant during its contracted period will also be the responsibility of the BOO Operator.

2.2 Location of the Project Site

CIL intends to set up at the Project its existing premises of Dankuni Coal Complex (DCC) at Dankuni, West Bengal (India).

The proposed Project is situated by the side of Durgapur Expressway in the north and Janai Road railway station of the grand chord line in the south at Dankuni village of Hooghly District of West Bengal, India. The Project site, adjacent to the Kolkata – Durgapur Expressway, is at a distance of about 25 km by road from Kolkata. Kolkata Airport is the nearest Airport to the proposed project site which is about 20 km.

2.3 Site Visit

2.3.1 The Bidder is advised to visit and examine the site of works and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into the Contract Agreement. Claims of any kind due to variation or ignorance of site conditions and environmental conditions will not be eligible in any circumstances.

2.3.2 The Bidder and any of its personnel or authorized representatives will be granted permission by Owner to enter upon its premises and lands for the purpose of such inspection. It is understood that as an implicit condition of such permission, the Bidder, its personnel and/or authorized representative(s) shall be understood to have released and indemnified Owner and its personnel from and against all liability in respect thereof and to have assumed all responsibility for personal injury (whether fatal or otherwise), loss of or damage to person or property and any other loss, damage, cost and expenses incurred as a result of such visit, including those sustained by any negligence or other act of tort on the part of Owner and/or its personnel and consultants. During such visits the Bidder shall abide by all the rules and regulations, as applicable.



2.3.3 The date of the site visit is to be confirmed by respective Bidder in consultation with the concerned officer indicated in the Invitation For Bid.

3.0 TIME SCHEDULE

3.1 Bidder shall be required to complete the Work under the Contract Agreement so as to achieve the Guaranteed Completion Date in accordance with the following milestones:

a) MECHANICAL COMPLETION	36 (thirty six) Months from Effective Date of Contract Agreement
b) COMMISSIONING	41 (forty one) Months from Effective Date of Contract Agreement

3.2 The “**Effective Date of Contract Agreement (EDC)**” shall be the date of issuance of Letter of Award (LOA)/ Notification of Award by the Owner.

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4.0 **ELIGIBLE BIDDERS**

- 4.1 The Bidder is not put on 'Holiday' by CIL or any of the JV partner/subsidiary of Owner or Public-Sector Project Management Consultant (like PDIL only due to "poor performance" or "corrupt and fraudulent practices") or banned/blacklisted by GOI/SG department/ Public Sector on due date of submission of bid or during the process of evaluation of bids. Further, neither Bidder nor their allied agency/(ies) (as defined in the Procedure for Action in case of Corrupt/Fraudulent/Collusive/Coercive Practices) are on banning list of CIL or any of the JV partner/subsidiary of Owner.

In case there is any change in status of the declaration prior to award of contract, the same has to be promptly informed to CIL/PDIL/Owner by the Bidder.

It shall be the sole responsibility of the Bidder to inform about their status regarding above on due date of submission of bid and during the course of finalization of the tender. Concealment of the facts shall tantamount to misrepresentation of facts and shall lead to rejection of the bid.

- 4.2 The Bidder should not be under any liquidation court receivership or similar proceedings on due date of submission of bid. In case there is any change in status of the declaration prior to award of contract, the same has to be promptly informed to CIL/PDIL/Owner by the Bidder.

It shall be the sole responsibility of the Bidder to inform CIL/Owner their status on above on due date of submission of bid and during the course of finalization of the tender. Concealment of the facts shall tantamount to misrepresentation of facts and shall lead to rejection of the Bid.

- 4.3 Bidder shall not be affiliated with a firm or entity:



- i. that has provided consulting services related to the Work to the Owner during the preparatory stages of the work or of the project of which the works/services forms a part of, or
- ii. that has been hired (proposed to be hired) by the Owner as an engineer/ consultant for the Project.

- 4.4 Pursuant to qualification criteria set forth in the Tender Document, the Bidder shall furnish all necessary supporting documentary evidence to establish Bidder's claim of meeting qualification criteria.

5.0 **SIGNATURE ON BIDS**

- 5.1 The Bid must contain the name, designation and place of business of the person or persons making the Bid and must be signed and sealed, on each page, by the Bidder with his usual signature. The names of all persons signing should also be typed or printed below the signature. The Bidder shall submit authority letter / power of attorney/ board resolution in favour of the authorized signatory(s) of the Bid. The Bidder's name stated on the proposal shall be the exact legal name of the Bidder

- 5.2 Bids by bodies corporate/ limited companies must be signed with the legal name of the corporation/limited company by the president, managing director or by the company secretary or any other person or persons holding power of attorney for signing their Bid.

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- 5.3 In case of a Single Bidder, power of attorney issued by the board of directors/ CEO / MD / Company Secretary of the Bidder/ all partners in case of Partnership firm/Proprietor in favour of the authorised employee(s) of the Bidder, in respect of the particular tender for signing the Bid and all subsequent communications, agreements, documents etc. pertaining to the tender and to act and take any and all decision on behalf of the Bidder, is to be submitted.
- 5.4 The authorized employee(s) of the Bidder shall be signing the bid and any consequence resulting due to such signing shall be binding on the Bidder.
- 5.5 Bid by a Consortium/JV must be signed by all members of the Consortium/JV. In case of Consortium, the exact legal names of all the members of the Consortium shall be stated and leader of Consortium shall be clearly indicated.

In case of a Consortium/JV, power of attorney (POA) issued by board of directors/ CEO / MD / C&MD/ company secretary of the Consortium leader as well as Consortium member(s) of the Consortium, in favour of the authorised employee(s), for signing the documents on behalf of each of the members, in respect of this particular tender, to sign the Bid and all subsequent communications, agreements, documents etc. Pertaining to the tender and act and take any and all decision on behalf of the Consortium, are to be submitted.

Power of Attorney shall be as per law of land; Format of POA as per Annexure 1.11.



- 5.6 Bid shall contain no cuttings, erasures or overwriting except as necessary to correct errors made by the Bidder in which case each such corrections or other changes in the Bid documents shall carry the initials of the person(s) signing the Bid.

6.0 PRE-BID MEETING

- 6.1 The Bidder may submit any queries/clarification/information pertaining to bidding documents in writing delivered by hand or by Fax or by E-mail as per Annexure-1.5 enclosed in the bidding documents so as to reach PDIL not later than the date specified in the Invitation For Bid. Queries/ Clarifications/ Information sought in any other manner shall not be responded to.
- 6.2 The Bidder or his authorised representative(s), is advised to attend a pre-bid meeting as indicated in the Invitation For Bid. A maximum of 2 (two) representatives of each Bidder shall be allowed to participate on production of an authority letter from the Bidder. The purpose of the meeting will be to clarify issues and to answer questions on any matter pertaining to the Tender conditions that may be raised at that stage by Bidders. CIL/Owner shall endeavour to provide clarifications and such further information as it may, in its sole discretion, consider appropriate for facilitating a fair, transparent and competitive bidding process. Any clarifications provided in the pre-bid conference are only indicative and Bidders will only be entitled to rely on the clarifications subsequently provided in writing by the Owner.
- 6.3 The Owner's responses to Bidder's queries/clarifications raised will be furnished as expeditiously as possible. Any modification of the Tender Documents which may become necessary as a result of the pre-bid meeting/conference shall be issued as Addendum/Amendment/Corrigendum.
- 6.4 Non-attendance of Bidders at the pre-bid conference will not be a cause for disqualification of the Bidder and it shall be presumed that the Bidder does not require any clarification.

7.0 BIDDING DOCUMENTS/TENDER DOCUMENTS

- 7.1 The Bidder is expected to examine the Bidding Documents/Tender Documents, including all instructions, Forms, terms and conditions of Contract, specifications, drawings and other

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documents and to fully familiarize itself with the requirements of the Bidding Documents. Failure to furnish all the information required by the Bidding Documents or the submission of a bid not substantially responsive to the Bidding Documents in every respect may result in the rejection of the Bid.

In case of any inconsistency, in the interpretation of meaning of any part of this Tender Documents, the Bidder shall give his best endeavor to resolve the inconsistency by expressing his assumption through his proposal to Owner.

8.0 AMENDMENT OF BIDDING DOCUMENTS

8.1 Bidders shall examine the Bidding documents thoroughly and inform the Owner of any apparent conflict, discrepancy or error.

At any time prior to the deadline for submission of bids as well as upto priced bid opening, the Owner may, for any reason whether at its own initiative or in response to a clarification or modification requested by any prospective Bidder(s), modify the Bidding Documents, if required.

8.2 Notice of issuance of any amendment to the Bidding Document (corrigenda/addenda/amendment) if any, shall be hosted on PDIL website/CIL website/ CPP Portal and shall not be advertised in press. Bidders are therefore advised to visit the website regularly for downloading the details of amendment to bidding document. The Bidders will be required to acknowledge notification of any such amendment to the Bidding documents. Bidders shall confirm the inclusion of addendum/corrigendum in their bid and shall follow the instructions issued along with addendum/corrigendum.

8.3 In order to afford Bidders reasonable time to take the amendment, issued prior to submission of BOO Bids, into account in preparing their bids, Owner may, at its discretion, extend the deadline for the submission of Bids.

9.0 MODIFICATION AND WITHDRAWAL OF BIDS



9.1 The Bidder may modify or withdraw its Bid after the Bid's submission, but before the last date and time of Bid submission as specified in this Tender provided that written notice of the modification or withdrawal is received by Owner prior to the deadline prescribed for submission of Bids.

9.2 A withdrawal notice may also be sent by FAX/E-mail but followed by a signed confirmation copy, post marked not later than the deadline for submission of Bids.

9.3 In case any clarifications are sought by the Owner after opening of tenders, then the replies of the Bidder should be restricted to the clarification sought. Any Bidder who modifies his bid (including a modification which has the effect of altering the value of his offer) after opening of Techno-contractual bids without specific reference by the Owner shall render the bid liable to be rejected without notice and without further reference to the Bidder.

9.4 Except as indicated above, a bid may not be withdrawn or modified after the deadline for submission of bids during the period of bid validity without forfeiting the Earnest Money Deposit (EMD) unless the modification shall be made upon an invitation by Owner permitting the Bidder to modify the bid.

9.5 The Owner reserves the right, at its discretion, to postpone the Bid Due Date and the date of opening of the Bids, or reject any or all Bids without giving any reason or to accept any Bid which, in the Owner's sole judgment and discretion, is the most beneficial to the Owner and/or to cancel the bidding process and reject all the Bids, at any time prior to the award of the Project, without thereby incurring any liability to the affected Bidder or Bidders and without any obligation to inform the affected Bidder or Bidders of the grounds or reasons for the Owner's actions. The Owner

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further reserves the right to negotiate with any or all the Bidders in relation to their Bids. Any such action shall not be called into question and the Bidders shall have no claim or cause of Action in that regard against the Owner or its officers, employees, consultants, agents, successors or assignees for rejection of its bids. Neither the Owner nor its employees or advisers shall entertain any claim of any nature, whatsoever, including without limitation, any claim seeking costs, expenses or damages in relation to the preparation or submission of Bids.

- 9.6 The Owner does not bind itself to accept the lowest Bid and reserves the right to reject any or all the Bids without assigning any reasons whatsoever and also to split up the work between two or more Bidders or accept the Bid in part and not in its entirety, at its sole discretion.

10.0 COST OF BIDS



The Bidder shall bear all costs associated with the preparation and submission of the Bid, and Owner will, in no case be responsible or liable for these costs, regardless of the conduct or outcome of the bidding process.

11.0 LANGUAGE OF THE BID

The bid prepared by the BIDDERS and all correspondence and documents relating to the Bid exchanged by the Bidder and the Company shall be written in the English language and all units shall be in Metric system. In case a supporting document, certificate, documentary evidence etc. accompanying the Bid such as copies of purchase orders, experience certificates, printed literature, etc. furnished by the Bidder is in a language other than English, the same should be accompanied by an English Translation, duly authorized by the Chamber of Commerce of the Bidders' country, in which case, for the purpose of interpretation of the bid, the English translation shall govern. Supporting materials, which are not translated into English, may not be considered. For the purpose of interpretation and evaluation of the Bid, the English language translation shall prevail.

12.0 BID SUBMISSION

- 12.1 Bidders are requested for the captioned item in complete accordance with bidding documents/attachments.
- 12.2 Bidder can download the Tender document from PDIL Website <http://pdilin.com> or from Govt. Website <https://etenders.gov.in/eprocure/app>.
- 12.3 Bidders are requested to submit e-bids electronically on the CPP Portal (URL: <https://etenders.gov.in/eprocure/app>) only in accordance with Tender document.
- 12.4 The following documents in addition to uploading the bid on CPP Portal (<https://etenders.gov.in/eprocure/app>) shall also be submitted in Original (in physical form) within 7 (seven) days from the bid due date provided the scanned copies of the same have been uploaded on CPP Portal (<https://etenders.gov.in/eprocure/app>) by the Bidder along with e-bid within the due date and time to the address mentioned in Clause no. 2.0 (M) of IFB:-
- i) EMD/Bid Security
 - ii) Power of Attorney
 - iii) Pre-Signed Integrity Pact
 - iv) Original Letter of TPI as per Annexure-1.15
 - v) Letter of No Deviation as per Annexure-1.6.

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12.5 The **Originals of the Documents as desired under Cover -1** shall be submitted as per the following:

The ENVELOPE shall be superscribed with the words-

“BID FOR COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL, INDIA TENDER No.: PNMM/PC-176/E-4001 Dated 25.09.2020.

Due date and time for Bid Submission:, 16:00 Hrs (IST)”.

The complete name of bidder with address shall be mentioned at the bottom left portion of envelope.

ENVELOPE shall be submitted at:

Projects & Development India Limited,

(Materials Management Department)
P.D.I.L Bhawan, A-14, Sector-1,
Noida-201301(UP) ,India
Fax no.:0120-2529801

Kind Attention:

Mr. P.R.Sahu
Addl. General Manager (MM)
Tel no. : 0120-2544063
E-mail: prsahu@pdilin.com / anjali@pdilin.com / tanzin@pdilin.com,



The envelopes without above details on the covers shall be opened at Bidder's risk.

13.0 PREPARATION/ SUBMISSION OF BIDS



13.1 The Bidder is expected to examine all instructions, forms, terms and conditions in the Tender Document. The Tender Document together with all its attachments thereto, shall be considered to be read, understood and accepted by the Bidders. Failure to furnish all information required or submission of a Bid not responsive to the Tender Document in every respect will be at the Bidder's risk and may result in the rejection of the Bid.

13.2 **Submission of Bids:** Bids shall be submitted as detailed below:



1. Bidders to submit the bids online through the Central Public Procurement Portal for e-Procurement at <https://etenders.gov.in/e procure/app>. **No other mode of Bidding shall be allowed.**
2. Possession of valid Digital Signature Certificate (DSC) and enrollment/registration of the contractors/bidders on the e-procurement / e-tender portal is a prerequisite for **e-tendering**.
3. Bidder should do the enrollment in the e-procurement site using the “Click here to Enroll” option available on the home page. Portal enrollment is generally free of charge. During enrollment/registration, the bidders should provide the correct/true information including valid email_id. All the correspondence shall be made directly with the contractors/bidders through email_id provided.

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4. Bidder need to login to the site thro' their user ID/ password chosen during enrollment/registration.
5. Then the Digital Signature Certificate (Class II or class III Certificates with signing key usage) issued by SIFY / TCS / nCode / eMudra or any certifying authority recognized by CCA India on eToken / SmartCard, should be registered.
6. The DSC that is registered only should be used by the bidder and should ensure safety of the same.
7. Contractor/Bidder may go through the ITB / tenders published on the site and download he required ITB documents/schedules for the tenders he/she is interested.
8. After downloading /getting the ITB / Tender document / schedules, the Bidder should go through them carefully and then submit the documents as asked, otherwise bid will be rejected.
9. If there are any clarifications, this may be obtained online through' the tender site, or thro' the contact details. Bidder should take into account the corrigendum published before submitting the bids online.
10. Bidder then logs in to the site through the secured log in by giving the user id/ password chosen during enrolment/registration and then by giving the password of the eToken / Smart Card to access DSC.
11. Bidder selects the tender which he / she is interested in by using the search option & then moves it to the 'my tenders' folder.
12. From my tender folder, he / she selects the tender to view all the details indicated.
13. It is construed that the Bidder has read all the terms and conditions before submitting their offer. Bidder should go through the tender schedules carefully and upload the documents as asked; otherwise, the bid will be rejected.
14. Bidder, in advance, should get ready the bid documents to be submitted as indicated in the tender document/schedule and generally, they can be in PDF/xls/rar/zip/dwf formats. If there is more than one document, they can be clubbed together and can be provided in the requested format. Each document to be uploaded through online for the tenders should be less than 2 MB. If any document is more than 2MB, it can be reduced through zip/rar and the same can be uploaded, permitted. Bidder Bid documents may be scanned with 100 dpi with black and white option. However of the file size is less than 1 MB the transaction uploading time will be very fast.
15. If there are any clarifications, this may be obtained through the sites, or during the pre-bid meeting if any. Bidder should take into account the corrigendum published from time to time before submitting the online bids.
16. The Bidders can update well in advance, the documents such as certificates, annual report details etc., under My Space option and these can be selected as per tender requirements and then send along with bid documents during bid submission, this will facilitate the bid submission process faster by reducing upload time of bids.
17. Bidder should submit the EMD as specified in the tender. The original should be posted/couriered/given in person to the TIA, within the bid submission due date & time for the tender. Scanned copy of the instrument should be uploaded as part of the offer.
18. While submitting the bids online, the bidder reads the terms & conditions and accepts the same to proceed further to submit the bid packets/Covers.

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19. The bidder has to select the payment option as offline to pay the EMD as applicable and enter details of the instruments.
20. The details of the DD / any other accepted instrument, physically sent, should tally with the details available in the scanned copy and the data entered during bid submission time. Otherwise submitted bid will not be acceptable.
21. The Bidder has to digitally sign and upload the required bid documents one by one as indicated. Bidders to note that the very act of using DSC for downloading the bids and uploading their offers shall be deemed to be a confirmation that they have read all sections and pages of the bid document including General conditions of contract without any exception and have understood the entire document and are clear about the requirements of the tender requirements.
22. The Bidder has to upload the relevant files required as indicated in the cover content. In case of any irrelevant files, the bid will be rejected.
23. If the price bid format is provided in a spread sheet file like BoQ_xxxx.xls, the rates offered should be entered in the allotted space only and uploaded after filling the relevant columns. The Price Bid / BOQ template must not be modified / replaced by the bidder; else the bid submitted is liable to be rejected for the tender.
24. The Bidders are requested to submit the bids through online e-tendering system to the TIA well before the bid submission end date & time (as per Server System Clock). the TIA will not be held responsible for any sort of delay or the difficulties faced during the submission of bids online by the bidders at the eleventh hour.
25. After the bid submission (i.e. after Clicking "Freeze Bid Submission" in the portal), the acknowledgement number, given by the system should be printed by the bidder and kept as a record of evidence for online submission of bid for the particular tender and will also act as an entry pass to participate in the bid opening date.
26. The time settings fixed in the server side & displayed at the top of the tender site, will be valid for all actions of requesting, bid submission, bid opening etc., in the e-tender system. The bidders should follow this time during bid submission.
27. All the data being entered by the bidders would be encrypted using PKI encryption techniques to ensure the secrecy of the data. The data entered will not viewable by unauthorized persons during id submission & not be viewable by any one until the time of bid opening.
28. Any bid document that is uploaded to the server is subjected to symmetric encryption using a system generated symmetric key. Further this key is subjected to asymmetric encryption using buyers/bid openers public keys. Overall, the uploaded tender documents become readable only after the tender opening by the authorized bid openers.
29. The confidentiality of the bids is maintained since the secured Socket Layer 128 confidentiality technology is used. Date storage encryption of sensitive fields is done.
30. The Bidder should logout of the tendering system using the normal logout option available at the top right hand corner and not by selecting the (X) exit option in the browser.
31. For any queries regarding e-tendering process, the bidders are requested to contact as provided in the tender document. Parallel for any further queries, the bidders are asked to contact over phone: 1-800-233-7315 or send a mail over to cppp-nic@nic.in.

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13.3 Tender for the present work shall be submitted online through CPP e-tender portal. The required documents are to be uploaded in respective Cover-1 & Cover-2 as listed in subsequent paras. However, **original hard copy of Cover-1 Documents to be submitted as per Cl. No. 12.5 above .**

For price bid, tenderer shall use Cover-3 (Price Bid). All rates shall be quoted in the Excel format -BoQ (password protected) provided and no other format is acceptable. Bidders are required to download the BOQ file, open it and complete the unprotected cells with their respective financial quotes and other details (such as name of the bidder). No other cells should be changed. Once the details have been completed, the bidder should save it and submit it online, without changing the filename, tampering/modification in BOQ file. The Price Bids of the tenderers will have no condition. The Price Bid which is incomplete and not submitted as per instruction given in Annexure-1.2 (Preamble to Price Bid/BOQ) will be rejected.

13.4 Once the contractor has uploaded the digitally signed file of tender documents along with unconditional acceptance Letter as an attachment, he is not permitted to upload any additional files / or put any remark(s) / condition(s) along with the Tender Documents.

13.5 In case the condition 13.3 & 13.4 above is found violated, the tender shall be rejected and Owner shall without prejudice to any other right or remedy be at liberty to forfeit the earnest money. The tenderer shall submit tender documents in the CPP e-tender portal only on or before the due date and time for submission of tender specified in Tender Document. The details of the data / documents to be submitted in respective Bid are as below:

13.6 Following 3 Covers shall be submitted through online at CPP e-tender portal by the bidder:

Cover-1:- It shall contain duly filled & signed scanned copy of the following.



- a. EMD/Bid Security
- b. Power of Attorney
- c. Pre-Signed Integrity Pact
- d. Original Letter of TPI as per Annexure-1.15
- e. Letter of No Deviation as per Annexure-1.6.

Cover-2:- To be submitted in Two parts and shall contain duly filled & signed scanned copy of the following:

PART-I:

Pre-Qualification Bid: (Refer. Section 2.0, VOLUME-I, COMMERCIAL)

i)	Letter of submission and synopsis of the proposal
ii)	Organization Profile covering (a) Name & address of the organization with telephone, fax, e.mail nos. with contact persons (b) history & structure of the organizations with names of directors & chief executives of bidder (in case of single bidder/JV) / all members of Consortium (in case of Consortium bid).
iii)	Copy of Article of Association of the Company or Board Resolution mentioning Chairman/ Chief Executive Officer / Managing Director of the Company of bidder (in case of single bidder/JV) / all members of Consortium (in case of consortium bid).
iv)	Power of Attorney of Bid Signatory from the competent authority as per Annexure-1.11
v)	Consortium Agreement as per Annexure-1.12 (if applicable).
vi)	Bidder has to submit letter of support I MOU from the Process Licensor for technology tie up for the proposed Coal Gasification technology. In case of his own technology, the bidder shall submit a self-declaration.
vii)	Bidder has to submit letter of support / MOU from the Process Licensor for technology tie up for the proposed Syn-Gas cleaning, Purification, Methanol Synthesis Gas Generation and Methanol Plant. In case of his own technology, the bidder shall submit a self-declaration.

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viii)	Bidder Pre-qualification Criteria in favour of Technology Criteria as per Exhibit-1A and Exhibit 1B along with Copies of documentary proof in support of prequalification requirement.
ix)	Bidder Pre-qualification Criteria in favour of Experience Criteria as per Exhibit-2 along with Copies of documentary proof in support of prequalification requirement.
x)	Bidder Pre-qualification Criteria in favour of Financial criteria as per Exhibit-3 along with documentary proof in support of prequalification requirement.
xi)	Solvency Certificate from Bidders' bankers as per Annexure- 1.14 Date of issue of this certificate should not be more than 6 (six) months old from the date of issue of Tender.
xii)	A declaration shall be submitted to the effect that Bidder/JV/Consortium members shall not be under liquidation, court receivership or similar proceedings as per Annexure-1.13.
xiii)	Undertaking from TPIA as per Annexure-1.15.
xiv)	Format for Financial Details of Holding Company as per Annexure-1.22



PART-II:

Technical and Unpriced Commercial Bid shall contain following Sections:

SECTION-I	i.	Bid Form as per Annexure-1.1
	ii.	Preamble to SOR (BOQ / Price Bid/Price Schedule) as per annexure 1.2
	iii.	Commercial Questionnaire as per Annexure-1.3
	iv.	Contents of Bid and Check List as per Annexure-1.4.
	v.	Format for bidder's queries for Pre Bid Discussion as per Annexure-1.5.
	vi.	Letter of Waiver of Conditions/Deviations as per Annexure-1.6
	vii.	Bidder's Proposed Schedule as per Annexure-1.7
	viii.	Authorisation to DSC holder as per Annexure-1.8
	ix.	A copy of BOQ, uploaded by Bidder in the Portal keeping price blank (hiding the price) and in place indicating "Quoted" or "√", as a confirmation of price quoted against each head, shall be submitted.
	x.	Certificate of Non-Involvement of Indian Agent as per Annexure-1.9
	xi.	Public Procurement (Preference To Make In India) Policy Undertaking as per Annexure 1.10.
	xii.	Provision for Procurement from a bidder which shares a land border with India as per Annexure1.23
	xiii.	Complete Bidding Document and all technical and commercial amendments/addendums if any issued, digitally signed as a token of having received and read all parts of the bidding document and having accepted and considered the same in preparing their bid
SECTION-II	i.	Technical Details/ documents specified under "Technical Information Required along with Bid"
	ii.	Any other information required in the Bidding Documents or considered relevant by the Bidder.

For convenience, the Bid shall be compiled in the form of Specific Sections conforming to the above. In case of non-submission of above documents or submission of incomplete documents, the Owner reserves the right not to evaluate such offers further and not to enter into correspondence in this regard after opening the Techno-commercial Unpriced Bid.

Cover-3: (PRICE BID)

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- 13.7 The Prices are to be submitted strictly as per the Excel format as indicated in the Bid document (BOQ / Schedule of Rate /Price Bid) of the Tender documents. CIL/PDIL shall not be responsible for any failure on the part of the bidder to follow the instructions.
- 13.8 Bidders are advised NOT to mention Rebate/Discount separately, either in the BOQ / Price Bid format or anywhere else in the offer. In case Bidder(s) intend to offer any Rebate/Discount, they should include the same in the item rate(s) itself under the “BOQ / Price Bid” and indicate the discounted unit rate(s) only.
- 13.9 If any unconditional rebate has been offered in the quoted rate the same shall be considered in arriving at evaluated price. However no cognizance shall be taken for any conditional discount for the purpose of evaluation of the bids.
- 13.10 In case, it is observed that any of the Bidder(s) has/have offered suo-moto Discount/Rebate after opening of unpriced bid but before opening of price bids such discount /rebate(s) shall not be considered for evaluation. However, in the event of the bidder emerging as the lowest evaluated bidder without considering the discount/rebate(s), then such discount/rebate(s) offered by the bidder shall be considered for Award of Work and the same will be conclusive and binding on the bidder.
- 13.11 In the event as a result of techno-commercial discussions or pursuant to seeking clarifications / confirmations from bidders, while evaluating the un-priced part of the bid, any of the bidders submits a sealed envelope stating that it contains revised prices; such bidder(s) will be requested to withdraw the revised prices failing which the bid will not be considered for further evaluation.



14.0 DEADLINE FOR SUBMISSION OF BIDS

- 14.1 Bids must be submitted through e-tender mode on CPP portal not later than the date and time specified in the IFB (Invitation For Bid).
- 14.2 The Owner may extend this deadline for the submission of Bids by amending the Tender Documents in accordance with provisions of Tender. In such case all rights and obligations of the Owner and Bidders under this Tender shall be subject to the extended deadline.
- 14.3 Documents received to address other than one specifically stipulated in the tender document will not be considered for evaluation/opening/award if not received to the specified destination within stipulated date & time.

15.0 OPENING OF BIDS

- 15.1 Owner will open Bids (online) in the presence of Bidder’s representatives who choose to attend at Date and time specified on cover page of Tender or as informed by Owner. The Bidder’s representative(s) present during the Bids opening shall sign a “Bids opening Status” sheet evidencing their attendance.
- 15.2 The Bidder’s name, presence or absence of the requisite EMD and such other details, as the Owner at its discretion may consider appropriate, will be announced during Bids opening.
- 15.3 The Bids shall be opened and evaluated in two stages:

15.3.1 Stage-I: Opening & Review of EMD, Pre-Qualification Bid, Technical and Un-priced Commercial Bids

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On the date of Public Bid opening as indicated on the Invitation for Bid of this Tender, cover containing EMD, Power of Attorney, Integrity Pact, TPI letter and Letter of No Deviation shall be opened and reviewed.

The Owner will review the bank guarantee (BG)/DD/banker's cheque submitted by Bidder against EMD, with respect to:

- its value
- validity
- issuing Bank.
- The format attached with the tender document.
- Whether the BG has been issued in favour of the bidding company

In case, the Bidder has not submitted the EMD or the BG submitted by the Bidder is not as per the requirement of Tender Document with respect to the above mentioned parameters, the Bids submitted by them may be rejected.

If the EMD submitted by the Bidder is found to be in order with respect to above mentioned parameters but if there is a minor deviation with respect to the format enclosed with the Tender, the Owner may at its discretion inform the Bidder who shall have to rectify the same before the date of opening of the Price Bid. In case the Bidder fails to rectify the EMD, it's Bids will be rejected.

Thereafter, Owner will open Pre-Qualification Bid, technical and un-priced commercial Bids of those Bidders, whose EMD, is found to be in order as described here above.

Owner/Consultant will first review Pre-qualification bid. Technical and Un-priced Commercial Bids shall be evaluated only for those bidders whose bid is found to be Pre-qualified based on Pre-qualification Criteria.

15.3.2 Bidders must submit the original "EMD, Power of Attorney, Integrity Pact, TPI letter and Letter of No Deviation as specified in the Tender Document to the address mentioned in IFB, in a sealed envelope, superscribing the details of Tender Document (i.e. tender number & tender for) within 7 (Seven) days from the date of un-priced bid opening.

15.3.3 Stage – II: Opening of Price Bid

The date of the opening of the Price Bid shall be intimated only to technically and commercially acceptable Bidders. The price bids of such shortlisted Bidders will be opened in the presence of Bidder's representative who chooses to attend the opening of price bid event on the date and time to be intimated. The bidder's name, bid price and such other details as the Owner at its discretion may consider appropriate, will be announced at the opening of price bids.



15.3.4 If the Bids as judged by the Owner are unresponsive, the Tender may be declared void and a new procedure for selection of CONTRACTOR as deemed appropriate by Owner may be adopted.

16.0 BID CURRENCIES

Bidders must submit bid in Indian Rupees only.

17.0 EARNEST MONEY DEPOSIT (EMD)

17.1 Bids must be accompanied with 'Earnest Money Deposit (EMD) / Bid Security' in the form of 'demand draft' or 'banker's cheque' or 'bank guarantee' (BG). The amount of EMD shall be as indicated in the Invitation For Bid. Currency of EMD shall be in INR.

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17.1.1 In case EMD is submitted in form of BG (BG should be Structured Financial Messaging System (SFMS) enabled BG), then the EMD offered shall be an irrevocable BG, issued by any bank appearing in the list of Owner approved banks, (Annexure-1.19), on a stamp paper of appropriate value. Proforma of the BG for EMD is enclosed as Annexure-1.17.

17.1.2 The BG shall be valid for a period of Bid Validity plus 9 (nine) months. The BG shall be extended suitably if there is a delay in awarding the contract. The relevant extension shall be on Bidders' account.

Or



In case EMD is submitted in form of DD/Bankers Cheque, then the EMD should be in favour of M/s Coal India Limited payable at Kolkata or value as outlined in the Invitation For Bid for this Tender.

EMD will not carry any interest.

- 17.2 Any Bid not accompanied with EMD shall be rejected by the Owner/Consultant as being non-responsive.
- 17.3 The EMD of unsuccessful Bidders will be returned by Owner without any interest to the unsuccessful Bidders as promptly as possible on acceptance of Bid of the successful Bidder or when the bidding process is cancelled by Owner, whichever is earlier. Where EMD has been paid by demand draft, the refund thereof shall be in the form of demand draft or NEFT in favor of the unsuccessful Bidder(s). Bidders may indicate the name and address in whose favour the said demand draft shall be drawn by the Owner for refund failing which it shall be drawn in the name of the Bidder and shall be mailed to the address given on the Transmittal Letter.
- 17.4 The successful Bidder's EMD will be discharged upon the Bidder accepting and signing the Contract Agreement and furnishing the Security Deposit cum Performance Bank Guarantee.
- 17.5 The EMD shall be forfeited and appropriated by Owner as mutually agreed loss and damage payable to Owner for, inter alia, time, cost and effort of Owner in regard to the Tender without prejudice to any other right or remedy to Owner under the following conditions:
- If a Bidder withdraws his Bid during the validity or agreed extension validity period duly agreed by the bidder
 - In case of Cartel of bids as per Clause 1.6 of Instruction to Bidders, EMD should be forfeited.
 - If the bid is varied or modified in a manner not acceptable to the Owner during the validity or agreed extension validity period duly agreed by the bidder
 - Any effort by the bidder to influence the Owner on bid evaluation, bid comparison or contract award decision.
 - Violates any other condition, mentioned elsewhere in the Tender Document, which may lead to forfeiture of EMD.
 - If a Bidder has indulged in corrupt/fraudulent /collusive/ coercive practice.
 - In the case of a successful Bidder, if the Bidder fails to sign the Contract Agreement in accordance with Signing of Contract

OR

If the successful bidder is seeking modifications to the agreed terms and conditions after issue of Letter of Award (LOA) /Notification of Award and prior to signing of the Contract.

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OR

If the successful bidder fails to furnish Security cum Performance Bank Guarantee as per provisions stipulated in bidding document.

The Bidder, by submitting its bid pursuant to this Tender Document, shall be deemed to have acknowledged and confirmed that the Owner will suffer loss and damage on account of withdrawal of its bid or for any other default by the Bidder during the period of validity of Bid as specified in the Tender Document. No relaxation of any kind on Bid Security shall be given to any Bidder.

- 17.6 In addition, upon the occurrence of any of the above set out conditions, the defaulting Bidder shall be debarred and black-listed from participating in any bids/tenders floated by CIL/TIA and/or its subsidiaries for a minimum period of [1 (one) year] from the date of getting declared as debarred/black-listed. It is further clarified that the decision of the Owner in relation to occurrence of the any of the above set out conditions shall be final and binding.
- 17.7 Micro and Small Enterprises (MSEs) as defined in MSE Procurement Policy issued by Department of Micro, Small and Medium Enterprises (MSME) will be exempt from the payment of earnest money. Such bidders will have to upload the scanned copy of the documents in support of their claim for exemption of EMD during submission of bid online.

18.0 VALIDITY OF BID



- 18.1 The submission of any bid connected with these documents and specifications shall constitute an agreement that the Bidder shall have no cause of action or claim against the Owner for rejection of his bid. The Owner shall always be at liberty to reject or accept any bid or bids at his sole discretion and any such action will not be called into question and the Bidder shall have no claim in that regard against the Owner.
- 18.2 The bids should be kept valid for acceptance for a period of 9 (Nine) Months from the date of opening of Technical and Unpriced Commercial Bids. A Bid valid for shorter period may be rejected by the Owner as being non-responsive.

Under the exceptional circumstances, prior to expiry of the original Bid validity period, the Owner may request the Bidder for a specified extension in the period of validity. The request and the responses thereto shall be made in writing or by telefax or by E-mail.

- 18.3 In the event of Owner seeking extension of period of validity of the Bids, the validity of EMD shall also be suitably extended.
- 18.4 A Bidder agreeing to the request of Owner seeking extension will not be required nor permitted to modify his bid, and will be required to extend the validity of his EMD correspondingly. However, Bidders request for revision/adjustment of Priced Bid under such circumstances will not be considered by the OWNER. The provisions of Clause-17.0 regarding discharge and forfeiture of EMD shall continue to apply during the extended period of Bid Validity.

19.0 POLICY FOR BID UNDER CONSIDERATION

Bids shall be deemed to be "Under Consideration" immediately after they are opened and until such time that the official intimation of award / rejection is made by the Owner to the Bidders. While the bids are under consideration, bidders and/or their representatives or other interested parties are advised to refrain from contacting by any means, the Owner and/or his employees / representatives on matters related to the bids under consideration.

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The Owner, if necessary will obtain clarifications on the bids by requesting for such information from any or all the Bidders, either in writing or through personnel contact as may be necessary. The Bidder will not be permitted to change the substance of the bid after the bid had been opened.

20.0 DEPUTATION OF REPRESENTATIVE FOR TECHNICAL & COMMERCIAL DISCUSSIONS

20.1 After opening of the Bids, to assist in the examination, evaluation and comparison of Bids, Owner may, at its discretion, ask the Bidder for clarification on its Bid. The request for such clarification and the response shall be in writing either through fax or email.

Further Owner may ask Bidder to visit Owner's/PDIL's office for technical, commercial or financial clarifications.

Bidder is expected to undertake such visits and participate in such meetings as and when called by the Owner. All costs related to such visits shall be borne by Bidder.

20.2 While evaluating the techno-commercial bids, if in the opinion of Owner and/or consultant appointed by the Owner certain additions / deletions / modifications in the tender conditions become inevitable, then the Owner/consultant shall discuss with all the participating bidders and finalize a common addition/deletion/modifications list. The Bidders shall also be asked to submit the 'Letter of Waiver' as per Annexure 1.6 of bid document taking cognizance of the common addition / deletion / modification list.

21.0 EVALUATION AND COMPARISON OF BIDS

21.1 Price evaluation of commercially and technically acceptable offers will be carried to arrive at the lowest evaluated price for selection of successful bidder and who shall be considered for Notification of Award.

21.2 For evaluation and comparison of Prices, BOO operation shall be considered under Tolling Model.

21.2.1 Accordingly, Net Present Value (NPV) for supply of Methanol will be carried out for 25 (twenty five) years of operation subsequent to First Delivery Date, considering 7920 hrs operation per year and at discount rate* based on the following formula:

* Discount Rate shall be considered as the YTM% p.a. (Annualized) of GSEC Rate for a tenure of 28-29 years plus 150 bps (risk premium) as on the day of opening of tender.

$$\text{Total Cash flow (Discounted @10\% for 25 years)} = CC_{Methanol} \times Q_{Methanol} + P_{ROM\ Coal} \times Q_{ROM\ Coal} + \sum (P_{Utilities} \times Q_{Utilities})$$

Where :

$CC_{Methanol}$ = Conversion Charge of Methanol in Rupees per MT

$Q_{Methanol}$ = Quantity of Methanol in MT per year



$P_{ROM\ Coal}$ = Price of **Raw Coal** in Rupees per MT

$Q_{ROM\ Coal}$ = Quantity of **Raw Coal** in MT per year

$P_{Utilities}$ = Price of Utilities (Power & Raw water)

$Q_{Utilities}$ = Quantity of utilities (Power & Raw water)

$Q_{Methanol}$, $P_{ROM\ Coal}$ and $P_{Utilities}$ provided by Owner shall be as indicated in Section 6.0 Conditions of Contract.

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$CC_{Methanol}$, $Q_{Raw\ Coal}$ and $Q_{utilities}$ to be indicated by bidder as per Schedule of Prices/BOQ in the Price Bid. **$CC_{Methanol}$ shall be the sum of fixed and Variable Price as per cl. No. 21.4 item no. A, i) & ii).**

21.2.2 Also, Yearly Cash out flows on account of the Methanol purchased will be worked out for the following:



For 1st year of operation - 90% of the installed capacity
 For 2nd year of operation - 95% of the installed capacity
 From 3rd year onwards till 25th year (i.e. for remaining 23 years) - 100% of the installed capacity.

The quantity of Methanol mentioned above is exclusively for the purpose of NPV evaluation. However, during the actual operation of plant, Owner, reserves the right to receive any amount of Methanol subject to above respective yearly capacity utilization of plants depending upon requirement .



21.3 Net Present Value (NPV) analysis shall be carried out for 25 (twenty five) years of operation subsequent to First Delivery Date, considering respective capacity utilization per year (assuming 330 (three hundred and thirty) days) and at discount rate* as mentioned above. The NPV of Prices so obtained on the first delivery date (i.e. 41 (forty one) Months from EDC) shall be further discounted to arrive at the present value on the date of EDC. The total least cash outflow so obtained shall be the selecting criteria for Bidder for the award of Work.

21.4 Yearly Cash flows for the Products / By Products / Utilities delivered by BOO Operator and Feed & utilities provided by Owner, as identified in the above formula, will be worked out for NPV evaluation purpose as per the following guidelines.

A	PRODUCTS
	Supply of Methanol of specified quality and quantity, as per Guaranteed ratio/quantities as quoted in the Price Bid, shall be on chargeable basis and Owner shall pay for this to the Bidder. Pricing formula for Supply of Methanol shall comprise of following components:
i)	<p>Fixed Monthly Charge for the Methanol</p> <p>The Fixed Monthly charge (in Rupees) shall have three components ;</p> <ol style="list-style-type: none"> 1) Constant amount (towards ROI of the BOO Operator); 2) Component related to WPI for manufactured Products (towards maintenance cost & other overheads). 3) Component related to CPI for industrial workers (towards manpower cost). <p>Fixed Monthly Charge shall be calculated on the basis of the following formula: $FMC_M = FMC_{BM} \times [XM_{ROI} + XM_{WPI} \times (WPI_N / WPI_O) + (XM_{CPI} \times (CPI_N / CPI_O))]$</p> <p>Where,</p> <p>FMC_M = Fixed Monthly Charge computed on account of Methanol delivered to Owner and will remain valid for that month, it will be released on pro- rata basis from first delivery date upto the end of the month and thereafter on monthly basis every month (e.g. If the first delivery date is 15th January, then FMCM will be computed on pro-rata basis from 15thJanuary to</p>

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	<p>31.01.2020.and from February onwards it will be computed in Calendar monthly basis)</p> <p>FMC_{BM} = Base monthly charge as per the Letter of Award</p> <p>XM_{ROI} = Constant Component on account of Return On Investment (which will not be adjusted due to inflation)</p> <p>XM_{WPI} = Constant Component related to “Wholesale Price Index for Manufactured Products”</p> <p>XM_{CPI} = Constant Component related to “Consumer Price Index for Industrial Labour”</p> <p>WPIN = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to Billing month or latest available as on that date.</p> <p>WPI_O= Average Wholesale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date.</p> <p>CPI_N= Average Consumer Price Index for Industrial workers as last declared by Reserve Bank of India for the month prior to billing month.</p> <p>CPI_O = Consumer Price Index for Industrial workers for the month of FOA (Fax of Acceptance) / LOI (Letter of Intent) or last published month before LOA.</p> <p>The Constant Component - XM_{ROI} , XM_{WPI} & XM_{CPI} to be quoted by the Bidder in the Schedule of Rate / BOQ .</p> <p>Note-1: [XM_{ROI} + XM_{WPI} + XM_{CPI} = 100%]</p>
ii)	<p>Variable charge per MT of Methanol</p> <p>Variable Charge per MT of Methanol = A_M x (WPI_N / WPI_O)</p> <p>Where,</p> <p>A_M = is to be submitted in the Price Bid, as per Schedule of Prices/BOQ</p> <p>WPI_N = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to Billing month or latest available as on that date.</p> <p>WPI_O = Average Whole sale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date.</p>
	<p>Note:</p> <p>Percent change in WPI/CPI for future years is to be considered based on percent change in WPI/CPI for manufactured products in last five years from</p>

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	the date of opening of commercial offer. Cash flows for the components related to WPI/CPI will be increased for the 25 years period at the rate of derived percent change of WPI/CPI per year in the NPV working.								
B	FEED & UTILITIES PROVIDED BY Owner								
	<p>Feed & Utilities as per the Guaranteed Quantity, as quoted by the Bidder shall be considered for evaluation. Yearly cash flow on account of feed & utilities provided by Owner at their battery limit will be worked out on the basis of Unit rate of feed & Utilities mentioned below:</p> <table border="1"> <thead> <tr> <th>Feed & Utilities</th> <th>Price /Unit</th> </tr> </thead> <tbody> <tr> <td>1. ROM Coal</td> <td>@ Rs 5127 /MT</td> </tr> <tr> <td>2. Power</td> <td>@ Rs 5.77 per KWH</td> </tr> <tr> <td>3. Raw Water</td> <td>@ Rs.4.50 /M³</td> </tr> </tbody> </table> <p>Note:</p> <ol style="list-style-type: none"> For evaluation, Percent change in WPI for Coal for future years will be applied based on average percentage change per annum in WPI for minerals during last five years from the date of bid closing date. Cash flow for the Coal will be increased for 25 years period at the rate of derived percent change of WPI per year in the NPV working. For evaluation, Percent change in WPI for Raw water, Power for future years will be applied based on average percentage change per annum in WPI for manufactured Products during last five years from the date of bid closing date. Cash flow for the raw water, power will be increased for 25 years period at the rate of derived percent change of WPI per year in the NPV working. 	Feed & Utilities	Price /Unit	1. ROM Coal	@ Rs 5127 /MT	2. Power	@ Rs 5.77 per KWH	3. Raw Water	@ Rs.4.50 /M ³
Feed & Utilities	Price /Unit								
1. ROM Coal	@ Rs 5127 /MT								
2. Power	@ Rs 5.77 per KWH								
3. Raw Water	@ Rs.4.50 /M ³								

22.0 TAXES & DUTIES

- 22.1 The Monthly Charges are currently subject to **Goods and Service Tax (GST)**. Bidders should quote the charges exclusive of GST.
- 22.2 For the purpose of evaluation, GST on all the charges will be calculated considering the Present prevalent rate of 12% (Twelve percent) against applicable HSN code 9988.
- 22.3 In actual operation, Owner shall reimburse the GST paid by the BOO operator on the services performed by the BOO operator under the Contract, subject to the BOO operator providing to Owner, appropriate documents/Tax Invoice.

23.0 SECURITY DEPOSIT/PERFORMANCE BANK GUARANTEE (SD/PBG)

- 23.1 Within 30 (thirty) days from the date of Letter of Award by Owner, for faithful performance of its Contractual obligation, the successful Bidder shall provide to Owner a bank guarantee for an amount equal to 5% (five percent) of the aggregate cost of Methanol Conversion Charge (without escalation) for the Contract Period as security deposit / performance bank guarantee ("**Security Deposit (SD)/ Performance Bank Guarantee (PBG)**"). This SD/PBG will be valid for the Contract



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Period plus 6 (six) months. In case, the Contract Agreement is renewed the SD / PBG shall be valid for the renewed period plus 6 (six) months.

- 23.2 During the Operation Phase, deduction of Security Deposit shall be done @ 5% from every running account bill for the 1st 12 (twelve) month after commencement of production (date of first delivery of methanol). The aggregate amount of SD so deducted for 12 (twelve) months shall be refunded back to BOO Operator, subject to the condition that BOO Operator shall submit a BG of an equivalent value valid for entire life of Contract. This BG shall be valid for the Contract Period plus 6 (six) months. Further, BOO Operator shall have to furnish additional BG in case of the value of annualised conversion cost has increased over the annualised value of the 1st year @ 5% of the difference value at the start of the 2nd year and same arrangement is to be repeated for every subsequent years for the Contract Period plus 6 (six) months. In case, the contract is renewed the SD / PBG shall be valid for the renewed period plus 6 (six) months.
- 23.3 The BG shall be issued by Nationalized/Scheduled Indian Bank or an Indian Branch of a Foreign Bank acceptable to Owner. The BG shall be strictly in the prescribed format enclosed in the Bidding Documents. Each page of the BG must be stamped & signed by the authorized signatory (ies) of the Bank. Corrections, if any, must also be initialed by the authorized signatory(ies) of the Bank. The Bank is required to send a copy of the BG(s) in confirmation directly at the address of Owner.
- 23.4 BOO Operator shall for due and faithful performance of its obligation during Contract Period provides to Owner a BG towards Security as above. Till such time the BOO Operator provides to Owner the Security Deposit as above, the Earnest Money Deposit (EMD) shall remain in full force and effect. Failure of the BOO Operator to provide the Security Deposit in accordance with this clause, shall entitle Owner to terminate this Agreement without being liable in any manner whatsoever to the BOO Operator and to appropriate the Earnest Money Deposit (EMD) as the pre estimated compensation for the cost, time and effort by Owner involved in the bidding.
- 23.5 Owner shall not be liable to pay any bank charges, commission or interest on the amount of Security Deposit.

24.0 CONTRACT AGREEMENT

- 24.1 The Contract Documents shall comprise of the following:
- Contract Agreement
 - Land Lease Agreement
 - The Notification of Award/Letter of Award.
 - The Detailed Letter of Acceptance (DLOA) including Statement of Agreed Variations, if any, and accepted Price-Schedule.
 - Amendments, if any, issued to the Bidding Documents.
 - Original Bidding Documents issued with its enclosures.
 - Integrity Pact (IP) signed between the Owner and the Bidder/BOO Operator.
- 24.2 A statement of agreed variations shall be prepared based on the finally agreed deviations, if any, to the Bidding Documents. All other correspondence and terms and conditions or other stipulations forming part of the offer prior to issue of Letter of Award shall be treated as null & void.
- 24.3 Any deviations or stipulations made and accepted by Owner after LOA shall be treated as amendment(s) to the Contract Documents and shall be governed by the conditions relating to amendment of Contract

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25.0 NOTIFICATION OF AWARD/LETTER OF AWARD

- 25.1 Prior to the expiry of 'Period of Bid Validity', Notification of Award for acceptance of the Bid will be intimated to the successful Bidder by Owner either by E-mail /Letter or like means defined as the "Letter of Award (LOA) / Notification of Award". The Contract Agreement shall enter into force on the date of LOA and the same shall be binding on Owner and successful Bidder/BOO Operator/Contractor. The Notification of Award/LOA will constitute the formation of a Contract. The Detailed Letter of Acceptance shall be issued thereafter incorporating terms & conditions of Tender Document, Corrigendum, Clarification(s), Bid and agreed variation(s)/acceptable deviation(s), if any. Owner may choose to issue Notification of Award in form of Detailed Letter of Acceptance without issuing LOA and in such case the Contract Agreement shall become valid, binding and enforceable on the date of Detailed Letter of Acceptance only.
- 25.2 Contract Period shall commence from the date of "Notification of Award" or as mentioned in the Notification of Award. The "Notification of Award" will constitute the formation of a contract, until the contract has been affected pursuant to signing of Contract Agreement as per ITB:Clause-32.
- 25.3 The successful Bidder on receipt of Notification of Award shall within 'fifteen [15 (fifteen)] days' of issuance of the same, shall sign and return the acknowledged copy to Owner.
- 25.4 Upon the successful Bidder's / Contractor's furnishing of 'SECURITY DEPOSIT/PERFORMANCE BANK GUARANTEE', pursuant to "ITB: Clause-23.0", CIL will promptly discharge his 'Earnest Money / Bid Security', pursuant to "ITB:Clause-17.0"

26.0 SIGNING OF CONTRACT



The successful bidder shall be required to execute a formal Contract Agreement and Lease Agreement with Owner as per the proforma enclosed with the Bidding Documents (subject to any applicable amendments as set out in the Statement of Agreed Variations) within 60 (sixty) days from the date of Notification of Award on a non-judicial stamp paper of Kolkata State (India) and of appropriate value. The cost of non-judicial stamp paper shall be borne by the Bidder. In the event of failure on part of the successful bidder to sign the Contract Agreement and Lease Agreement within the above stipulated period, the EMD shall be forfeited and the acceptance of the Tender shall be considered as cancelled.

It is hereby clarified that for the purposes of the Contract and the Lease Agreement, CIL, shall have the right to nominate any of its subsidiaries or a special purpose vehicle / joint venture nominated by CIL ("**CIL Nominee**"), in which case the successful bidder shall execute the Contract Agreement and Lease Agreement with such CIL Nominee.

27.0 GENERAL INSTRUCTIONS

27.1 Suitability of Plant

Before submitting his bid the Bidder shall ensure that compliance with any requirements of the specification would not render the plant unsuitable in any respect for the purposes mentioned or inherent in the Specification. Should the Bidder consider that compliance with any requirements of the Specification would render the plant unsuitable, he shall submit a proposal or proposals for

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modifying the requirements and shall include these in the "Schedule of Deviations" from the specification.

27.2 TRANSFER OF TENDER DOCUMENTS/PROPOSAL

Transfer of Bid submitted by one BIDDER to another is not permitted. No alteration in the essence of a Bid, once submitted, shall be permitted.

27.3 Owner reserves the right to verify all statements/information submitted to confirm the Bidder's claim on experience on the performance of equipment offered and capabilities of the Bidder to perform the Scope of Work. Owner may inspect similar facilities built by the Bidder. Bidder shall co-ordinate and arrange for visit. However all expenses of such visit of Owner's officials / Owner's representative will be borne by Owner.

27.4 Owner shall not entertain any correspondence with any Bidder on acceptance or rejection of any Bid.

27.5 Oral statements made by the Bidder at any time regarding any matter including quality, or arrangement of the equipment or any other matter will not be considered and will not be binding on the Owner.

27.6 Standard catalogue pages and other documents of the Bidder may be used in the Bid to provide additional information and data as deemed necessary by the Bidder.

27.7 Bidder will furnish the Bid with all relevant information's as called for. Bids with incomplete information are liable for rejection.

27.8 The Bid shall be submitted in line with clause wise compliance of this Tender.

27.9 Pre Bid Queries/clarifications shall be submitted as per Annexure1.5.

27.10 If at any later date, it is found that documents, information and data submitted by the Bidder in the Bid, and based on which the Bidder has been considered eligible or successful or has been awarded the contract is incorrect or false to the extent that had the correct or true information been made available to the Owner at the time of Bid evaluation, the bid would have been declared ineligible or unsuccessful, the Bidder shall be forthwith disqualified or, as the case may be, the contract awarded based on such incorrect or false information shall be cancelled and the EMD/PBG shall be liable to be forfeited.



28.0 CONTACTING Owner

A Bidder shall not contact the Owner on any matter relating to his bid from the time of priced bid opening to the time that the contract is awarded, unless requested to do in writing. Any effort by a bidder to influence the Owner in the Owner's decisions in respect of bid evaluation or contract award will result in the rejection of that bidder's bid.

29.0 OWNER'S RIGHT TO ACCEPT/REJECT BIDS

29.1 The Owner reserves the right to accept or reject any bid and to annul the bidding process and reject all bids at any time prior to award of contract without thereby incurring any liability to the affected bidder(s) or any obligation to inform the affected bidder(s) of the ground of Owner's action.

29.2 It is observed that many bidders indulge in trading in contracts by entering into undisclosed back-to-back arrangements for the whole or a substantial portion of a Contractor's obligations under the

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contract. Consequently, if a Bidder proposes to enter into any such arrangements upon a successful award of work or has in place any such arrangement which will become operative upon the award of work, the bidder must make a complete disclosure of such arrangement or proposed arrangement in its proposal, and all provisions applicable to sub-contractor(s) in terms of bidding documents shall apply to such arrangements.

- 29.3 If the existence of such an undisclosed arrangement is reasonably apprehended by the Owner in the case of a bidder, the Owner may reject such bidder's bid as not responsive.
- 29.4 If such an undisclosed arrangement is discovered after the award of work, such arrangement(s) shall be deemed to constitute an assignment of contract and a ground of termination pursuant to the provisions of termination under the Conditions of Contract.

30.0 INTEGRITY PACT

Bidders are required to unconditionally accept the "Integrity Pact (IP)", as per Annexure 1.16, (executed on plain paper) and submit the same duly signed on all pages by the bidder's authorized signatory along with the bid. **Bidder's failure to comply with the aforesaid requirement regarding submission of 'Integrity Pact (IP)' shall lead to outright rejection of the Bid and in such case the Bids shall not be opened.**

31.0 PUBLIC PROCUREMENT (PREFERENCE TO MAKE IN INDIA)POLICY

Purchase preference to Central government public sector Undertaking, Local Content (PP-LC) bidders and Micro and Small Enterprises (MSEs) shall be allowed as per Government instructions in vogue.

The "PUBLIC PROCUREMENT (PREFERENCE TO MAKE IN INDIA) POLICY" is enclosed as Annexure 1.10.

32.0 PROVISION FOR PROCUREMENT FROM A BIDDER WHICH SHARES A LAND BORDER WITH INDIA

Inline with Department of Expenditure's O.M. No. F.6/18/2019-PPD dated 23.07.2020 and Order (Public Procurement No. 1) dated 23.07.2020 and subsequent orders, bidder to submit Certificate as per Form I & II enclosed as Annexure 1.23.

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ARTICLE- 1.0: DEFINITIONS

The following words and expressions as used in the Agreement (as hereinafter defined) shall have the meanings hereof assigned to them except where the context otherwise requires:

“Applicable Law”	means any statute, law, regulation, ordinance, rule, judgment, rule of law, order, decree, clearance, approval, directive, guideline, policy, requirement, or other governmental restriction or any similar form of decision, or determination by, or any interpretation or administration of any of the foregoing by, any statutory or regulatory authority whether in effect as of the Bid Date or thereafter and in each case as amended, in any relevant jurisdiction.
“Basic Design Package”	means the diagrams, drawings, design data, equipment lists, major equipment specifications, engineering standards, and other documents, information, and materials prepared by Process Licensor.
“Bid”	mean the documents in their entirety comprised in the bid submitted by the selected Bidder in response to the Tender Documents in accordance with the provisions thereof and "Bids" shall mean the bids submitted by any and all pre-qualified Bidders.
“Bidder”	means any single person or entity or(including a Consortium) who submits a Bid pursuant to the Tender Documents.
“Bidding Document / Tender Document”	means this document (including the Conditions to Contract) along with any subsequent amendments made from time to time.
“BOO Operator”	means the Successful Bidder. The Successful Bidder shall install “Production Plant” based on coal gasification on a site licensed by the Owner at Dankuni, Hoogly District, West Bengal (India) as per the requirements and specifications mentioned on mutually agreed terms. The Successful Bidder shall install the facilities, own, operate and maintain the same under the terminology and conditions commonly known as Build-Own- Operate (BOO),and supply the Products and By-products as per terms and conditions set out in this bidding document.
“Best Operating Practices”	means those procedures, practices, methods, techniques and standards as changed from time to time, that are generally accepted for generation of Methanol operation internationally taking into account conditions in India and commonly used in best utility engineering and operations to design, construct, test, operate and maintain equipment lawfully, safely, efficiently and economically as applicable to Methanol Plant of the size, services and type similar to such plants operating worldwide and generally conform to the statutory requirement, manufacturers' specifications and maintenance guidelines followed for these Plants.

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"By-product"	means any product acceptable to Owner, in the production plant other than Methanol, like elemental Sulphur.
"Construction Period"	means a period of 41 (forty one) months from the Effective Date which includes 36 months for Mechanical Completion and 5 months for Commissioning.
"Contract Period"	means the tenure of the Project, comprising of the Construction Period and the Operations Period.
"Dimensions"	means the dimension as per metric system.
"Effective Date/ Effective Date of Contract (EDC)"	means the date of issue of Letter of Award by Owner.
"Feed and Utilities Delivery Point"	means the Railway Wagon/ Truck Lorry receipt point for Feed (Coal) where weight of the coal will be checked and received by BOO Operator. Delivery point for Utilities shall be flange(s)/ points (for power) where BOO Operator shall connect for receiving the feed and Utilities. Feed and Utilities Delivery Point shall be the point outside the battery limit of BOO Operator. BOO Operator also accepts title to and risk of loss of Feed and Utilities after the Delivery Point.
"Feed Stock"	means Coal of specification specified in Volume II, Section 1.4, Design Basis at Annexure-1 supplied by Owner at the Battery Limit of BOO operator.
"First Delivery Date"	means the date on which the delivery of Product commences, subject to delivering at least Methanol (2050 MTPD), (corresponding to availability of Coal) to Owner, at delivery point, for an uninterrupted period of 72 (seventy two) hours.
"Fixed Monthly Charge"	means the fixed monthly charge specified in Preamble to Schedule of Price for Methanol, as escalated from time to time in accordance with the provisions of Article 15.0 hereof.
"Gasification Process Licensor"	Means who makes a proposal for the technology which not only includes the description of the process and its performances, the cost of the license, process design package as well as proprietary equipment.
"GOI"	means the Government of India including any and / or all ministries thereof and /or departments thereof having duly constituted authorities to grant approvals under any applicable statutes, rules and regulations enforced from time to time.
"Guaranteed Quantity"	means Guaranteed Production of Methanol (corresponding to availability of Coal) as set out under Volume II, Section 1.4, Design Basis.
"Installed Capacity"	means the output of the Production Plant under conditions of continuous maximum loading.

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“Instantaneous”	means the average of all readings of any single flow meter over 3 (three) minutes period.
“Interface Diagram”	means a block-and-line diagram representing the logical interfaces that connect components within a system or system segment.
“Letter Of Award(LOA)/ Notification Of Award”	means based on the offer of BOO Operator, Owner issues its acceptance to the said offer requesting BOO Operator to start executing the jobs in terms of the Agreement(s) to be signed within 60 (sixty) days from the date of LOA.
“License”	means shall mean any consent, license, approval, registration, notarization, endorsement, waiver, filing, relaxation, no-objection, exemption, permit, corporate resolution or other authorization of any nature which is required to be granted by any statutory or regulatory authority or other government authority in accordance with Applicable Law for: (a) the execution of the Contract; (b) fulfilling the Works; and(e) completing all other obligations under the Tender Documents, as may be necessary for the BOO Operator.
“Material Adverse Effect”	means any act or event that materially and adversely affects the ability of either Party to perform any of its obligations under and in accordance with the provisions of this Agreement.
“Methanol”	means the Product of specified parameters (quantity, quality and pressure and temperature at Delivery point) as mentioned in Volume II, Section 1.4, Design Basis and produced in the Production Plant installed by BOO operator and delivered to Owner at Delivery point.
“MIS”	means Management Information System.
“Monthly”	with respect to a billing cycle means after every 30 (thirty) days in a month of 30(thirty) days, after 31 (thirty-one) days in a month of 31 (thirty-one) days, after 28 (twenty eight) days in a month of 28 (twenty eight) days, and after 29 (twenty nine) days in a month of 29 (twenty nine) days.
“Notification date for Production Plant readiness”	means when BOO Operator’s Supply System is capable of delivering at least Methanol (2050 MTPD), for an uninterrupted period of 72 (seventy two)hours, BOO Operator will so notify Owner in writing, and the date of such notice will be the notification date for Production Plant readiness.
“Operations Period”	means a period of 25 (twenty five) years commencing from the First Delivery Date.
“Owner”	means:(a) Coal India Limited a Schedule ‘A’ Maharatna CPSE under the administrative jurisdiction of Ministry of Coal, Government of India, registered in India under the Indian Companies Act-1956, with its Registered and Corporate office located at COAL BHAWAN, Premises No.:04,MAR, Plot No.

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	AF-III, Action Area-1A New Town, Rajarhat, Kolkata-700156 (India) and shall include its successors and assigns; or (b) any of subsidiary of Coal India Limited or a special purpose vehicle / joint venture nominated by Coal India to enter into the Contract/Agreement with the successful Bidder (“CIL Nominee”).
“Party”	mean a party (BOO Operator or Owner) to the Agreement.
“Plant availability factor or On-stream Factor (OSF)”	means percentage of supplied quantity to the requested quantity in a year excluding the period of planned shutdown and periods on account of Force Majeure conditions in that year.
“Pressure”	means the pressure (gauge pressure) of the Product, Feed and Utilities.
“Process License”	Means A license is an official permission or permit to do, use, or own something.
“Product”	means Methanol.
“Product Delivery Point”	means the Railway Wagon Rail Receipt point, where the measurement of the Product so produced shall be taken. Owner also accepts title to and risk of loss of product after the Delivery Point.
“Production Plant”	<p>means the following plant, at Owner’s designated land set up by the BOO Operator:</p> <p>A brand new Methanol Production Plant based on Coal gasification technology with its necessary ancillary facilities consisting of but not limited to Coal gasification section, By-products recovery section (if any), Downstream gas processing units from Coal Gasification, Methanol Plant, Heat recovery & steam generation, Ash handling system, Cooling Tower, DMW Plant, Instrument Air Plant, Inert Gas (N₂) Generation Plant (if required), Effluent Treatment Plant etc. and to be designed, engineered, financed and installed by BOO Operator on site allocated to BOO Operator under license for use from Owner. The BOO Operator shall operate, monitor and maintain the Production Plant for the production and supply of Methanol , of Quantity and Specifications, specified in Volume II, Section 1.4, Design Basis and any acceptable By-Products, to Owner, at Delivery Point. The Production Plant shall also include all Ancillary Equipment, Utilities System and Interconnecting Pipelines up-to Delivery Point. The Production Plant shall have a minimum design life of 25 years and shall have design characteristics as set forth in Volume II, Section 1.4, Design Basis.</p>
“Production Plant Site”	means the plot of land located at the site of Owner's Plant, which will be allocated to BOO Operator by Owner under lease for use as per Lease Agreement attached as Draft for Lease Agreement of Volume I, Sec. 1.21, Draft Project Agreements, for the BOO Operator's Production Plant as

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	provided in Article 23. The Production Plant Site, location and boundaries are described in Volume II, Section 1.1, Project Description.
“Purity”	means the purity of the Methanol as per the parameters specified in Volume II, Section 1.4, Design Basis.
“Requested Quantity”	means Owner’s Normal demand for Methanol as set out under Article-7 and under Volume II, Section 1.4, Design Basis.
“Scheduled Outage”	means a planned interruption of Production Plant that (i) is not a unscheduled Outage, (ii) has been scheduled and allowed by Owner in accordance with Article-18 hereof, and is for inspection, testing, corrective maintenance, repairs, replacement or improvement as the case may be, together with any other maintenance measures that the BOO Operator, plans to carry out during the scheduled period of the relevant year on the basis of Best Operating Practices.
“SG”	means the West Bengal State Government including any and / or all ministries thereof and /or departments thereof having duly constituted authorities to grant approvals under any applicable statutes, rules and regulations enforced from time to time.
“Shortfall”	means the difference between the Requested Quantity and quantity supplied by BOO Operator to Owner during any relevant period case the Requested Quantity is higher than the Guaranteed Quantity, then the Shortfall will be computed as the “Guaranteed Quantity minus the Quantity supplied by BOO Operator to Owner during any relevant period”.
“Shut Down”	means the total duration between stoppage of Methanol upto resumption of supply of Methanol.
"Specifications"	means, the Technical Specifications, Schedules, statements of technical data, Performance Characteristics, Values and all such particulars.
“Successful Commissioning for Production Plant”	mean when the Production Plant shall give a level of output not less than Contracted Quantity of Methanol at specified parameters as specified in Article-7, 8 &12 respectively.
“TIA”	means the Projects & Development India Limited.
“Unscheduled Outage”	mean an unplanned interruption of Production Plant that has not been scheduled in advance and notified by the BOO Operator to Owner that (i) this is not a Scheduled Outage and (ii) is for the purpose of performing work on specific components, which should not, in the opinion of the BOO Operator, be postponed until the next Scheduled Outage.
“Variable Charges”	means the applicable Variable Charges of Methanol as specified in Preamble to Schedule of Price, as escalated from time to time in accordance with the provisions of Article 15.0 hereof.

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1.1 Units for measurements

- a) **Normal Cubic Meter" or "Nm³"** used as a measure, which are in gaseous form would occupy a volume of one cubic meter at 0 degrees Celsius temperature and 1 atmospheric pressure (equal to 1.0133 bar and 273.15 K). Such quantity is herein referred to as "Normal Cubic Meter" or "Nm³".
- b) **"Nm³/h"** used as a measure of Gaseous fluid shall mean an instantaneous rate of flow which would be equivalent to 1 (one) Nm³ if continued for a one (1) hour period at required pressure.
- c) **"Tonne"** used as a measure of Steam means 1000 Kg of Steam.
- d) **Tonne/hr (T/h)"** used as a measure of Steam shall mean an instantaneous rate of flow which would be equivalent to 1 (one) Tonne of Steam if continued for 1 (one) hour period at required pressure and temperature.

ARTICLE- 2: INTERPRETATION AND DISCLAIMERS

2.1 Interpretation

In the Agreement:

- a) the paragraph headings and numbering are for convenience only and shall be ignored in the interpretation of the Agreement.
- b) the singular includes the plural and vice- versa
- c) reference to any Agreement, enactment, ordinance or regulations includes any amendment or replacement thereof in whole or in part
- d) reference to Articles, paragraphs and Annexures are, unless the context otherwise requires, references to Articles, paragraphs and Annexures respectively, of the Agreement
- e) the words "include" and "including" shall be deemed to be followed by "without limitation" or "but not limited to" whether or not they are followed by such phrases or words of like import and export.
- f) terms defined in Article-1 shall have the meanings ascribed thereto in that Article when used elsewhere in the Agreement.
- g) references to Applicable Laws or any provision thereof shall include amendment or re-enactment or consolidation of such Applicable Laws or any provision thereof so far as such amendment or re-enactment or consolidation applies or is capable of applying to any transaction entered into hereunder.
- h) references to laws of the State, laws of India or Indian law or regulation having the force of law shall include the laws, acts, ordinances, rules, regulations, bye laws or notifications which have the force of law in the territory of India and as from time to time may be amended, modified, supplemented, extended or re-enacted.
- i) references to a "person" and words denoting a natural person shall be construed as

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a reference to any individual, firm, company, corporation, society, trust, government, state or agency of a state or any association or partnership (whether or not having separate legal personality) of two or more of the above and shall include successors and assigns.

- j) the table of contents, headings or sub-headings in this Agreement are for convenience of reference only and shall not be used in, and shall not affect, the construction or interpretation of this Agreement.
- k) the words "include" and "including" are to be construed without limitation and shall be deemed to be followed by "without limitation" or "but not limited to" whether or not they are followed by such phrases.
- l) references to "construction" or "building" include, unless the context otherwise requires, investigation, design, developing, engineering, procurement, delivery, transportation, installation, processing, fabrication, testing, commissioning and other activities incidental to the construction, and "construct" or "build" shall be construed accordingly.
- m) references to "development" include, unless the context otherwise requires, construction, renovation, refurbishing, augmentation, upgradation and other activities incidental thereto, and "develop" shall be construed accordingly.
- n) references to "excavation" include, unless the context otherwise requires, cutting, scooping or digging out a part of solid mass comprising earth, rocks, coal and other materials with the objective of segregating coal from earth, rocks and other materials for lifting and transportation thereof to the Coal Depot or Delivery Point, and "excavate" shall be construed accordingly.
- o) any reference to any period of time shall mean a reference to that according to Indian Standard Time.
- p) any reference to "hour" shall mean a period of 60 (sixty) minutes.
- q) any reference to "day" shall mean a reference to a calendar day.
- r) references to a "business day" shall be construed as a reference to a day (other than a Sunday or a public holiday) on which Owner is open for general business in the State in which the Project is situated.
- s) any reference to "month" shall mean a reference to a calendar month as per the Gregorian calendar.
- t) references to any date, period or Project Milestone shall mean and include such date, period or Project Milestone as may be extended pursuant to this Agreement.
- u) any reference to any period commencing "from" a specified day or date and "till" or "until" a specified day or date shall include both such days or dates; provided that if the last day of any period computed under this Agreement is not a business day, then the period shall run until the end of the next business day.
- v) references to the "winding-up", "dissolution", "insolvency", or "reorganisation" of a company or corporation shall be construed so as to include any equivalent or analogous proceedings under the law of the jurisdiction in which such company or

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corporation is incorporated or any jurisdiction in which such company or corporation carries on business including the seeking of liquidation, winding-up, re-organisation, dissolution, arrangement, protection or relief of debtors.

- w) save and except as otherwise provided in this Agreement, any reference, at any time, to any agreement, deed, instrument, licence or document of any description shall be construed as reference to that agreement, deed, instrument, licence or other document as amended, varied, supplemented, modified or suspended at the time of such reference; provided that this sub-clause (w) shall not operate so as to increase liabilities or obligations of the Owner hereunder or pursuant hereto in any manner whatsoever.
- x) any agreement, consent, approval, authorisation, notice, communication, information or report required under or pursuant to this Agreement from or by any Party shall be valid and effective only if it is in writing under the hand of a duly authorised representative of such Party in this behalf and not otherwise.
- y) the Schedules and Recitals to this Agreement 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.
- z) references to Recitals, Articles, Clauses, Sub-clauses, Provisos or Schedules in this Agreement shall, except where the context otherwise requires, mean references to Recitals, Articles, Clauses, Sub-clauses, Provisos and Schedules of, or to, this Agreement, references to an Annex shall, subject to anything to the contrary specified therein, be construed as a reference to an Annex to the Schedule in which such reference occurs, and references to a Paragraph shall, subject to anything to the contrary specified therein, be construed as a reference to a Paragraph of the Schedule or Annex, as the case may be, in which such reference appears.
- aa) the damages payable by either Party to the other, as set forth in this Agreement, whether on per diem basis or otherwise, are mutually agreed genuine pre-estimated loss and damage likely to be suffered and incurred by the Party entitled to receive the same and are not by way of penalty (the "Damages").
- bb) time shall be of the essence in the performance of the Parties' respective obligations. If any time period specified herein is extended, such extended time shall also be of the essence.
- cc) in the event of any disagreement or dispute between the BOO Operator and the Owner regarding the materiality or reasonableness of any matter including any event, occurrence, circumstance, change, fact, information, document, authorisation, proceeding, act, omission, claims, breach, default or otherwise, the opinion of the Owner as to the materiality or reasonableness of any of the foregoing shall be final and binding on the BOO Operator.
- dd) where any statement in this Agreement is qualified by the expression "to the knowledge" or "to the best of the knowledge or information or belief" or any similar expression, that statement shall, save as expressly provided to the contrary herein, be deemed to mean that it has been made after due and careful inquiry by the person making such statement.
- ee) If there is any conflict between any provision of the main body of the Agreement

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and any provision in the schedules or attachments then the former shall prevail.

- ff) No provisions of the Tender Documents shall be interpreted in favour of, or against, any Party by reason of the extent to which such Party or its counsel participated in the drafting hereof or by reason of the extent to which any such provision is inconsistent with any prior draft hereof.

2.2 Disclaimers

- (a) The BOO Operator acknowledges that prior to the execution of the Contract Agreement, the BOO Operator has, after a complete and careful examination, made an independent evaluation of the Contract Documents, Project site, existing structures, local conditions, physical qualities of ground, subsoil and geology and all information provided by the CIL/Owner or obtained, procured or gathered otherwise, and has determined to its satisfaction the accuracy or otherwise thereof and the nature and extent of difficulties, risks and hazards as are likely to arise or may be faced by it in the course of performance of its obligations hereunder. CIL/Owner makes no representation whatsoever, express, implicit or otherwise, regarding the accuracy, adequacy, correctness, reliability and/ or completeness of any assessment, assumption, statement or information provided by it and the BOO Operator confirms that it shall have no claim whatsoever against the Authority in this regard.
- (b) The BOO Operator acknowledges and hereby accepts the risk of inadequacy, mistake or error in or relating to any of the matters set forth in Article 2.2(a) above and hereby acknowledges and agrees that CIL/Owner shall not be liable for the same in any manner whatsoever to the BOO Operator or any person claiming through or under any of them.
- (c) The Parties agree that any mistake or error in or relating to any of the matters set forth in Article 2.2(a) above shall not vitiate this Agreement or render it voidable.
- (d) In the event that either Party becomes aware of any mistake or error relating to any of the matters set forth in Article 2.2(a), that Party shall immediately notify the other Party, specifying the mistake or error; provided however, that a failure on part of CIL/Owner to give any notice pursuant to this Article shall not prejudice the disclaimer of CIL/Owner contained in this Article and shall not in any manner shift to CIL/Owner any risks assumed by the BOO Operator pursuant to the Contract Agreement.
- (e) Except as otherwise provided in these Contract Documents, all risks relating to the Project shall be borne by the BOO Operator and CIL/Owner shall not be liable in any manner for such risks or the consequences thereof.

ARTICLE-3 : BUILD

- 3.1 BOO Operator shall install the Production Plant for supply of Methanol to Owner as per the terms of the Agreement within the stipulated period from the date of issue of LOA under the Agreement and subject to the schedule mentioned in Article 12.2 herein below.
- 3.2 The BOO Operator shall submit, Specifications of flow meters for Product, feed and utilities and energy meter for power, to be installed at the Delivery Point of Production Plant, to Owner

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for their review prior to their procurement. Any disagreement on these specifications will be settled mutually between Owner and BOO Operator.

- 3.3 The BOO Operator shall obtain all Licenses, for construction, installation & commissioning of the Production Plant as required before start of construction as well as from time to time from the appropriate authorities at local, state and national level for operations of the Plant.
- 3.4 The BOO Operator shall ensure implementation of efficient 'Project Management and Quality Assurance Systems during Construction Period.
- 3.5 The construction and commissioning of the Production Plant shall be under periodical inspection of representatives of Owner.
- 3.6 The BOO Operator shall adhere to the schedule of commissioning of the Production Plant and in no case the BOO Operator shall delay in commissioning the Plant due to any reason whatsoever other than Force Majeure and subject to Owner fulfilling its obligations under the Agreement.
- 3.7 In the event of any delay in commissioning of the Production Plant, the BOO Operator shall compensate Owner for the loss suffered by Owner in the form of liquidated damages in accordance with Art. 26 of the Conditions of Contract.
- 3.8 The BOO Operator shall follow all the norms and regulation under Central Pollution Control Board / State Pollution Control Board. BOO Operator shall take all necessary permissions/certificates in this regard as applicable from the appropriate authority.
- 3.9 The BOO Operator shall follow all statutory provisions including labour laws and Industrial Laws for installation of the Production Plant and in no case the employees / workers engaged by the BOO Operator directly or indirectly shall be the employee of Owner and claim for the same. For violation of any of the provisions by the BOO Operator and / or its representatives, Owner shall be indemnified against any claim / demand made by any authority.
- 3.10 The BOO Operator shall ensure that all the personnel / employees, contractors, contract labours/ workers engaged by them in operating the Production Plant for continuous supply of Methanol and acceptable By-Products, if any and shall follow all the safety rules as applicable.
- 3.11 Methanol and acceptable By Products, if any, shall be provided by the BOO Operator at Delivery Point of Production Plant. Pipelines from BOO Operator's Production Plant to the Delivery Point located at the boundary limit of the Production Plant site shall be installed and maintained by the BOO Operator at its own expense.
- 3.12 BOO Operator shall at its own expense provide meters for measuring Methanol and acceptable By Products and maintain, repair and replace the meter as stipulated in Article – 9. The meter shall at all times remain the property of BOO Operator. The total volume of supply of Methanol and acceptable By Products shall be measured by these meters. The meters shall be integrating type online Coriolis Mass Flowmeter with accuracy of $\pm 0.05\%$ and measurement of Methanol will be in mass and volume, the unit of which shall be the cubic metre and MT.
- 3.13 BOO Operator shall also at its own expense provide meters for measuring Coal, Raw water and Energy Meter for Power and maintain, repair and replace the meters as stipulated in Article – 9. The Meters shall at all times remain the property of BOO Operator.

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- 3.14 The BOO Operator shall comply with all Applicable Laws and applicable Licenses (including renewals as required) in the performance of its obligations under this Agreement.
- 3.15 The BOO Operator shall discharge its obligations in accordance with standard industry practice and as a reasonable and prudent person.

ARTICLE – 4: OWN

- 4.1 Production Plant along with all other systems, pipelines, metering system, etc. installed by the BOO Operator to meet its obligations under the Agreement, shall be the property of the BOO Operator at all times during the entire Contract Period and the Owner shall not create liens, mortgages or charges over property of BOO Operator.
- 4.2 The BOO Operator shall take all necessary steps for registration, obtaining License from the appropriate authority for owning the Production Plant under its own management.
- 4.3 The BOO Operator shall notify Owner regarding readiness of Production Plant. Owner will thereafter decide upon the date for carrying out a test run for capacity and product quality demonstration as defined in the tender elsewhere and notify the same to the BOO Operator. Duration of this test and modalities of this test run shall be mutually agreed upon in writing with the BOO Operator. If BOO Operator fails to demonstrate the performance with respect to capacity and product quality(ies), the BOO Operator will be given an opportunity for corrective engineering till the performance is demonstrated through subsequent test runs.

Owner will provide all the feed / Utilities under Owner's scope at cost including taxes and duties to the BOO Operator for the Commissioning /First test run and all subsequent test runs.

ARTICLE– 5: OPERATE

- 5.1 The BOO Operator shall ensure that the Production Plant is completed and fully operational within the aforesaid time schedule and capable of delivering Methanol to Owner at required parameters.
- 5.2 The BOO Operator shall engage its personnel / employees and workers directly or / and indirectly through contractors for operating and maintaining the Production Plant. BOO Operator should ensure that only qualified and trained manpower is given the responsibility of operation of the Production Plant.
- 5.3 The personnel / employees or workers engaged in the Production Plant by the BOO Operator for operating the same shall in no way be the employee of Owner.
- 5.4 BOO Operator shall arrange to procure all necessary Licenses on wherever required, and Owner shall render all necessary assistance to BOO Operator, including providing relevant documents, and certificates, to enable BOO Operator to obtain such Licenses.
- 5.5 The authorized representatives of Owner shall have free access to BOO Operator's Plant during erection, commissioning of Production Plant and during the operation phase also till the completion of contractual period.

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- 5.6 Representatives of BOO Operator and Owner shall meet to co-ordinate, as far as reasonably possible for chalking out Scheduled Maintenance of the Production Plant.

ARTICLE- 6: SUPPLY

- 6.1 From the First Delivery Date as defined in Article 10.5 and thereafter, continuously during the Operations Period and in accordance with the stipulations of the Agreement, the BOO Operator shall operate the Production Plant to supply Methanol as per conditions given in Volume II, Section 1.4, Design Basis.
- 6.2 Representatives of BOO Operator and the Owner shall meet to co-ordinate, as far as reasonably possible for chalking out Scheduled requirement Methanol.
- 6.3 Owner shall notify BOO Operator to rectify the quality of Methanol, in case, it falls below the contracted quality as given in Volume II, Section 1.4, Design Basis of the Agreement which needs to be complied by the BOO Operator.
- 6.4 BOO Operator and Owner shall adopt and comply with operational and communication guidelines as mutually agreed from time to time.

ARTICLE- 7 : QUANTITY

- 7.1 BOO Operator will deliver requested/ targeted Quantity of Methanol (corresponding to availability of Coal) as per the specified quality specification given in Vol II, Section 1.4 at delivery point(s) as set forth below:

Methanol Plant	: 2050 MTPD
Continuous Normal requirement	: 85.4 Mt/hr (100%)
Maximum requirement:	: 94 Mt/hr (110%)
Minimum requirement:	: 42.7 Mt/hr (50%)

- 7.2 Delivery point of the Product shall be considered at the Railway Wagon/ Truck Lorry Receipt point and the measurement of the product delivered to the Owner shall be measured at this point.
- 7.3 BOO Operator shall use all efforts to deliver Products and acceptable By Products, if any, at the requested quantity. BOO Operator will record in its operating records requested quantity and changes thereto requested by Owner's representative, the quantity of Product delivered to Owner and any curtailed hours. Access to such records shall be made available to Owner on an ongoing basis. BOO Operator shall adjust the approximate rate of delivery of Products as requested by an authorized representative of Owner in a timely manner.
- 7.4 BOO Operator shall use all efforts to deliver Products and acceptable By Products, if any, at the requested quantity. BOO Operator will record in its operating records requested quantity and changes thereto requested by Owner's representative, the quantity of Product delivered to Owner, and any curtailed hours. Access to such records shall be made available to Owner on an ongoing basis. BOO Operator shall adjust the approximate rate of delivery of Products as requested by an authorized representative of Owner in a timely manner.
- 7.5 Owner will provide to BOO Operator the following information regarding the

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estimated Product requirements of Owner's Plant:

- (a) By March 15th of each year, Owner will provide BOO Operator with an estimate of the requirements of Methanol for the following financial year (1st April to 31st March of next year);
- (b) By the 26th day of each Month, Owner will provide BOO Operator with an estimate of the daily quantity of Methanol from BOO Operator during the next month.
- (c) By 8.00(hrs) IST each day, Owner will update with its requirement of Methanol for the next 24 (twenty-four) hours to BOO Operator. These updated requirements will be considered as Requested Quantity for that day.

At its option, Owner will provide such estimates to BOO Operator electronically or in writing.

- 7.6 In case of "Shortfall" in supply of Methanol during the period of Agreement, the penalty on account of such "Shortfall" in quantity shall be made as set forth in Article-27 and subsequent amendments hereof.
- 7.7 BOO Operator's Production Plant will include facilities to store Coal, Sulphur and Fly as/Slag as mentioned in Volume II, Section 1.4, Design Basis.

ARTICLE- 8 : SPECIFICATIONS

- 8.1 BOO OPERATOR BOO Operator agrees to convert Coal to be supplied by Owner, into Methanol subject to the Specifications and other terms and conditions set forth in this Article-8.

Owner's responsibility of supplying Coal as per the specifications indicated in Volume II, Section 1.4, Design Basis will end at the Delivery Point.

- 8.2 Coal Specification: Owner will deliver or cause to be delivered Coal to BOO Operator at Delivery Point (i.e. the transfer of Title / custody of Raw Coal from Owner to BOO Operator shall be at the point where the wagon(s) is emptied / unloaded from a BOBR-type wagon in to Bottom Hopper / Screen Vibrator) of Production Plant meeting the specifications as indicated in Volume II, Section 1.4, Design Basis.
- 8.3 Methanol Specification: BOO Operator represents and warrants that maximum requirement of Methanol will be delivered provided that Owner has delivered or caused to be delivered required Coal meeting the applicable Specifications as indicated in Volume II, Section 1.4, Design Basis.

BOO Operator's responsibility of supplying Methanol, as per the specifications indicated in Volume II, Section 1.4, Design Basis will end at the Delivery Point to Owner. If Owner has delivered Coal which does not conform to its respective Specifications, the impact of such variation in Coal quality on Methanol specification and other impacts on Production Plant will be mutually agreed between the Owner and BOO Operator.

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8.4 In case Methanol do not conform to the foregoing specifications the same may be rejected by Owner by providing BOO Operator with verbal notice and subsequent written confirmation by e-mail within 24 (twenty four) hours of delivery thereof and no payment will be made for the Product so rejected. Any rejected Product shall be deemed to be Product not delivered for the purposes of Article 27 hereof. Any quantity received after verbal notice for rejection will be considered as non-receipt till such time the quality of Product is not conforming to specifications. The price for any off-spec product used before rejection will be mutually agreed. Both Parties shall have the right to verify and confirm on line data. In case of any difference, result from a mutually agreed third party laboratory will be final and binding in such cases. Forthwith upon becoming aware of the fact that the Product does not conform to the specifications, BOO Operator shall at its cost, take such steps as may be necessary to remedy the situation.

ARTICLE-9 : OPERATING / SYSTEM PARAMETERS

9.1 Installed & turn down capacity, specification of Methanol Start-up periods shall be as per Volume II, Section 1.4, Design Basis.

9.2 METERINGEQUIPMENT

BOO Operator shall at its own expense install all flow meters shown in Interface Diagram in Technical part, Volume-II for measuring Methanol & Raw water, and energy meter for Power. All meters shall be installed close to Delivery Point in BOO Operator's Production Plant.

9.2.1 The metering equipment for the purpose of billing/ recording for Methanol, Raw Water, Construction Water & Energy Meter for Power will be under the custody of BOO Operator. Meters shall be designed, installed and operated in accordance with recognized international standards viz. API MPMS, AGA etc. The locking arrangement for the metering equipment shall be mutually agreed between the parties. The payment shall be made based on joint reading of BOO Operator's metering equipments on monthly basis or at a frequency mutually agreed between BOO Operator and Owner and monthly invoice based on such reading shall be raised by BOO Operator at an agreed cut off date of the month.

Accuracy Table for BOO Operator

The type and minimum accuracy of the meters to be installed by the BOO Operator shall conform to the Table-1.0 given below: **Table 1.0**

Description	Recommended Measurement method / Flow Meter	Applicable Standards	Unit	Limits of Accuracy (of Flow Rate) (Instrument Accuracy)	Repeat ability
Coal (Raw)	Complete Automatic Microprocessor Based Smart Belt Weigher System	Refer Note C	Tonnes /hr	+/- 0.25 % of range	+/- 0.2%
Construction	Magnetic Flow Meter	API	m3/hr	+/- 0.5 %	+/-

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water / Raw Water					0.5%
Treated Effluent	Orifice Plate	ISO 5167	m ³ /hr	+/- 0.5 %	+/- 0.5%

The above measurements shall be utilized for custody transfer. All the measurement data shall be accumulated including any verification or proving (as applicable) computed in the respective stream flow computers using Pulse Signal in the control room in an audit trail environment as per the requirements of API MPMS 21. Custody HMI system shall be only for acquiring data, reporting, trending, alarming, net fiscal accounting etc. No data computation shall be performed in the Custody HMI system for the purpose of billing. The complete system shall have redundant Ethernet architecture including stream flow computer and Windows HMI. A Custody HMI system shall also to be provided in Owner Control Room (Location of Control room to be decided during Kick-Off Meeting) for acquiring data, reporting, trending, alarming, net fiscal accounting etc.

For all liquid measurement, applicable certificate of approval from concerned Government body viz. Weight and Measures etc. shall be obtained by BOO operator for the flow meter, provers and the stream flow computers etc. If any such statutory approval is also required for gas flow measurement, then the same shall be obtained by BOO operator.

Preferably common, in-situ field proving shall be provided for the CO+2H₂ measurement lines as per listed standards with the criteria of field repeatability verification for 5 successive runs as per relevant API MPMS standards with necessary applicable corrections tables. Density measurement shall be as per relevant chapters of API MPMS standard. One set of calibration facility as per relevant API MPMS standard shall also to be provided by BOO operator for in-situ provers.

All gas flow measurement points shall be in full compliance to the respective standards including design, selection, installation, field verification guidelines. In-situ field performance testing shall be performed at field operating conditions for Methanol as listed in respective AGA standard (Section 9.2) with a reference module in-built. The complete as system shall be built such that common influences as listed do not affect the field performance of the meter.

During the Contract Period for BOO operation, custody transfer system shall be updated from time to time by BOO operator w.r.t. requirements of latest revision of API MPMS/AGA or any other relevant standards. Any cost arising out of the above updation of custody transfer system will be mutually agreed at that point of time.

- 9.2.2 Owner may also install additional metering equipment for the Products at its battery limit. Owner will maintain and operate such metering equipment to measure and calculate the quantities of Product delivered to Owner. The metering equipment will remain the property of Owner at all times.
- 9.2.3 BOO Operator, at its expense, will test and calibrate BOO Operator's metering equipment at an interval of 6(six) months or within interval as per manufacturer's recommendation in presence of Owner's representative. Periodic joint calibration shall be carried out at, mutually agreed upon date. BOO Operator shall provide all the testing / calibrating equipment / standard gas during the joint calibration of the meters. The BOO Operator shall also provide the calibration certificates of each of the calibrating equipment duly certified from reputed organization with traceability of the calibration Certificate to National Physical Laboratory (NPL)/ National Test House/ National Institute of Standards and Technology (NIST), USA.

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In addition, at the request of Owner, with reasonable advance notice, BOO Operator will test the metering equipment in the presence of Owner's representatives, and if the metering equipment is found on such test to be accurate, OWNER will pay BOO Operator the cost and expense of such test, but on such test if found to be inaccurate, then the cost and expense of such test and of correcting the inaccuracy in the metering equipment will be borne by BOO Operator. If on any test, the metering equipment is found to be inaccurate, a correcting invoice will be rendered to cover the actual amount of Product, Feed and Utilities exchanged between BOO Operator and Owner. If on any test of the metering equipment, the measurement of accuracy and repeatability is within limits as specified in the above Table-1.0, the meter will be considered accurate.

- 9.2.4 During any period when a meter is not operating within limits of accuracy and repeatability as specified in the above Table-1.0 of the measured data, rate of Product/ Feed/ Utilities deemed to be supplied shall be agreed by the parties based either on the readings obtained from the calibration meter and/ or the average of flows before the meter ceased to operate.

ARTICLE-10: INSTALLATION AND FIRST DELIVERY

- 10.1 BOO Operator, at its expense, will construct, operate and maintain the Production Plant on the Production Plant site, which Owner shall allocate to BOO Operator under a lease for use for the purpose of setting up the Production Plant for the period required for the construction of the Production Plant plus 25 years from the date of First Delivery of Methanol and acceptable By-Products (unless terminated earlier as per the provisions of the Agreement) and during extension period of the Agreement as may be agreed between the BOO Operator and Owner. The Production Plant will remain the property of BOO Operator at all times and may be removed by BOO Operator within 12 (twelve) months of the expiry or termination of the Agreement. Should the BOO Operator fail to remove the Production Plant or any part thereof from the Leased site or to vacate the site within the said 12 (twelve) month period, the BOO Operators Production Plant (or such part thereof as remains un- removed) and the BOO operator's property whatsoever remaining on the Production Plant Site shall vest in Owner free from any mortgage, charge, pledge, hypothecation or other encumbrance or third party rights whatsoever and/or liabilities whatsoever, and Owner shall be entitled to take such measures as it considers necessary (including but not limited to measures under the Public Premises (Eviction of Unauthorized Occupants) Act,1971) for the eviction of all BOO Operator's or third party personnel or their agents or representatives from the site.
- 10.1.1 BOO Operator shall use the leased land for setting up the Production Plant only pursuant to the Agreement and not for any other purpose, including any other commercial activity, or residential purpose.
- 10.1.2 Owner and BOO Operator shall execute, in addition to any other agreement that may be required, the following agreements:
- i) Land Lease Agreement (for Production Plant Site);
 - ii) Contract Agreement

on the lines of the Draft Formats as prescribed by Owner and annexed hereto as in Volume I, Commercial, Draft Lease Agreements.

- 10.2 As part of the Production Plant, BOO Operator shall also install, own and maintain the facilities for Methanol Plant as follows:
- a. Coal Handling System including Crushing-Milling-Drying unit

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- b. Air Separation unit
- c. Coal Gasification Including Purification unit
- d. Ash Handling
- e. Methanol Plant (2050 MTPD) along with storage & loading facilities
- f. Associated Offsite and Utilities facilities

- 10.3 When BOO Operator's Supply System is capable of delivering at least 2050 MTPD of Methanol of (corresponding to availability of Coal) to Owner for an uninterrupted period of 72 (seventy-two) hours, BOO Operator will so notify Owner in writing, and the date of such notice will be the Notification date for Production Plant readiness. If this notification date for Production Plant readiness is before agreed Time Schedule, BOO Operator shall not be eligible for any Prices set forth in Article-15.0.
- 10.4 BOO Operator assures Owner that subject to Owner meeting its obligations contained in Articles 23 and 25, the Production Plant shall be installed and commissioned by BOO Operator so as to ensure that the First Delivery of Product takes place as per Time Schedule indicated in Article 12.2 of the Agreement. The date on which the delivery of Product commences, subject to delivering at least 2050 MTPD of Methanol (corresponding to availability of Coal) to Owner for an uninterrupted period of 72 (seventy-two) hours, is referred to herein as "First Delivery Date" for purpose of the Agreement.
- 10.5 Should Owner fail to supply feedstock/utilities by the date set forth in the schedules, contained in Articles 12.2, 23 & 25 or should Owner be unable to receive the Product through no fault of BOO Operator, First Delivery shall be deemed to take place after 3 (three) months from the Time Schedule indicated elsewhere in the Agreement or actual delivery whichever occurs first as per requirement of Owner. BOO Operator will invoice Owner, and Owner will pay the Fixed Monthly Charges as set forth and adjusted under Article 15, plus the amount of any taxes as set forth in Article 17, effective such date of First Delivery.
- 10.6 BOO Operator recognises and acknowledges the fact that a delay by it in making the First Delivery of Products within the time stipulated in Article 12.2, would result in damages that are difficult or impossible to determine with certainty and have, therefore, in good faith, estimated as fair compensation in the form of Liquidated Damages as set forth in Article-26.
- 10.7 Owner reserves the right to reschedule (i.e. postponement) the first delivery date within 12 (twelve) months from date of issue of Letter of Award, and such rescheduling can be for a maximum period of 6 (six) months. On such re-scheduling, the re-scheduled date shall be the date of First Delivery of Product under the Agreement and Owner will not pay any charges (including Monthly Fixed Charges) during this period site.

ARTICLE-11 : IMPLEMENTATION PLAN

- 11.1 BOO Operator shall complete the installation, testing and commissioning of the Production Plant so as to start delivering Methanol and acceptable By Products, if any, to Owner at required parameters by agreed Time Schedule.
- 11.2 It is clearly understood between the parties that the BOO Operator shall be solely responsible for the completion of the Production Plant in time for its successful, sustained integrated operation and maintenance, subject to the terms and conditions of the Agreement.

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- 11.3 Within one month of Effective Date of the Agreement the BOO Operator shall submit an Implementation schedule giving milestones of scheduled progress on monthly basis.

ARTICLE-12 : TIME SCHEDULE & DURATION OF AGREEMENT

- 12.1 The Agreement shall come into effect from the date of the Letter of Award subject to the provisions of Article 12.3 hereof. Unless priorly terminated in accordance with the terms of the Agreement, the Agreement shall remain in force for a period of 25 (twenty five) years from the First Delivery Date of Methanol (corresponding to availability of Coal) with the right of Owner to review the technical capability and soundness of the Production Plant and upon its satisfaction to extend the Contract Period by another 5 (five) years or more on mutually agreed terms and conditions.
- 12.2 The first delivery Methanol (corresponding to availability of Coal) shall be made within a period of 41 (forty one) months from the date of issue of Letter of Award unless rescheduled under Article 10.8 hereof. Owner shall provide the physical possession of the land for Production Plant within 3 (three) months from the date of LOA. The schedule of providing Raw water and Power for commissioning shall be decided based on mutual agreement between Owner and successful Bidder.
- 12.3 In the event that production in BOO Operator's Production Plant is suspended on account of Force Majeure, the duration of the Agreement shall be extended by such period as mutually agreed between BOO Operator and Owner, provided that the Agreement is not terminated as a result of such Force Majeure in accordance with the provisions of the Agreement.

ARTICLE-13 : BOO OPERATOR'S SCOPE OF WORK AND RELATED OBLIGATIONS

- 13.1 The scope of work of the BOO Operator shall be to Build, Own, Operate and Maintain Production Plant and supply Methanol (corresponding to availability of Coal) to Owner as per provisions of various clauses of the Agreement.
- 13.2 The BOO Operator shall set up the Production Plant to meet the demand of Methanol as specified in the Agreement. The facilities to be provided by the BOO Operator shall be so designed as to ensure continuous and reliable supply of Methanol at all times at the parameter(s) of flow, purity and pressure/temperature specified in Volume II Technical Part of Tender.
- 13.3 The BOO Operator shall notify Owner regarding the readiness of Production Plant for commissioning. All inputs required for commissioning and operating the Production Plant (excluding feed stock, except fluxant, Raw water and power) as detailed in Volume II, Section 1.5, Delivery Point Interface including consumables, spare parts, catalyst, chemicals and supplies & services etc. shall be arranged by the BOO Operator at his own cost and without dependence on Owner. For First Commissioning and till the completion of first test run for capacity and product quality demonstration of Production Plant, Owner shall supply feedstock, raw water and Power. Within 4 (four) days of continuous availability of defined coal feed, BOO Operator shall commence the first test run to demonstrate capacity and product quality. Modalities and format for this test run shall be mutually agreed upon in writing with the BOO Operator at least 3 (three) months before First Delivery Date. Product supplied till the first test run shall be free of

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cost to Owner. If BOO operator fails to demonstrate the performance w.r.t. capacity and product quality (ies), the BOO operator will be given an opportunity for remedial action till the performance is demonstrated through subsequent test runs. Only after the demonstration of the plant with respect to capacity and product quality, it will be considered that the First Delivery by the BOO Operator is achieved.

However, the date on which the supply of Methanol commence at Guaranteed Rate & quality from the BOO Operator's Production Plant from the feed coal supplied by Owner, will be considered as the date of commissioning only for the purpose of Liquidated Damages for Production Plant as per Article 26.3.

- 13.4 The BOO Operator shall ensure that Best Operating Practice is followed in the Production Plant by well experienced and competent management team. Quality Assurance System; Health, Environment & Safety policies etc. with performance reporting system as elaborated elsewhere in the Agreement shall be followed.

13.5 Safety, Health & Environment (SHE)

The BOO Operator shall have a formal and effective SHE management system. SHE performance shall be reported to Owner on regular basis.

13.6 Quality Management System

The BOO Operator's Production Plant shall have formal Quality Management System. Quality assurance Records and Documentation shall be shared with Owner.

13.7 Other Services

- 13.7.1 Daily log-sheets and trend chart of monitoring of quality as well as quantity of Methanol and acceptable By-Products, if any, monitored by the BOO Operator by suitable measuring equipment shall be made available to Owner. Online information on major parameters of Production Plant shall be made available by the BOO Operator through DCS in main control rooms as per Owner's requirement.

- 13.7.2 In case the BOO OPERATOR wishes to make an improvement in the Production Plant involving additional investment or otherwise during the tenure of Contract, BOO OPERATOR will present the implications of the proposal to OWNER and implement such improvement after mutual consent.

ARTICLE-14 : OWNER'S OBLIGATION

- 14.1 Owner shall permit BOO Operator & their authorized personnel with access to Metering Unit (if any) installed within Owner's property at all times, including the right to cross Owner's property by designated routes as necessary, on need basis.
- 14.2 Owner shall keep the BOO Operator informed about any changes in the Product requirement, turndown schedules, shutdown schedules and other matters which may affect the operation of the Production Plant of the BOO Operator.
- 14.3 Owner shall make regular payments to the BOO Operator as per the provisions of the Agreement.

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- 14.4 Owner shall supply free of cost Raw Coal, Raw Water, Power as required by the BOO Operator for production of Methanol.
- 14.5 BOO Operator shall treat liquid effluent generated within its Plant Battery Limit during normal/ worst / start-up/ shutdown operation, BOO Operator shall make all endeavour to limit the discharges within the design values as will be confirmed by the BOO Operator during detail design. BOO operator shall indicate in their Technical Bid the type of effluents, quality, quantity and the treatment required before disposal as per the Environmental Regulation.
- 14.6 Owner shall fulfill its obligations as mentioned in Article 23.
- 14.7 Failure by Owner to comply with its obligations in Article 14 in accordance with the agreed time schedule shall result in extension of the schedule for First Delivery of Methanol set forth in Article 12.2 by an equivalent period of the delay by Owner in complying with any such obligation.

ARTICLE-15: PRICES AND ADJUSTMENT/REGULATION OF PRICES

15.1 Prices and Adjustment/Regulation of Prices of product

Upon First Delivery of Product and thereafter as promptly as possible after the end of each monthly billing period, BOO Operator will read the metering equipment installed pursuant to Article 9.0 to determine the quantity of Product delivered to Owner during such billing period. BOO Operator will inform Owner of the time of such readings and Owner may have a representative present during such readings. Based upon such readings, BOO Operator will invoice Owner and Owner will pay BOO Operator those charges as per the relevant formula of this Article 15.

Owner will have the option to receive any amount, subject to guaranteed figures, of Methanol throughout the agreement. The claim by BOO Operator for Fixed monthly charge and Variable charge is admissible only after submission of following documents in triplicate:

- a. Payment records of the operation / maintenance crews with PF/ ESI and other challans etc.
- b. Submission of payment documents related to taxes, duties and levies etc.
- c. Proof of payment of Income Tax by BOO Operator for their operation/ maintenance crew as per applicable Income Tax Laws.
- d. Proof of obtaining all required statutory clearances.
- e. Annual Medical Fitness record of operation / maintenance crew.

BOO Operator will submit all the documents mentioned above along with the first invoice and thereafter on annual basis or at every renewal.

- 15.1.1 Adjustment/ Regulation of Prices (Conversion charge) for Methanol: The conversion charge of Methanol shall comprise of two components:
- i) Fixed Monthly charge
 - ii) Variable Charge

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15.1.1.1 Fixed Monthly charge for Methanol

The Fixed Monthly charge shall have three components:

- 1) Constant amount (towards ROI of the BOO Operator);
- 2) Component related to WPI for manufactured Products (towards maintenance cost & other overheads).
- 3) Component related to CPI for industrial workers (towards manpower cost).

Fixed Monthly Charge shall be calculated on the basis of the following formula:

$$FMC_M = FMC_{BM} \times [XM_{ROI} + XM_{WPI} \times (WPI_N / WPI_O) + XM_{CPI} \times (CPI_N / CPI_O)]$$

Where,

FMC_M = Fixed Monthly Charge computed on account of Methanol delivered to Owner and will remain valid for that month, it will be released on pro-rata basis from first delivery date upto the end of the month and thereafter on monthly basis every month (e.g. If the first delivery date is 15th January, then FMC_M will be computed on pro-rata basis from 15th January to 31.01.2020. and from February onwards it will be computed in Calendar monthly basis)

FMC_{BM} = Base monthly charge as per the Letter of Award

XM_{ROI} = Constant Component on account of Return On Investment (which will not be adjusted due to inflation)

XM_{WPI} = Constant Component related to "Wholesale Price Index for Manufactured Products"

XM_{CPI} = Constant Component related to "Consumer Price Index for Industrial Labour"

WPI_N = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to Billing month or latest available as on that date.

WPI_O = Average Whole sale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date.

CPI_N = Average Consumer Price Index for Industrial workers as last declared by Reserve Bank of India for the month prior to billing month.

CPI_O = Consumer Price Index for Industrial workers for the month of Letter of Award or last published month before LOA.

The Constant Component XM_{ROI} , XM_{WPI} & XM_{CPI} to be quoted by the Bidder in the Schedule of Rate / BOQ .

The Bidder will quote FMC_{BM} , XM_{ROI} , XM_{WPI} and XM_{CPI} for Methanol in the Price Bid,

Table-1: Table for values for Fixed Monthly charge for Methanol
(To be indicated in the Price Bid)

S.No	Price Factors	Values to be quoted by the Bidder

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1.0	FMCBM (Rs./ Month)	
S.No	Price Factors	Values to be quoted by the Bidder
2.0	XMROI (Note-1)	To be indicated in the Schedule of Price/BOQ
3.0	XMWPI (Note-1)	
4.0	XMCPI(Note-1)	

Note:

1) $XM_{ROI} + XM_{WPI} + XM_{CPI} = 100\%$

2) The price adjustment /regulation under the formula referred in Article- 15.1.1.1, will be made on monthly basis commencing from the First Delivery of the Product

15.1.1.2 Variable charge per MT of Methanol

$$\text{Variable Charge per MT of Methanol} = A_{BM} \times (WPI_N / WPI_O)$$

Where,

A_{BM} = is to be submitted in the Price Bid, as per Schedule of Prices/BOQ

WPI_N = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to Billing month or latest available as on that date.

WPI_O = Average Whole sale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date.

Table-1: Table for values for Variable charge per MT of Methanol

S.No	Price Factors	Values to be quoted by the Bidder
1.0	A_{BM} (Rs. / MT of Methanol)	To be indicated in the Schedule of Price/BOQ


Note: The price adjustment /regulation under the formula referred in Article- 15.1.1.2, will be made on monthly basis commencing from the First Delivery of the Product.15.2.

Subject to the provisions of Article 15.1 hereof, BOO Operator will Invoice Owner the Fixed monthly charge and Variable Charge for the Product supplied and as adjusted as per Article 15.1.1.1 and Article 15.1.1.2. Such invoice will be payable within the 30 (thirty) days of its submission.

15.2 The Fixed monthly base charge and Variable Monthly base charge for Methanol shall remain fixed for the entire Agreement except for variation/adjustment in the Product Prices as per the Article 15.1.1.1 and Article 15.1.1.2. Price for Methanol shall be paid based on the actual quantity of Methanol supplied by BOO Operator to owner.

15.3 However, if no Methanol is lifted by Owner, no Variable Charges shall be payable for Methanol. Only the Fixed monthly charges shall be payable subject to the provisions of Article 15.1.1.1 hereof.

15.4 Regulation/Adjustment of Prices of Feed/ Utilities

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15.4.1 Upon First Delivery of Product and thereafter as promptly as possible after the end of each monthly billing period, BOO Operator will read the metering equipment installed pursuant to Article 9.0 to determine the quantity of Feed / Utilities delivered to BOO Operator during such billing period. BOO Operator will inform Owner of the time of such readings and Owner may have a representative present during such readings. Based upon such readings, the adjustment amount based on the unit rates as set forth below in Table-3 will be worked in case of deviations beyond the allowable limit of guaranteed ratio.

Table-3

Sl. No.	Feed / Utility	Unit	Unit Rate
1.	ROM Coal	MT	@ Rs 5127 /MT
2.	Power	Kwh	@ Rs 5.77 per KWH
3.	Raw Water	M ³	@ Rs.4.50 /M ³

15.4.2 Regulation/Adjustment of Prices for Coal

During the period of Agreement, Coal Price for the category being supplied by Owner, appearing at the website of Coal India Limited, will be applicable for the billing cycle period for working out the adjustment amount in case of deviations beyond the allowable limit of guaranteed ratio.

15.4.3 Regulation/Adjustment of Prices for Power

During the period of Agreement, the Power charge will be considered as per actual Power tariff applicable for the billing cycle period for working out the adjustment amount in case of deviations beyond the allowable limit of guaranteed ratio.

15.4.4 Regulation/Adjustment of Prices for Raw Water

During the period of Agreement, the prices of Raw Water will be applicable for the billing cycle period as follows:

$$\text{Price of Raw Water } C_{RW} = A_{BW} \times (WPI_N / WPI_O)$$

Where,

C_{RW} = The charge of Raw Water per M³ for billing month

A_{BW} = The base charge of Raw Water as indicted at table above.

WPI_N = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to Billing month or latest available as on that date.

WPI_O = Average Whole sale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date

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15.5 Subject to the provisions of Article 15.4 hereof, OWNER will work out the adjustment amount in case of deviations beyond the allowable limit of guaranteed ratio and the same shall be adjusted against the payment towards Conversion charges.

For arriving at on any commercial impact with respect to deviations in Feed and utilities consumption ratios with respect to Methanol the following will be considered:

Computation of feed utilities and product transfer between OWNER and BOO OPERATOR will be carried out on daily basis (08-00 hrs of the day to 08-00 hrs of the next day) based on the meter reading as agreed. The daily consumption will cumulated for each calendar month (08-00 hrs. of the 1st day of the calendar month to 08-00 hrs of the first day of the succeeding calendar month) the calculated monthly quantities will be equated for unit supply of Methanol. The deviation with respect to guarantee will be the difference between the actual consumptions and the guaranteed value.

15.6 The unit rate of Feed/Utility supplied by OWNER as specified in Article 15.5 shall be for the entire Agreement Feed.

ARTICLE-16 : GUARANTEES

16.1 BIDDER shall furnish guarantee for Production Plant as specified under the following heads.

- Agreed date of supply of Methanol
- Capacity
- Ratios for Consumption of Feed and Utilities and other Chemical/ Catalyst Quality of the product(s)
- Plant Availability Factor

16.2 Agreed date of supply of Methanol:

BIDDER shall guarantee supply of Methanol as per guaranteed capacity and quality, by agreed date of supply of Methanol as defined in Article 12.0.

16.3 **Capacity:**

BIDDER shall guarantee supply of Methanol as per following:

Methanol – 2050 MTPD (minimum)

16.4 **Consumption:**

As per Schedule of Prices.

If the actual consumption is within the following specified limits, there will be no financial adjustment. Financial value of any performance inferior to the guaranteed ratios will be debited to the BOO Operator, subject to the following:

Coal (Feed/ fuel) consumption	: Within \pm 1.0% of Guaranteed ratio
Raw water	: Within \pm 1 % of Guaranteed ratio
Power	: Within \pm 1 % of Guaranteed ratio

16.5 **Quality of the Product:**

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BIDDER to guarantee supply of Methanol as per the following quality:

Methanol : 99.85 % (minimum)

16.6 Plant Availability:

BIDDER shall guarantee minimum Plant Availability Factor for Production Plant as 98.5%.

16.7 Ash Content:

24% ash content in coal shall be the basis of design for Coal Gasification plant along with all associated facilities to generate Methanol Syn. gas, Methanol Plant (2050 MTPD), Steam Generation Plant and all associated offsite & utilities etc. Bidders shall also furnish the Guaranteed specific coal consumption (in Metric Tonnes of coal per tonne of Methanol) at different levels of ash content as specified in clause no. 2.3 of Section 1.4 of Volume-II Technical part of Tender document.

ARTICLE-17: TAXES AND DUTIES

- 17.1 Bidder to quote the Fixed Monthly Charge and Variable charge as per Article 15 exclusive of taxes and duties. Bidder have to discharge statutory obligations like GST and other taxes and duties applicable on the assessable value. It shall be the obligation of the Bidders to satisfy the tax authorities on valuation aspects.
- 17.2 The Conversion charge (fixed monthly charge and the variable charge) shall be subject to GST. The Bidders should quote the above charges exclusive of GST. For the purpose of evaluation, the quotes of GST on the Conversion charges will be considered at the present prevalent rate of 12% (Twelve percent) against applicable HSN code 9988. There will not be any other taxes and duty leviable on feed and utilities as the same shall be supplied free of cost during execution of the Contract. In actual operation Owner shall reimburse the GST paid by the BOO operator on the services performed by the BOO operator under the Contract Documents, subject to the BOO operator providing to Owner, appropriate documents/Tax Invoice.
- 17.3 If at any time during the Contract Period any tax or any other duty, cess, imposed or levy is newly imposed on BOO Operator by any governmental authority chargeable on the Conversion charges or on the production or delivery of Methanol to Owner hereunder, then Owner will reimburse BOO Operator therefore, to the extent applicable to deliveries to Owner hereunder, on submission of the relevant invoices & proper documentary evidence.
- 17.4 If at any time during the term of the Agreement any new law, ordinance, rule, or regulation (collectively, "Law") is in effect or is enacted or promulgated by any governmental or quasi-governmental authority, including any new Law relating to the emission or release of greenhouse gases, that increases BOO Operator's costs incurred in the production, transportation, or delivery of Methanol to Owner hereunder, including any costs arising from any modification made by BOO Operator with respect to (a) the Production Plant, (b) the Metering Equipment, or (c) BOO Operator's operation of the Production Plant (any such increased costs being hereinafter referred to as "New Costs"), the impact of such New Costs,

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effective as of the date such Law causes BOO Operator to incur any New Costs, shall be suitably adjusted in the monthly fixed charges upon mutual agreement between Owner and the BOO Operator provided that Owner is satisfied with the effort of BOO Operator to minimize or mitigate the effect of any such Law on the operation of the Production Plant (including without limitation through the filing of available judicial challenges to any such Law) and shall consult with Owner for purposes of determining the most cost effective way of complying with any such Law.

- 17.5 BOO Operator should have Permanent Account Number (PAN) as per provisions of Indian Income Tax Act. Income tax will be deducted at source under section 194 C and Section 195 read with section 197 from the payments to Indian / Non-residential parties respectively at the prevailing rates as per income Tax Act 1961 / DTAA. Deduction at lower rate on nil rate has to be substantiated by submitting certificate under section 197 from the income tax authority by the BOO Operator.
- 17.6 BOO Operator shall bear and pay all corporate income taxes and/or turnover taxes, if any, based upon or measured by its net income, and all taxes imposed on corporations on account of their existence or their right to transact business. BOO Operator shall pay all duties, taxes and levies associated with the procurement of BOO Operator's equipments, catalysts, chemicals, consumables, their transportation to the site and erection & commissioning on the site.
- 17.7 Please note that the responsibility of payment of GST (CGST & SGST or IGST or UTGST) lies with the BOO Operator only. BOO Operator providing taxable service shall issue tax Invoice/Bill, as the case may be as per rules/ regulation of GST. Further, returns and details required to be filled under GST laws & rules should be timely filed by Service Provider with requisite details.
- 17.8 In case the GST rating of vendor on the GST portal / Govt. official website is negative / black listed, then the bids may be rejected by CIL. Further, in case rating of bidder is negative / black listed after award of work, then Owner shall not be obligated or liable to pay or reimburse GST to such Bidder/Vendor and shall also be entitled to deduct /recover such GST along with all penalties / interest, if any, incurred by CIL.
- 17.9 BOO Operator shall issue tax invoices, file appropriate returns, and deposit the applicable GST to the account of appropriate Government within the time limit prescribed under the GST Law. In the event of any default, BOO Operator shall be liable to pay the amount, if so imposed on Owner due to such default.
- 17.10 Owner will deduct GST at source at the applicable rates in case transactions under the CONTRACT are liable to GST deduction at source as per the prevailing provisions of GST Law.
- 17.11 Further, Section 171 of CGST Act, 2017 provides that "any reduction in rate of tax on any supply of goods or services or the benefit of input tax credit shall be passed on to the recipient by way of commensurate reduction in prices". Accordingly, Bidders are required to ensure compliance to the anti-profiteering clause under GST law.
- 17.12 There will be no materials under the scope of the Contract Agreement which will be consigned to Owner, unless otherwise specifically mentioned elsewhere in the tender. The Owner will not issue / provide Road permits/e-way bill to the Contactor except in respect of material directly purchased by the Owner.

ARTICLE-18 : PLANT START-UP AND PLANNED SHUT DOWN

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18.1 Plant Start-Up

For the first year i.e. 365 (three hundred sixty five) days of operation from the first supply of Methanol, maximum 4 (four) nos. of unplanned shutdowns will be allowed for Production Plant. However, during subsequent years (after the 1st year) the maximum 2 (two) nos. of unplanned shutdowns will be allowed for Production Plant.

18.2 Plant Shut Down

BOO Operator may require from time to time to shutdown the production facilities of the Production Plant for such period of time as may be necessary for BOO Operator to make ordinary repairs and for maintenance consistent with proper operation. However, such planned shutdown (turn – around) shall be limited to about 25 (twenty five) days at a stretch each year. BOO Operator will design all the equipment/ steam generators etc. those requires mandatory statutory inspection for a minimum run length of 2 years.

In addition, the Production Plant will be planned for shutdown to meet the requirements of regulatory bodies (such as Indian Boiler Regulations) at intervals as specified by those respective regulatory bodies. BOO Operator will be allowed to undertake such shutdown as per statutory requirements. BOO Operator will make all endeavour to utilise these shutdown on account of statutory requirements for other maintenance of plant as may be necessary from time to time as well as for replacement of catalyst. Duration of such shutdown will be mutually agreed between the parties.

18.3 In case the number of unplanned shutdown, as per Article-18.1 is less than 4 (four) emergency shutdowns in 1st year and 2 (two) in subsequent years, there will neither be any reward nor the same will be allowed to carry forward for the next year.

ARTICLE- 19: CONTINGENCIES

The following contingencies shall be applicable for the Agreement.

In situations other than force-majeure

If Owner fails to provide the Utilities and/or feed under the scope of supply of Owner which results in reduction in production of Methanol below the guaranteed quantities as defined in the Agreement or no production of Methanol in the BOO Operator's Plant; or Owner fails to lift requested quantities of Methanol, then the Monthly Fixed Charge will be payable in all situations.

ARTICLE-20: INSURANCE

BOO Operator shall effect and maintain at its own cost, during the Contract Period, procure insurances, for such maximum sums as may be required under the Applicable Laws, and such insurances as may be necessary or prudent in accordance with standard industry practice, for the Production Plant and facilities and operating personnel in BOO Operators battery limit.

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The BOO Operator, at its sole cost and expense, shall continue to obtain and maintain all the Construction Insurance Policies and Operational Insurance Policies required to be taken in respect of the Production Plants as required by the Financers, or by the laws of India; or as may be necessary in accordance with the Best Operating Practices. The BOO Operator shall ensure that Owner is named as an additional insurer on all insurance policies with respect to third party liability insurance. Third party Insurance policy taken by BOO Operator shall have provision for Waiver of Subrogation in favour of Owner.

No later than 45 (forty five) days prior to commencement of the Construction Period the BOO Operator shall by notice furnish to the Owner, in reasonable detail, information in respect of the insurances that it proposes to effect and maintain in accordance with this Article 20. Within 30 (thirty) days of receipt of such notice, the Owner may require the BOO Operator to effect and maintain such other insurances as may be necessary pursuant hereto, and in the event of any difference or disagreement relating to any such insurance, the dispute resolution procedure shall apply.

All insurances obtained by the BOO Operator in accordance with this Article 20 shall be maintained with insurers on terms consistent with standard industry practice. Within 15 (fifteen) days of obtaining any insurance cover, the BOO Operator shall furnish to the Owner, notarised true copies of the certificate(s) of insurance, copies of insurance policies and premium payment receipts in respect of such insurance, and no such insurance shall be cancelled, modified, or allowed to expire or lapse until the expiration of at least 45 (forty five) days after notice of such proposed cancellation, modification or non-renewal has been delivered by the BOO Operator to the Owner.

Any failure by the BOO Operator to obtain the insurance coverage or certificates of insurance as required, shall neither relieve the BOO Operator of the insurance requirements set forth herein nor relieve or limit in any way the BOO Operator's obligations and liabilities under any other provision of the Agreement. If the BOO Operator shall fail to effect and keep in force all insurances for which it is responsible pursuant hereto, the Owner shall have the option to either keep in force any such insurances, and pay such premium and recover the costs thereof from the BOO Operator.

The under mentioned minimum coverage or such additional coverage as may reasonably be required, shall be maintained or cause to be maintained by the BOO Operator throughout the Agreement period:

- Workers Compensation and Employers Liability
- General Liability Insurance
- Builders All Risk Insurance
- Marine Cargo insurance
- All Risk Property/Comprehensive Machinery Insurance (Upon Completion of Construction)
- Third Party Liability Insurance
- Public Liability Insurance

To the extent that the above insurance policies are available through Indian insurance companies, preference shall be given to using these companies.

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Notwithstanding any liability that may arise under the Agreement, any loss for which compensation is due to the BOO Operator under this Article, shall not be charged to Owner. All insurance policies in respect of the insurance obtained by the BOO Operator pursuant to this Article 20 shall include a waiver of any and all rights of subrogation or recovery of the insurers there under against, *inter alia*, the Owner/CIL, and its assigns, successors, undertakings and their subsidiaries, affiliates, employees, insurers and underwriters, and of any right of the insurers to any set-off or counterclaim or any other deduction, whether by attachment or otherwise, in respect of any liability of any such person insured under any such policy or in any way connected with any loss, liability or obligation covered by such policies of insurance.

The BOO Operator shall cause its insurers or agents to provide Owner with certificates of insurance for required replacement policies or renewals as evident from the endorsements of policies, at least thirty 30 (thirty) days prior to i.e. termination or expiration of any policy hereunder.

Similarly, Owner agrees to cover Owner's plant, facilities and operating personnel under insurance along with coverage of third party liability.

ARTICLE-21 : SAFETY, HEALTH AND LIABILITY APPORTIONMENT

- 21.1 Owner acknowledges that there are hazards associated with the use of Methanol. Owner agrees that its personnel involved in activities related to Methanol are aware of the hazards and assumes all responsibility for warning and protecting its employees and independent contractors of all hazards to persons and property in any way connected with the handling of Methanol.

Owner will notify BOO Operator of any hazards and safety procedures at DCC and Owner will notify BOO Operator in advance of any anticipated construction, renovation or change in operations in the area of the Metering Equipment site so that any hazards associated with same can be minimized.

The BOO Operator shall ensure that all the personnel / employees, contractors, contract labours/ workers engaged by them in operation and Maintenance of the Production Plant for continuous supply Methanol and any other By-Products and to Owner shall follow all the safety rules as applicable.

Owner will receive documents from BOO Operator, including "BOO Operator's Material/Product Safety Data Sheet(s) containing BOO Operator's safety and health information pertaining to Methanol and any other acceptable By-Products delivered for appropriate use into Owner's safety program.

Each party hereby agrees to indemnify the other and hold the other harmless from any actions, lawsuits, demands, claims, losses, expenses, costs, including but not limited to legal fees, and damages, arising from the injury, illness or death of their respective employees while engaged in activities connected with the Agreement, whether or not such injury, illness or death is claimed to have been caused by, resulted from, or was in any way connected with the negligence of the party to be indemnified.

- 21.2 BOO Operator will design the Production Plant so that noise levels will not exceed during daytime and night- time, the maximum limits provided in statutory guidelines at the Production Plant Site boundary for a continuous noise source during normal plant operation. BOO

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Operator shall provide to his employees all Personal Protection Equipment and shall also comply with government regulations in this regard.

- 21.3 BOO Operator will be solely responsible for fulfilment of all requisite statutory obligations in vogue from time to time as per requirement of State Government, Central Government pertaining to this Production Plant during entire period of Agreement.
- 21.4 BOO Operator will make all endeavour to use Best Operating Practices.

OWNER will notify BOO OPERATOR of any hazards and safety procedures at DCC and OWNER will notify BOO OPERATOR in advance of any anticipated construction, renovation or change in operations in the area of the Metering Equipment site so that any hazards associated with same can be minimized.

The BOO OPERATOR shall ensure that all the personnel / employees, contractors, contract labours/ workers engaged by them in operation and Maintenance of the Production Plant for continuous supply Methanol and any other By-Products and to OWNER shall follow all the safety rules as applicable.

OWNER will receive documents from BOO OPERATOR, including "BOO OPERATOR's Material/Product Safety Data Sheet(s) containing BOO OPERATOR's safety and health information pertaining to Methanol and any other acceptable By-Products delivered for appropriate use into OWNER's safety program.

Each party hereby agrees to indemnify the other and hold the other harmless from any actions, lawsuits, demands, claims, losses, expenses, costs, including but not limited to legal fees, and damages, arising from the injury, illness or death of their respective employees while engaged in activities connected with the Agreement, whether or not such injury, illness or death is claimed to have been caused by, resulted from, or was in any way connected with the negligence of the party to be indemnified.

- 21.2 BOO OPERATOR will design the Production Plant so that noise levels will not exceed during daytime and night- time, the maximum limits provided in statutory guidelines at the Production Plant Site boundary for a continuous noise source during normal plant operation. BOO OPERATOR shall provide to his employees all Personal Protection Equipment and shall also comply with government regulations in this regard.
- 21.3 BOO OPERATOR will be solely responsible for fulfilment of all requisite statutory obligations in vogue from time to time as per requirement of State Government, Central Government pertaining to this Production Plant during entire period of Agreement.
- 21.4 BOO OPERATOR will make all endeavour to use Best Operating Practices.

ARTICLE-22: CONFIDENTIALITY

- 22.1 The Agreement The Agreement and all drawings, diagrams, specifications, operating data, pricing and costs and other information furnished by BOO Operator relating to the use and/or delivery of Methanol furnished hereunder and the information therein are proprietary to BOO Operator. Owner may not reproduce or distribute such materials except: (a) to government agencies for the purpose of obtaining permits; and (b) to Owner's employees for the purpose of carrying out their duties relating to the use of Methanol. In the case of any of the aforementioned disclosures; Owner "agrees to inform its employees or governmental agencies that such information is the confidential information of BOO Operator and is to be

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treated accordingly. All such information relating to Products supplied directly by BOO Operator (except information as may be established to be in the public domain) shall be received in confidence and Owner shall exercise the same degree of care to hold such information in confidence as it uses with respect to its own trade secrets and/or confidential and proprietary material. Unless otherwise agreed to by the parties, Owner agrees that it shall keep all such material confidential for a period, which shall expire 5 (five) years after the expiry or termination date of the Agreement.

- 22.2 Any information relating to Owner's plant, supplied directly by Owner shall be received in, confidence and BOO Operator shall exercise the same degree of care to hold such information in confidence as it uses with respect to its own trade secrets and/or confidential and proprietary material.
- 22.3 It is understood that the foregoing obligation of confidentiality does not apply to materials and information that: (i) was already known to the receiving party prior to the disclosure of same hereunder, as evidenced by the receiving party's written records prepared prior to such disclosure; (ii) was in or hereafter comes within the public domain, other than by the receiving party's failure to fulfill its obligations hereunder; (iii) is made available to the receiving party by a third party who does not have any direct or indirect obligation of secrecy to the disclosing party; or (iv) is developed by the receiving party independent of any disclosure under the Agreement as evidenced by its written records.

ARTICLE-23 : PRODUCTION PLANT SITE (S)

- 21.1 Owner will allocate the land to BOO Operator under lease, as per Draft Lease Agreement annexed hereto in Volume I, Sec. 1.10, Draft Project Agreements, for locating the Production Plant approximately as per Plot Plan/Scope drawing enclosed on signing of Agreement. Production Plant site provided shall be in graded condition, cleared, graded, and free from any toxic or hazardous materials and underground or overhead obstructions, with provisions for drainage of surface and rain- water, without any charge to BOO Operator. BOO Operator shall - carryout Hazop study through an agency nominated by BOO.
- Operator and submit the report to Owner for review and comments. Owner shall have the right to verify the incorporation of all Hazop recommendations. BOO Operator shall submit the final Hazop study report, and a plot plan for Owner's record. In addition, Owner and/or its authorized representative will have the right to monitor and review BOO Operator's implementation plan and progress thereof.
- 23.2 BOO Operator, at its sole cost and expenses shall obtain and maintain all requisite statutory clearances including all central, state or local permits. BOO Operator shall also obtain Licenses for construction and operation of the Production Plant. Owner shall provide assistance to BOO Operator whenever necessary, if requested.
- 23.3 Owner, at its expense, will provide a clear approach suitable for access to the Production Plant Site for movement of tractor, tanker, trucks, cranes, construction plant and equipment etc. along with handing over of the site.
- 23.4 Owner grants 24 (twenty-four) hours a day access to the authorized personnel of BOO Operator to the Production Plant Site for the term of the Agreement. Owner's authorized personnel shall have unrestricted access to the BOO Operator's Plant both during construction & operation of the plant.
- 23.5 Owner will hold BOO Operator harmless from and against liens and claims against the Production Plant due to its location on Owner's premises. BOO Operator will take adequate

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safety precautions, as required, for any hazards associated Methanol and any other By-Products production, pressurization and transportation up to Delivery point.

- 23.6 BOO Operator shall ensure that the Production Plant area shall not be used for Truck Parking purpose. However, trucks/tankers with prior permission of Owner shall be allowed to enter the Production Plant Site only for unloading of necessary inventories required for O&M purpose. No maintenance of the trucks/tankers shall be allowed inside the Plant Site. BOO Operator shall be responsible for the security and safety of trucks/tankers.

ARTICLE -24 : ENVIRONMENTAL CONDITIONS

- 24.1 The Production Plant design shall be based on technical specifications as per Volume II, Section 1.4, Design Basis throughout the Agreement period and the present plot plan of Owner's Plant as enclosed in Technical Part, Volume-II.
- 24.2 The BOO Operator shall follow all the norms and regulation including conditions of Environmental Clearance (EC) & No Objection Certificate (NOC) from Central Pollution Control Board / State Pollution Control Board.
- 24.3 Owner will make TOR application to MOE&F and carry out EIA/EMP studies. BOO Operator shall provide necessary technical assistance to Owner / its Consultant to obtain initial Environment Clearance. EC shall be transferred to BOO Operator after the first date of delivery and all subsequent modification to the process including fresh EC application shall be in the scope of the BOO Operator. Additionally, BOO Operator, at its sole cost and expenses shall obtain and maintain all requisite statutory clearances including all central, state or local permits. BOO Operator shall also obtain Licenses and authorizations for construction and operation of the Production Plant. Owner shall provide assistance to BOO Operator whenever necessary to obtain statutory clearances. BOO operator will also renew all clearances, license, wherever applicable from time to time as required by statutory bodies of State Government & Government of India.
- 24.4 Owner warrants that there are no toxic or hazardous materials or substances on, in or under the Production Plant Site(s). Owner shall indemnify and hold BOO Operator harmless from and against any and all claims, liabilities, costs (including attorney's fees), expenses, damages, penalties and fines resulting from any breach of the foregoing warranty or from any toxic or hazardous materials now or hereafter in, on or under the Production Plant Site(s) which did not occur or result directly from BOO Operator's performance pursuant to the Agreement.

ARTICLE-25 : UTILITIES

Owner shall provide utilities as detailed below to BOO Operator, upto delivery point, for use in Production Plant. Owner's responsibility of supplying Utilities as detailed below will end at the Delivery Point.

- 25.1 Construction Power:

Owner, at its expense, will provide temporary construction power to BOO OPEARATOR from the Existing DCC Plant Sub-station up to a total maximum load of 10 MVA, subject to availability, as per prevailing rate of power. However, BOO Operator, at its own cost, shall arrange alternative source of power to meet interruptions, if any in construction power supply

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provided by Owner. BOO Operator at it's own expense shall lay the cable and draw the power from the nearest construction power substation outside it's premises and further distribute to it's work sites maintaining all safety regulations as per IE Act. However, in case of non-availability of construction Power due to any reason BOO Operator at it's own expenses shall arrange for power to keep the progress of construction and no compensation on account of time & cost shall be admissible in such eventuality.

25.2 Construction water:

Owner shall provide construction water at one point at BOO Operator's plant Delivery Point on chargeable basis till Mechanical Completion, Subject to availability. However, in case of non-availability of construction water due to any reason BOO Operator at it's own expenses shall arrange for construction water to keep the progress of construction and no compensation on account of time & cost shall be admissible in such eventuality.

25.3 Electrical Power:

Power shall be provided free of cost from state grid at 132 KV.

25.4 Raw Water:

Raw water shall be supplied at BOO Operator's plant battery limit free of cost. However, BOO Operator shall take all precautions to ensure that any misuse of Raw water does not take place.

25.5 The above mentioned utilities shall be provided by Owner free of cost. However, in case of deviation beyond allowable limit of guaranteed ratio, the rates, as set in article-15, will be applied for working out the adjustment amount.

25.6 All the utilities (other than construction power and water) required for First Commissioning (i.e., commissioning upon mechanical completion of Production Plant) and till the completion of first test run and further upto Agreement period shall be supplied by BOO operator. For First Commissioning and till the completion of first test run for capacity and product quality demonstration, if BOO operator fails to demonstrate the performance w.r.t. capacity and products quality(ies), the BOO operator will be given an opportunity for corrective engineering till the performance is demonstrated through subsequent test runs within the date of first delivery as mentioned elsewhere in the Agreement.

25.6 BOO Operator shall ensure that the utilities provided by Owner are used for intended purpose only.

25.7 Owner shall ensure availability of utilities falling in Owner's scope of supply in terms hereof, as are required for pre-commissioning/commissioning, as per mutually agreed schedule required for normal commissioning of the Production Plant. Methanol as produced during the commissioning and up to First Delivery date shall be supplied by BOO Operator to Owner on demand, free of cost.

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ARTICLE-26 -LIQUIDATED DAMAGES

26.1. For Late Start-Up for Production Plant

If the BOO Operator fails to ensure the timely First delivery of Methanol as defined in Article 10.4, Owner will suffer very substantial damages on this account far in excess of the Liquidated Damages as set forth below. However, with a view to limit the BOO Operator's liability, the Parties have in good faith, fixed the ceiling for the liquidated damages, on account of delay in First delivery of Methanol, as set forth below on the clear acknowledgement that the actual damages incurred by Owner will be very much greater.

- 26.2 For any delay in commissioning the Production Plant beyond the contractual date for commencement of supply of Methanol, BOO Operator shall pay to Owner liquidated damages at the rate of Rs 4.5 Crore on pro rata basis for delay of every week or part thereof subject to a ceiling of Rs 108 Crore.
- 26.3 Liquidated damages shall not apply in case Owner is not ready to take Methanol from the contractual date of commencement. In such case Liquidated damages shall be applicable from the date Owner is ready to take Methanol.
- 26.4 In case delay in readiness of Owner to start usage of Methanol beyond contractual date of commencement is intimated to the BOO Operator and if BOO Operator is ready to supply Methanol, Owner shall pay the Fixed Monthly charge as specified in Article 10.6. However, Variable Charges will be paid from the date of Methanol supply subject to production of Guaranteed Quantity of Methanol.
- 26.5 In case the BOO Operator abandons the project before the schedule date of commissioning of Production Plant, Owner will have the right to encash Security Deposit and the conditions mentioned under Termination clause shall become applicable.
- 26.6 Owner may deduct the sum of liquidated damages from any money due or that may become due to BOO Operator or by encashing Security Deposit.
- 26.7 Payment of the liquidated damages described in this Article 26 shall be BOO Operator's sole liability and Owner's sole remedy for any delay in Plant startup.
- 26.8 The BOO Operator agrees and acknowledges that the damages payable under this Article 26, are mutually agreed genuine pre-estimated loss and damage likely to be suffered and incurred by CIL/Owner and that CIL/Owner is entitled to receive the same and are not by way of penalty.

ARTICLE-27 : PENALTY AND RISK PURCHASE

27.0 PENALTY AND RISK PURCHASE

27.1 PENALTY FOR NON-COMPLIANCE OF GUARANTEED PARAMETERS.

a) ON ACCOUNT OF SHORT FALL IN METHANOL

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If the BOO Operator at any time fails to deliver the Methanol as per specified quality i.e. Grade 'AA' up to the Maximum requirement or Requested Quantities as stipulated in Article 7.0, Owner will suffer anticipated revenue loss and bear penalties on account of envisaged long term agreements with off take suppliers of Methanol. The BOO Operator also acknowledges the fact that such damages are difficult or impossible to determine with certainty. However, with a view to limit the BOO Operator's liability, the Parties have in good faith, fixed the ceiling for the penalty, on account of Shortfall in Methanol Supply, as set forth below on the clear acknowledgement that the actual damages incurred by Owner may be higher. The penalty for such Shortfall will be equivalent to:

Penalty= (0.985xTotal Requested Quantity – Total Supplied Quantity) x (Fixed Charge per MT of Methanol + Variable Charge per MT of Methanol)

Fixed Charges per MT of Methanol = (Monthly Fixed Charge x 12) / (2050 x 365)

Wherever applicable, yearly average WPI/CPI will be considered for computing the Fixed Charge and Variable Charge

b) ON ACCOUNT OF NOT MEETING SPECIFIED LIMITS OF PURITY

In case Methanol cannot be purchased by Owner due to lower purity as compared to Guaranteed purity at Delivery Point, then this shall be treated as supply shortfall and penalties shall be levied as per serial no. 27.1 a).

c) ON ACCOUNT OF EXCEEDING THE NO. OF UNPLANNED INTERRUPTIONS BEYOND FOUR (4) IN FIRST YEAR AND TWO (2) IN SUBSEQUENT YEARS

In case the number of interruption/ emergency shutdowns of Production Plant in a year is more than 4 (four) in 1st year and 2 (two) in subsequent years, there will be penalty of Rs.....Lakh per episode of emergency shutdown in Production Plant over and above 4 (four) emergency shutdowns in 1st year and 2 (two) emergency shutdowns in subsequent years of Contract Period.

d) ON ACCOUNT OF NOT MEETING PLANT AVAILABILITY:

BOO Operator shall guarantee minimum plant availability of Methanol as 98.5%. In case minimum Plant availability of Methanol falls below 98.5% for reasons other than Force Majeure or reasons attributable to Owner, then this shall be treated as no supply and penalties shall be levied as per serial no 27.1 a) .

27.2 The penalties under Article 27.1 hereof payable by the BOO Operator to Owner shall, without prejudice to any other mode of recovery available to Owner, be recoverable by deduction from the Monthly invoice of BOO Operator. The actual supply of Methanol will be totalised, for each, for every 15 minutes and recorded through Distributed Control system (DCS). The average delivery rate for each 15 minute supply will determine the corresponding pricing window. The sum total of every 15 minute record will determine the delivery for the day / month / year and will also be the basis for calculating the short supply with respect to requested quantity.

27.3 Penalty will not be applicable under the following conditions/circumstances:

- a) During Scheduled Outages of Production Plant
- b) During Force Majeure
- c) During the non-performance by Owner of its obligation under the Agreement which in turn affects the production facilities of BOO Operator.

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d) For the 4 (four) unplanned shutdown in 1st year and 2 (two) in unplanned shutdown subsequent years,

27.4 Payment of the penalties described in this Article 27 shall be BOO Operator's sole liability and Owner's sole remedy for any shortfall in the supply of Methanol.

ARTICLE-28 : LIABILITY

28.1 BOO OPERATOR BOO Operator will be fully responsible for any and all liabilities and obligations accruing to it by virtue of its carrying on industrial operations in the premises of the BOO Operator, including but not restricted to liabilities and obligations arising under various laws including labour, environmental and safety and taxation laws.

28.2 BOO Operator shall insure its installation at its own cost to cover all risks/losses.

28.3 The workforce / labour employed by the BOO Operator for carrying out any activity in connection with its Production Plant for supplying Methanol and acceptable By Products, if any, to Owner shall remain BOO Operator's liability during and after the contractual period and also in case the contract is terminated at an early date.

28.4 The Production Plant, built on the land Leased by Owner, shall at all times remain the property of BOO Operator.

28.5 Owner & BOO Operator warrant each other that its activities in relation to the Agreement will not infringe upon or violate any property or other rights of any third party.

28.6 Subject to the provisions of Article 21, each of BOO Operator and Owner accept liability for death of or injury to individual persons, to the extent caused by its negligence or breach of this Agreement.

For the purpose of this condition, BOO operator's liability includes all such liabilities of BOO operator and / or of all its associates, contracts, subsidiaries and / or any other agency lined up by the BOO operator.

28.7 Neither Owner & BOO Operator shall be liable to one another for any indirect, incidental or consequential losses including (without limitation) loss of revenue, loss of profits, loss of use, and loss of contracts.

28.8 BOO Operator fully understands that one of the reason for it being a Successful Bidder is that it is an expert (and fully conversant with) in construction, operation, monitoring and maintenance of the Production Plant including safety and environment aspects. BOO Operator fully understands that it will be fully responsible for any and all liabilities and obligations accruing to Owner by virtue of BOO Operator carrying on industrial operations in the Production Plant/Project Site and/or operation and /or maintenance of the Production Plant, including but not restricted to liabilities and obligations with respect to safety and environment aspects and also arising under various laws including labour, environmental and safety and taxation laws. BOO Operator undertakes to fully indemnify Owner for any penalties, liabilities, demands, orders, assessment, fine, cess, interest and/or any damages or other costs levied/demanded from Owner owing to any acts, omission or commission on the part of BOO Operator in construction, operation, monitoring and maintenance of the Production Plant.

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Similarly, Owner fully understands that it will be fully responsible for any and all liabilities and obligations accruing to BOO Operator by virtue of Owner carrying on industrial operations in Owner's Plant and/or operation and /or maintenance of Owner's Plant, including but not restricted to liabilities and obligations with respect to safety and environment aspects and also arising under various labour, environmental and safety and taxation laws. Owner undertakes to fully indemnify BOO Operator for any penalties, liabilities, demands, orders, assessment, fine, cess, interest and/or any damages or other costs levied/demanded from BOO Operator owing to any acts, omission or commission on the part of Owner in construction, operation, monitoring and maintenance of Owner's Plant.

ARTICLE-29 :TEMPORARY TAKEOVER OF THE PLANT BY OWNER

BOO OPERATOR BOO Operator recognises the fact that it is absolutely critical to Owner's interests that a consistent and uninterrupted supply of Product as per the specification and upto the quantities stipulated in Article 8 and Article 7 respectively should always be maintained. Accordingly, BOO Operator agrees, without prejudice to the provisions of Liquidated Damages, Penalty and Risk Purchase as set forth hereinabove, that if for any reason whatsoever (not being attributable to a fault of Owner) BOO Operator defaults or delays in the strict performance of its obligations under the Agreement for a continuous period of 30 (thirty) days and has not reasonably demonstrated its willingness to set right the Production Plant as per Owner's opinion, then Owner shall have the right to take over the operation of the Production Plant for such duration and take such remedial steps and incur such costs and expenses at the risk and account of the BOO Operator as may be necessary for Owner to operate the Production Plant so that BOO Operator's obligations under the Agreement are satisfied. BOO Operator shall reimburse such cost and expenses incurred by Owner promptly upon demand and assure Owner of its full co- operation in the matter. In case of such eventualities the BOO Operator shall agree to share all Production Plant related documents including documents from the Production Plant licensor.

ARTICLE-30 : TERMINATION AND TAKEOVER

30.1 Owner may terminate the Agreement prior to completion of the Production Plant if:

- (a) The BOO Operator has abandoned the Project or has suspended work on the Project for consecutive 6 (six) weeks or more;or
- (b) The rate of progress of construction of the BOO Operator's Production Plant lags with respect to the agreed schedule for the Project even after taking remedial measures which shall result in overall delay of more than 3 (three) months in completion of the Production Plant taking into account the scheduled or re-scheduled date(s) of First Delivery.

30.2 Owner may also terminate the Agreement during the period of Agreement in case of the following:

- (a) The BOO Operator becomes insolvent, bankrupt, is the subject of proceedings for liquidation or dissolution, ceases to carry on business, or becomes unable to pay its debts as they become due;

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- (b) Failure of BOO Operator to diligently implement the remediation plan agreeable to Owner, to be submitted by the BOO Operator within 7 (seven) days of continuous non-supply of Methanol

Or

Methanol do not meet 90% of requested quantities on a monthly basis in respect thereof under Article 7 for a continuous period of 6 (six) months for reasons other than reasons attributable to Owner or Force Majeure.

Or

- (c) Apart from the failure of BOO Operator's obligation as indicated at Article-30.2(b), the BOO Operator has committed a material breach of any other provision of the Agreement and the BOO Operator (i) fails to remedy such breach within 15 (fifteen) days of receiving a notice of breach from the aggrieved party, or (ii) fails promptly to submit remediation plan to Owner and diligently implement the same, where the breach is of a nature that cannot be rectified within 15 (fifteen) days.

30.3 Upon occurrence of any of the events described in 30.1 or 30.2 above, Owner may give written notice to the BOO Operator, if applicable, regarding occurrence of the relevant event and instruct the BOO Operator to rectify/cure the default within agreed time schedule, and should the BOO Operator fail to rectify/cure the default to the satisfaction of Owner within that period, Owner shall have the right, after the expiration of such time schedule to terminate this Agreement by giving notice in writing to the BOO Operator and take over the Production Plant permanently including the right to the technology licenses at fair value mutually discussed and agreed.

30.4 On completion of 25 (Twenty five) years from the date of First Delivery of Methanol, the Agreement shall automatically terminate without any compensation to either Party, unless extension of the Term of the Agreement is agreed in writing between Owner and BOO Operator.

30.5 In case of termination of the Agreement, the land lease shall automatically stand cancelled and the BOO Operator shall lose all rights to use and/or occupy the leased land only to dismantle and remove the Production Plant (including all BOO Operator's fixtures, fittings, equipment and structures and constructions thereon) if Owner does not exercise the option to take-over provided in Article 30.3 hereof and handover the vacant land to Owner clear from all equipment, fixtures and construction whatsoever within 12 (twelve) months from the date of such termination. Should the BOO Operator fail to clear the leased land of all BOO Operator's plant, equipment, machinery, fixtures, fittings and constructions (excluding all foundations, concrete pads and footings, and all underground pipelines installed by the BOO Operator) within 12 (twelve) months from the date of termination of the Agreement, the same or such part thereof as has not been dismantled, removed or have not been taken away from the said land shall vest in Owner, free from any mortgage, charge, hypothecation, pledge, lien or other third party right or liability (including liability to or in respect of any workmen, staff or personnel, technology licensors) and free of any cost or liability to compensate the BOO Operator in respect thereof.

30.6 Further, In the event of termination on account of BOO Operator's default as specified in Article 30.2 hereof or for Force Majeure conditions under Article 31 hereof, during the period of Agreement, Owner shall have the option of taking over the Production Plant free from any mortgage, charge, hypothecation, pledge, lien or other third party right or liability (Including

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liability to or in respect of any workmen, staff or personnel) and free of any cost of any technology licenses or liability to compensate the BOO Operator in respect thereof at fair value by (should be only in case of force majeure) giving the BOO Operator at the time of issue of the notice of termination written notice of such takeover. Should the Parties be not able to agree on such value within 2 (two) months, such issue shall be resolved through arbitration. However, such Agreement/arbitration shall not affect the takeover of the Production Plant by Owner.

- 30.6.1 Also, on exercise by Owner of the right of takeover, the BOO Operator shall continue providing assistance to Owner in operation and maintenance of the Production Plant for a period of 6 (six) months after the takeover, the cost of which shall be reimbursed by Owner to BOO Operator during the above period. In case BOO Operator, on account of takeover of the Production Plant by Owner opts for arbitration, Owner shall pay BOO Operator 50% (one half) of the monthly Fixed Monthly Charges which would have been payable but for the takeover as interim payment for the balance of the contract duration or settlement of arbitration, whichever occurs earlier. The interim payment(s) made by Owner to the BOO Operator shall be adjusted from the fair value awarded by the Arbitrator(s).
- 30.6.2 The BOO Operator shall co-operate with Owner to ensure a smooth and complete takeover of the Production Plant by Owner as here in contemplated.
- 30.7 In the event of termination on account of BOO Operator's default under Article 30.1 & 30.2 above, Owner will have the option to forfeit the security deposit/performance bank guarantee of the BOO Operator, if applicable. In such event, Owner will take over the Production Plant on an "as is where is" basis free from any mortgage, charge, hypothecation, pledge, lien or other third party right or liability (including liability to or in respect of any workmen, staff or personnel, technology licensors) and free of any cost or liability to compensate the BOO Operator in respect thereof and complete the Production Plant to meet its requirement of Methanol. The fair value of the plant in the event of termination would be as per methodology set forth in Article 30.6 above. Should the Parties not be able to agree on such compensation, the issue shall be resolved through arbitration.
- 30.8 Except as stated in Article 30.4, neither party shall terminate this agreement in case a) the reason for the other parties breach is of a nature that can't be remedied within 15 (fifteen) days of intimation of breach b) the breaching party has submitted a detailed mutually agreed remediation plan including a reasonable time table for completion and; c) the party in breach is diligently carrying out the remediation plan and is providing progress reports to the other party on a weekly basis.

ARTICLE- 31: FORCE MAJEURE

- 31.1 As used in this Agreement, the expression "Force Majeure" or "Force Majeure Event" shall, save and except as expressly provided otherwise, mean occurrence in India of any or all of Non-Political Event, Indirect Political Event and Political Event, as defined below, if it affects the performance by the Party claiming the benefit of Force Majeure (the "Affected Party") of its obligations under this Agreement and which act or event (a) is beyond the reasonable control of the Affected Party, and (b) the Affected Party could not have prevented or overcome by exercise of due diligence and following standard industry practice, and (c) has Material Adverse Effect on the Affected Party:
- (i) Non-Political Event

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A Non-Political Event shall mean one or more of the following acts or events:

- (A) act of God, epidemics, pandemics, outbreak of diseases (including the COVID-19 virus), quarantines, national or regional emergencies, government acts or orders (which a Party is not responsible for), extremely adverse weather conditions, natural disaster, floods, war, lightning, earthquake, landslide, cyclone, flood, volcanic eruption, chemical or radioactive contamination or ionising radiation, fire or explosions (to the extent of contamination or radiation or fire or explosion originating from a source external to the Project site);
- (B) strikes or boycotts or stoppage of work or 'bandh' (other than those involving the BOO Operator or their employees/ representatives, or attributable to any act or omission of any of them) interrupting supplies and services to the Project for a continuous period of 24 (twenty four) hours and an aggregate period exceeding 7 (seven) days in a financial year, and not being an Indirect Political Event;
- (C) any judgment or order of any court of competent jurisdiction or statutory authority made against the BOO Operator in any proceeding for reasons other than (i) on account of breach of any Applicable Law or Applicable License or any contract, or (ii) enforcement of this Agreement, or (iii) exercise of any of its rights under this Agreement by the Owner;
- (D) the discovery of geological conditions, toxic contamination or archaeological remains on the Site that could not reasonably have been expected to be discovered through inspection of the Site; or
- (E) any event or circumstances of a nature analogous to any of the foregoing.
- (ii) Indirect Political Event

An Indirect Political Event shall mean one or more of the following acts or events:

- (A) an act of war (whether declared or undeclared), invasion, armed conflict or act of foreign enemy, blockade, embargo, riot, insurrection, terrorist or military action, civil commotion or politically motivated sabotage;
- (B) industry-wide or State-wide strikes or industrial action for a continuous period of 24 (twenty four) hours and exceeding an aggregate period of 7 (seven) days in a financial year;
- (C) any civil commotion, boycott or political agitation which prevents Works by the BOO Operator for an aggregate period exceeding 7 (seven) days in a financial year;
- (D) any Indirect Political Event that causes a Non-Political Event; or
- (E) any event or circumstances of a nature analogous to any of the foregoing.

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(iii) Political Event

A Political Event shall mean one or more of the following acts or events by or on account of any Government authority:

- (A) any change in Law, only if consequences thereof cannot be dealt with under and in accordance with the provisions of this Agreement;
- (B) compulsory acquisition in national interest or expropriation of Project assets or rights of the BOO Operator;
- (C) unlawful or unauthorised or without jurisdiction, revocation of, or refusal to renew or grant without valid cause, any clearance, licence, permit, authorisation, no objection certificate, consent, approval or exemption required by the BOO Operator to perform their obligations under this Agreement; provided that such delay, modification, denial, refusal or revocation did not result from the BOO Operator's inability or failure to comply with any condition relating to grant, maintenance or renewal of such clearance, licence, authorisation, no objection certificate, exemption, consent, approval or permit; or
- (D) any event or circumstance of a nature analogous to any of the foregoing.

31.2 Effects of Force Majeure Events

Subject to the provisions of the Agreement, in the event that a Party is rendered unable, by reason of event of Force Majeure affecting the Party after the date hereof to perform wholly or in part any material obligation of that Party set forth in the Agreement the obligations of both Parties shall be suspended or excused to the extent affected by such Force Majeure.

31.3 Notice

Upon the occurrence of an event of Force Majeure, the affected Party shall notify the other Party in writing within 72 (seventy two) hours of the alleged beginning thereof giving full particulars, its estimated duration of Force Majeure event and satisfactory evidence in support of its claim, and notwithstanding the prior commencement of the force majeure event, the force majeure event shall be deemed to have occurred not earlier than 72 (seventy two) hours after the other Party receives the notice of the force majeure.

31.3.1 Upon cessation of the event of Force Majeure, the affected Party shall forthwith give written notice of such cessation to the other Party and shall as soon as reasonably possible, resume performance of its obligations suspended by the forcemajeure.

31.4 Actions consequent upon forcemajeure

31.4.1 The affected Party shall:

- (a) Use reasonable endeavours to minimize the effects of Force Majeure and remedy any inability to perform due to Force Majeure.
- (b) Provide daily reports to the other Party regarding its progress in overcoming the adverse affects of the Force Majeure.

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- (c) As soon as reasonably practicable, provide the other Party in writing such information as may be reasonably required to justify the claim of Force Majeure.
- (d) If the BOO Operator's Production Plant is in whole or part damaged or destroyed due to the Force Majeure event, the BOO Operator shall forthwith take all steps necessary to repair, restore and/or replace the BOO Operator's Production Plant to make it operational and productive as soon as is reasonably possible. BOO Operator shall ensure to take all steps reasonably required to restore its ability to perform its obligations under the Agreement as soon as is reasonably possible, including the rebuilding of any affected part of the Production Facility provided that the affected BOO Operator shall not be obliged to take any steps which would not be in accordance with Good Industry Practice.

31.4.2 Upon the occurrence of the Force Majeure, both parties shall promptly meet to discuss in good faith the effect and the likely duration of the effect of the Force Majeure and the steps to be taken to overcome the effects of the Force Majeure and the remedial actions to be taken by the other Party to mitigate the effects of the Force Majeure on the BOO Operator's Production Plant or relative Owner's plant(s) as the case maybe.

31.5 Continuation of Force Majeure

If the duration of the Force Majeure is uncertain or exceed 6 (six) months, Owner and BOO Operator will each have the right to terminate the Agreement unless mutual Agreement is reached otherwise.

31.6 Monetary Obligations during Force Majeure

No amounts shall be payable in respect of Events or circumstances which are covered by Force Majeure Events. If there is Force majeure at Owner's premises and Owner is unable to consume Requested quantity of Methanol then Owner will also not pay any penalty to BOO Operator.

31.7 In the event that Production in BOO Operator's Production Plant or Owner plant is suspended on account of Force Majeure, the duration of Agreement shall be extended by such period as mutually agreed between Owner and BOO Operator so that BOO Operator can recover the shortfall in Fixed Monthly Charges due to such Force Majeure, provided that the Agreement is not terminated as a result of such Force majeure in accordance with the provisions of the Agreement.

ARTICLE-32 – ARBITRATION

32.1 Any Dispute which is not resolved amicably by conciliation, as provided in Article 44.2, shall be finally decided by reference to fast track arbitration under the International Centre for Alternative Dispute Resolution, New Delhi (the "**Rules**") and shall be subject to the provisions of the Arbitration and Conciliation Act, 1996, as amended from time to time. The place of such arbitration shall be Kolkata, and the language of arbitration proceedings shall be English.

32.2 There shall be an arbitral tribunal comprising 3 (three) arbitrators, of whom each Party shall select one, and the third arbitrator shall be appointed by the 2 (two) arbitrators so selected, and in the event of disagreement between the 2 (two) arbitrators, the appointment shall be made in accordance with the Rules.

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- 32.3 The venue of the arbitration shall be Kolkata. The language of arbitration shall be English.
- 32.4 The arbitral tribunal shall make a reasoned award (the "Award"). Any Award made in any arbitration held pursuant to this Article shall be final and binding on the Parties as from the date it is made, and the Mine Operator and the Owner agree and undertake to carry out such Award without delay.
- 32.5 The BOO Operator and the Owner agree that an Award may be enforced against the BOO Operator and/or the Owner, as the case may be, and their respective assets wherever situated.
- 32.6 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.
- 32.7 The existence of any dispute or arbitration shall not operate as a suspension or discharge of any rights or obligations of Owner or BOO Operator under the Contract Documents.
- 32.8 The termination of the Agreement shall not result in the termination of any arbitration proceeding pending at the time of such termination nor otherwise affect the rights and obligations of the Parties under or with respect to such pending arbitration.

ARTICLE- 33 : REPRESENTATIONS AND WARRANTIES

33.1 OWNER 's Representations and Warranties

Owner represents and warrants as to itself that:

- (a) It is duly organised and validly existing entity under the laws of India and has all requisite legal right, power and authority to execute and deliver the Agreement and all the Agreements to which it is a Party and to carry out the terms, conditions and provisions hereof and thereof.
- (b) The execution, delivery and performance by it of the Agreement and all of the Agreements and documents referred to herein to which it is a Party have been duly authorised by all requisite corporate action, and will not contravene any provisions of, or constitute a default under, any other Agreement or instrument to which it is a party. The execution, delivery and performance by it of the Agreement and all of the Agreements and documents referred to herein to which Owner is a Party does not constitute a violation of any statute, judgment order, degree or regulation or rule of any court, government authority or arbitrator of competent jurisdiction applicable or relating to Owner , its assets or its business; and
- (c) The Agreement constitutes its valid, legal and binding obligation, enforceable in accordance with the terms hereof except that the enforceability thereof may be limited by applicable bankruptcy, insolvency, reorganisation, moratorium or other similar Law affecting Owner's rights generally and except to the extent that the remedies of specific performance, injunctive relief and other forms of equitable relief are subject to

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equitable defences, the discretion of the court before which any proceeding thereof may be brought and the principles of equity ingeneral.

33.2 BOO Operator's Representation and Warranties

The BOO Operator represents and warrants as to itself that:

- (a) It is duly organised and validly existing entity under the laws of India. It has complied with the requirements of all applicable laws and all requisite legal right, power and authority to execute and deliver the Agreement and all the Agreements and documents referred to herein to which it is a Party and to carry out the terms, conditions and provisions hereof and thereof.
- (b) The execution delivery and performance by it of the Agreement and all of the Agreements and documents referred to herein to which it is a Party have been duly authorised by all requisite corporate action, and will not contravene any provisions of, or constitute a default under, any other Agreement or instrument to which it is a party . The execution, delivery and performance by it of the Agreement and all of the Agreements and documents referred to herein to which the BOO Operator is a Party does not constitute a violation:-
 - (i) of any statute, judgment order, degree or regulation or rule of any court, government authority or arbitrator of competent jurisdiction applicable or relating to the BOO Operator, its assets or its business;

OR

- (ii) the BOO Operator articles, constituting documents or any indenture, Agreement or Agreement to which it is a party or by which it or its property is bound.
- (c) The Agreement constitutes its valid, legal and binding obligation, enforceable in accordance with the terms hereof except that the enforceability thereof may be limited by applicable bankruptcy, insolvency, reorganization, moratorium or other similar Law affecting BOO Operator's rights generally and except to the extent that the remedies of specific performance, injunctive relief and other forms of equitable relief are subject to equitable defences, the discretion of the court before which any proceeding thereof may be brought and the principles of equity in general.
- (d) There are no attachments or warrants served on it, in respect of GST, income tax, Central Govt. revenues or any other State Government of India revenues, any other taxes and dues, that might materially adversely affect its ability to meet and carry out its obligations under the Agreement.
- (e) There are no actions, suits of proceeding pending or, to its knowledge threatened against or affecting the BOO Operator, before any court or administrative body or arbitral tribunal that might materially adversely affect its ability to meet and carry out its obligations under the Agreement.
- (f) 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 there under, including any obligation, liability or responsibility hereunder.
- (g) The information furnished in the Bid and as updated on or before the date of this Agreement is true and accurate in all respects as on the date of this Agreement.

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- (h) It has no knowledge of any violation or default with respect to any order, writ, injunction or decree of any court or Government body which results in or may result in a Material Adverse Effect 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.
- (i) It has complied with Applicable Laws 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.
- (j) No sums, in cash or kind, have been paid or will be paid, by it or on its behalf, to any person by way of fees, commission or otherwise for securing the Agreement or entering into this Agreement or for influencing or attempting to influence any officer or employee of the Owner in connection therewith.
- (k) It is aware of the restrictions on procurement from a “bidder from a country which shares a land border with India”, as defined and specified under the General Financial Rules, 2017 read with the OM no. F.No.6/18/2019-PPD dated 23 July 2020 issued by the Public Procurement Division, Department of Expenditure, Ministry of Finance, Government of India (“Indian Public Procurement Laws”) and represents and warrants that it is not incorporated or registered in a country which shares a land border with India and is eligible to be considered, in terms of the Indian Public curement Laws] OR [is incorporated or registered in a country which shares a land border with India and is registered with the competent authority, as prescribed under the Indian Public Procurement Laws.
- (l) It is not in default under any Agreement to which it is a party or by which it or its property may be bound, nor in any material default of any obligation under the Agreement and all of the Agreements and documents referred to herein to which it is a Party.

33.3 In the event that any occurrence or circumstance comes to the attention of either Party that renders any of its aforesaid representations or warranties untrue or incorrect, such Party shall immediately notify the other Party of the same. Such notification shall not have the effect of remedying any breach of the representation or warranty that has been found to be untrue or incorrect nor shall it adversely affect or waive any right, remedy or obligation of either Party under Contract Documents.

ARTICLE- 34: BREACH OF TERMS

Should either Owner or BOO Operator hereto commit breach of any of the terms of the Agreement and in any such case the other party, shall be entitled, without incurring any liability what-so-ever, to fore-bear from doing such acts or fulfilling such obligations as are to be done or fulfilled by it hereunder until the party committing breach of terms herein makes good the said breach.

ARTICLE-35: STATUTORY APPROVAL

35.1 The BOO The BOO Operator at its sole cost and expenses shall acquire and maintain all requisite Licenses for the performance of its obligations under the Agreement, including but not limited to the following:

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- a) environmental clearances from central and state pollution control boards, GOI and Government of West Bengal State as the case maybe.
- b) Environmental clearances from Ministry of Environment & Forest & Climate Change (MOEFCC) , GOI if required.
- c) clearance for effluent discharge approval by concerned department, Government of West Bengal State (if applicable).
- d) Any other necessary approval other than mentioned above are to be obtained by the BOO Operator.

35.2 The BOO Operator shall obtain all necessary clearances(s), License(s) and will renew them, wherever applicable, from time to time as required by the statutory bodies of State Government & Government of India such as Factory Inspector, Boiler Inspector, Chief Controller of Explosives, Chief Electrical Inspector, Central Electricity Authority (CEA)etc.

35.3 The BOO Operator shall comply with all Applicable Laws and procure and maintain all applicable Licenses (including renewals as required) in relation to labour, industrial and environmental matters from Factory Inspector, Boiler Inspector, Chief Controller of Explosives, Chief Electrical Inspector, Central Electricity Authority (CEA)etc. as may be required in the performance of its obligations under this Agreement.

35.4 The BOO Operator shall take all necessary steps for registration, obtaining License from the appropriate authority for owning the Production Plant under its own management.

ARTICLE-36 : CO-ORDINATION COMMITTEE

36.1 Authorised representative of Owner shall have overview of all problems during erection of the Production Plant whereas during Commissioning, stabilisation and operation of the project, BOO Operator shall nominate it's representative for sorting out day to day problems till completion of contractual time period. Frequency of such coordination meetings shall be mutually agreed.

ARTICLE- 37: JURISDICTION & GOVERNING LAW

37.1 Notwithstanding any other Court or Courts having jurisdiction to decide the question(s) forming the subject matter of the reference if the same had been the subject matter of a suit, any/all actions and proceeding arising out of or relative to the Contract Documents or any award arising there from, shall lie only in the Court of competent civil jurisdiction in the behalf at Kolkata (where the Contract Documents has been signed on behalf of Owner) and only said Court(s) shall have jurisdiction to entertain and try any such action(s) and/or proceeding(s) to the exclusion of all other Courts.

37.2 These Conditions of Contract shall be governed in all aspects by the law of the Republic of India, without application of the doctrine of Renvoi.

ARTICLE-38 : NOTICES

38.1 Subject Any notice or other communication to be given by any party to the other party under or in connection with the matters contemplated by this Agreement shall be in writing and shall:

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- (a) in the case of the BOO Operator, be given by facsimile or e-mail and by letter delivered by hand to the address given and marked for the attention of the person set out below or to such other person as the BOO Operator may from time to time designate by notice to the Owner; provided that notices or other communications to be given to an address outside the city specified in this sub-Article (a) may, if they are subsequently confirmed by sending a copy thereof by registered acknowledgement due, or by courier, be sent by facsimile or e-mail as the BOO Operator may from time to time designate by notice to the Owner:

Attention:

{Designation:

Address: Fax No: Email:}

- (b) in the case of the Owner, be given by facsimile or e-mail and by letter delivered by hand at the address given and marked to the attention of the person set out below with a copy delivered to the authority representative or such other person as the Owner may from time to time designate by notice to the BOO Operator; provided that if the BOO Operator does not have an office in the same city as the Owner, it may send such notice by facsimile or e-mail and by registered acknowledgement due, or by courier:

Attention:

{Designation:

Address:

Fax No:

Email:}; and

- (c) any notice or communication by a party to the other party, given in accordance herewith, shall be deemed to have been delivered when in the normal course of post it ought to have been delivered and in all other cases, it shall be deemed to have been delivered on the actual date of delivery; provided that in the case of facsimile or e-mail, it shall be deemed to have been delivered on the working day following the date of its delivery.

38.2 On award of the contract, both BOO Operator and Owner will communicate in writing each other's first point of contact for both operational and legal notices.

ARTICLE-39 :NON-ASSIGNABILITY

The contract and benefits and obligations thereof shall be strictly personal to the BOO Operator and it shall not on any account be assignable or transferable to a third party by the BOO Operator without having obtained in writing the prior approval of Owner. Notwithstanding anything to the contrary contained in this Agreement, the Owner may, after giving notice to the BOO Operator, assign and/ or transfer any of its rights and benefits and/or obligations under this Agreement to an assignee who is, in the reasonable opinion of the Owner, capable of fulfilling all of the Owner's then outstanding obligations under this Agreement and has the financial standing necessary for this purpose.

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ARTICLE-40 : PUBLICITY

Owner and BOO Operator will mutually agree as to the timing, form and content, prior to issuing any press release, advertisement or announcement, or otherwise making any public statement with respect to the transactions contemplated hereby, and will not issue any press release, advertisement or announcement or otherwise make any published statement concerning the transactions contemplated hereby to any third party prior to receiving written Agreement with respect thereto from the other party, except as may be required by law.

ARTICLE-41 : HEADINGS

- 41.1 Any headings contained in the Agreement are used only as a matter of convenience and reference and are in no way intended to define, limit, expand or describe the scope of the Agreement.
- 41.2 The singular includes the plural & vice versa.

ARTICLE-42 : WAIVER

- 42.1 No waiver by either Owner or BOO Operator of any default by the other in the performance of the Agreement (i) shall be effective unless recorded in a document duly executed by an authorised representative of such Party; (ii) shall operate or be construed as a waiver or any other or further default whether of a similar or different character; (iii) (c) shall not affect the validity or enforceability of this Agreement in any manner.
- 42.2 No failure or delay by Owner in enforcing any right or remedy of Owner in terms hereof or any obligation or liability of the BOO Operator in terms thereof shall be deemed to be a waiver of such right, remedy, obligation, or liability, as the case may be, by Owner and notwithstanding such failure or delay, Owner shall be, entitled at any time to enforce such right, remedy, obligation or liability, as the case maybe.
- 42.3 No failure of delay by the BOO Operator in enforcing any right or remedy of the BOO Operator in terms of the Agreement or any obligation or liability of Owner in terms thereof shall be deemed to be a waiver of such right, remedy, obligation, or liability, as the case may be, by the BOO Operator and notwithstanding such failure or delay, the BOO Operator shall be entitled at anytime to enforce such right, remedy, obligation or liability, as the case maybe.
- 42.4 The grant of additional time or order indulgence by one party to the other, or acceptance of any variation in performance, shall not constitute a waiver.

ARTICLE-43 : CONTRACT DOCUMENTS

- 43.1 The following Documents shall constitute the Contract documents, namely:
- a) Contract Agreement & Land Lease Agreement
 - a) The Notification of Award/Letter of Award.

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- b) The Detailed Letter of Acceptance (DLOA) including Statement of Agreed Variations, if any, and accepted Price-Schedule.
- c) Amendments, if any, issued to the Bidding Documents.
- d) Original Bidding Documents issued with its enclosures.
- e) Integrity Pact (IP) signed between the Owner and the Bidder/Contractor

To the extent there is any conflict between the above-mentioned documents, the terms of the Conditions of Agreement shall govern.

ARTICLE-44: ENTIRE CONTRACT

The Contract Documents mentioned in Article- 43 hereof embody the entire agreement between the parties hereto, and the parties declare that in entering into the Contract Documents they do not rely upon any previous representation, whether express or implied and whether written or oral, or any inducements, understanding or agreements of any kind not included within the Contract Documents and all prior negotiations, representations, contracts and / or agreements and understandings are hereby cancelled..

ARTIICLE-45: GENERAL PROVISIONS

- 45.1 The provisions made under the Agreement shall be applicable except where the context requires otherwise.
- 45.2 **Disclosure of Information and Right of Inspection:** Owner & BOO Operator shall furnish to each other all information reasonably requested in regard to the performances of their respective duties and obligations under the Agreement in such manner and form as Owner & BOO Operator may mutually determine from time to time. The BOO Operator shall permit representatives of Owner to inspect the Project during construction period on prior reasonable notice thereof.
- 45.3 **Amendments and Supplements:** All additions, supplements, amendments or variations to the Agreement shall be in writing and shall be signed by the duly authorized representatives of Owner & BOO Operator.
- 45.2 **Disclosure of Information and Right of Inspection:** OWNER & BOO OPERATOR shall
- 45.4 **Indemnity:**
- (a) The BOO Operator will indemnify, defend, save and hold harmless the Owner and its officers, servants, agents, and CIL owned and/or controlled entities/enterprises, (the "**Owner Indemnified Persons**") against any and all suits, proceedings, actions, demands and claims from third parties for any loss, damage, cost and expense of whatever kind and nature, whether arising out of any breach or default by the BOO Operator of any of its obligations under this Agreement or any related agreement or on account of any defect or deficiency in the provision of services to the Owner or from any negligence of the BOO Operator under any contract or tort or on any other ground whatsoever, except to the extent that any such suits, proceedings, actions, demands and claims have arisen due to any negligent act or omission, or breach or default of this Agreement on the part of the Owner Indemnified Persons.
 - (b) Without limiting the generality of the Article above, the BOO Operator shall fully indemnify, hold harmless and defend the Owner and the Owner Indemnified Persons from and against any and all loss and/or damages arising out of or with respect to:

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- (i) failure of the BOO Operator to comply with Applicable Laws and Licenses;
- (ii) payment of Taxes required to be made by the BOO Operator in respect of the income or other Taxes of the BOO Operator's contractors, suppliers and representatives; or
- (iii) non-payment of amounts due as a result of materials or services furnished to the BOO Operator or any of its contractors which are payable by the BOO Operator or any of its contractors.
- (c) Without limiting the generality of the provisions of this Article, the BOO Operator shall fully indemnify, hold harmless and defend the Owner Indemnified Persons from and against any and all suits, proceedings, actions, claims, demands, liabilities and damages which the Owner Indemnified Persons may hereafter suffer, or pay by reason of any demands, claims, suits or proceedings arising out of claims of infringement of any domestic or foreign patent rights, copyrights or other intellectual property, proprietary or confidentiality rights with respect to any materials, information, design or process used by the BOO Operator or by the BOO Operator's contractors in performing the BOO Operator's obligations or in any way incorporated in or related to the Project. If in any such suit, action, claim or proceedings, a temporary restraint order or preliminary injunction is granted, the BOO Operator shall make every reasonable effort, by giving a satisfactory bond or otherwise, to secure the revocation or suspension of the injunction or restraint order.

(d) Notice and contest of claims

In the event Owner Indemnified Person receives a claim or demand from a third party in respect of which it is entitled to the benefit of an indemnity under this Article (the "**Indemnified Party**") it shall notify the BOO Operator (the "**Indemnifying Party**") within 15 (fifteen) days of receipt of the claim or demand and shall not settle or pay the claim without the prior approval of the Indemnifying Party, which approval shall not be unreasonably withheld or delayed. In the event that the Indemnifying Party wishes to contest or dispute the claim or demand, it may conduct the proceedings in the name of the Indemnified Party, subject to the Indemnified Party being secured against any costs involved, to its reasonable satisfaction.

(e) Defense of claims

- (i) The Indemnified Party 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 such Party in respect of, resulting from, related to or arising out of any matter for which it is entitled to be indemnified hereunder, and reasonable costs and expenses thereof shall be indemnified by the Indemnifying Party. If the Indemnifying Party acknowledges in writing its obligation to indemnify the Indemnified Party in respect of loss to the full extent provided by this Article, the Indemnifying Party shall be entitled to assume and control the defence of such claim, action, suit or proceeding, liabilities, payments and obligations at its expense and through the counsel of its choice; provided it gives prompt notice of its intention to do so to the Indemnified Party and reimburses the Indemnified Party for the reasonable cost and expenses incurred by the Indemnified Party prior to the assumption by the Indemnifying Party of such defence. The Indemnifying Party shall not be entitled to settle or compromise any claim, demand, action, suit or proceeding without the prior written consent of the Indemnified Party, unless the Indemnifying Party provides such security to the Indemnified Party as shall be reasonably required

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by the Indemnified Party to secure the loss to be indemnified hereunder to the extent so compromised or settled.

- (ii) If the Indemnifying Party has exercised its rights under Article 45.4(d), the Indemnified Party shall not be entitled to settle or compromise any claim, action, suit or proceeding without the prior written consent of the Indemnifying Party (which consent shall not be unreasonably withheld or delayed).
- (iii) If the Indemnifying Party exercises its rights under Article 45.4(d), the Indemnified Party shall nevertheless have the right to employ its own counsel, and such counsel may participate in such action, but the fees and expenses of such counsel shall be at the expense of the Indemnified Party, when and as incurred, unless:
- (A) the employment of counsel by such party has been authorised in writing by the Indemnifying Party;
- (B) the Indemnified Party shall have reasonably concluded that there may be a conflict of interest between the Indemnifying Party and the Indemnified Party in the conduct of the defence of such action;
- (C) the Indemnifying Party shall not, in fact, have employed independent counsel reasonably satisfactory to the Indemnified Party, to assume the defence of such action and shall have been so notified by the Indemnified Party; or
- (D) the Indemnified Party shall have reasonably concluded and specifically notified the Indemnifying Party either:
- that there may be specific defences available to it which are different from or additional to those available to the Indemnifying Party; or
 - that such claim, action, suit or proceeding involves or could have a Material Adverse Effect upon it beyond the scope of this Agreement:

Provided that if sub-Articles (B), (C) or (D) of this sub-Articles shall be applicable, the counsel for the Indemnified Party shall have the right to direct the defence of such claim, demand, action, suit or proceeding on behalf of the Indemnified Party, and the reasonable fees and disbursements of such counsel shall constitute legal or other expenses hereunder.

45.5 **No Third party Beneficiaries:** The Agreement is intended solely for the benefit of the Parties. Nothing in the Agreement shall be construed to create any duty to, standard of care with respect to, any liability to, or any right of suit or action in, any third party.

45.6 **Severability:** If for any reason whatever, any provision of this Agreement is or becomes invalid, illegal or unenforceable or is declared by any court of competent jurisdiction or any other instrumentality to be invalid, illegal or unenforceable, the validity, legality or enforceability of the remaining provisions shall not be affected in any manner, and the Parties will negotiate in good faith with a view to agreeing to one or more provisions which may be substituted for such invalid, unenforceable or illegal provisions, as nearly as is practicable to such invalid, illegal or unenforceable provision.

	<p style="text-align: center;">COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS</p> <p style="text-align: center;">CONDITIONS OF CONTRACT</p>	PNMM/PC-176/E- 4001/6.0	0	
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- 45.7 **Relationship of the Parties:** The Agreement shall not constitute either Party as a Partner, agent or legal representative of the other Party. Neither Party shall have any right or authority to assume, create or incur any liability or obligation of any kind, expressed or implied, against, in the name of or on behalf of the other Party except in accordance with the Agreement or as may otherwise be agreed in writing by the Parties.
- 45.8 **Governing Language:** The language which governs the interpretation of the Agreement is the English language. All Notices required to be given by either Party to the other and all other communications and documentation which are in any way relevant to the Agreement or which are relevant to the execution and implementation of the Agreement, including any dispute resolution proceedings, shall be in English language.
- 45.9 **Counterparts:** The Agreement may be executed in two counterparts, each of which when executed and delivered shall constitute an original, but both counterparts shall together constitute but one and the same instrument.
- 45.10 **General Liability Provision:** The rights and obligations of the parties are finally and conclusively defined in the Agreement. Claims for indirect, remote or consequential damages such as loss of production, loss of profit, loss of use are excluded.
- 45.11 **Successors and Assigns:** The Agreement shall be binding upon, and inure to the benefit of the Parties and their respective successors and permitted assigns.
- 45.12 **No Partnership:** The Agreement shall not be interpreted or construed to create an association, joint venture or partnership between the Parties, or to impose any partnership obligation or liability upon either Party, and neither Party shall have any right, power or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party.
- 45.13 **Waiver of Immunity:** Each Party unconditionally and irrevocably:
- (a) agrees that the execution, delivery and performance by it of this Agreement constitute commercial acts done and performed for commercial purpose;
 - (b) agrees 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 Party with respect to its assets;
 - (c) waives any right of immunity which it or its assets, property or revenues now has, may acquire in the future or which may be attributed to it in any jurisdiction; and
 - (d) consents generally, in respect of the enforcement of any judgment or award against it in any such proceedings and to the giving of any relief or the issue of any process in any jurisdiction in connection with such proceedings (including the making, enforcement or execution against it or in respect of any assets, property or revenues whatsoever irrespective of their use or intended use of any order or judgment that may be made or given in connection therewith).

	<p align="center">COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS</p> <p align="center">CONDITIONS OF CONTRACT</p>	<p>PNMM/PC-176/E- 4001/6.0</p>	<p align="center">0</p>	
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ARTICLE-46: GOVERNMENT OF INDIA - EXCLUSION OF LIABILITY

Owner is an independent legal entity with power and authority to enter into contracts solely on its own behalf under the applicable laws of India and the general principles of contract law. BOO Operator expressly agrees and acknowledges that Owner is not an agent, representative or delegate of the Government of India and that the Government of India is not and shall not be liable for any acts, omissions, commissions, breaches or other wrongs arising out of the Agreement. BOO Operator hereby expressly waives, releases and foregoes any and all actions or claims, including cross claims, impleader claims or counter claims, against the Government of India arising out of the Agreement and covenants not to sue the Government of India for any manner of claim, cause of action or thing whatsoever arising out of or under the Agreement.

VOLUME-I, COMMERCIAL

SECTION 7.0

ANNEXURES

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS BID FORM	PNMM/PC-176/E-4001/ Annx-1.1	0	
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SUBJECT: : COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

Ref.: 1.Tender No.: _____ 2. Tender Id: _____

Dear Sir,

Sub: Tender No.

Ref.: 1. Tender No. _____ : 2. TenderId: _____

Dear Sir,

Sub: Tender No.

1. We _____ (Name of the Bidder) hereby represent that we have gone through and understood the Bidding Documents, NIT NO:PNMM/PC-176/E-4001 DATED.....2020 (including but not limited to) the Commercial & Technical Requirements/ Specifications in Volume-I Commercial and Volume-II-Technical of the Bidding documents and amendments, if any, and that our Bid has been prepared accordingly in compliance with the requirements stipulated in the said documents.
2. We confirm to accept all terms and conditions contained in the tender document unconditionally and to be abide by the same in all respect.
3. We confirm to accept that the bid is being submitted in accordance with the terms, conditions and instructions of NIT documents, after verifying all the facts relating to contract and Scope of Works and after being fully aware of the terms and conditions of NIT documents and being fully satisfied to the same.
4. We confirm to accept that the terms and conditions of this NIT including its implementation and the decision of CIL will not be challenged . We have perused the terms and conditions of NIT before submitting bid and submitted the bid after accepting the same in all respect.
5. We agree to abide by this bid for a period of 9 (nine) months from the date of technical and Unpriced bid opening and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
6. We confirm that until a formal contract is prepared and executed, this bid together with your written acceptance thereof and your Notification of Award/Letter of intent, shall constitute a binding contract between us.
7. We understand that you are not bound to accept the lowest or any bid you may receive.
8. We confirm that the contents of the offer are given after fully understanding and

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all information furnished by us are correct and true and complete in every respect.

9. We confirm to accept that the work shall be done and completed within the stipulated time.
10. We confirm to accept that the price shall remain fixed and firm without any price variation due to any escalation in price as provided in NIT documents.
11. We confirm that all information/ documents / credentials submitted along with the tender are genuine, authentic, true and valid.
12. We confirm that if any information or document submitted is found to be false / incorrect forged/tampered in any way, the said offer shall be considered absolutely null & void and action as deemed fit may be taken against us including termination of the contract, forfeiture of all dues including EMD / Security Deposit and Banning of our firm along with all partners of the firm as per provisions of tender document/Purchase Manual of CIL/Provisions of law inforce.
13. We have never been banned or delisted by any Government or Quasi-Government Agency or any Public Sector Undertaking or Private Firm or Financial Institutions.

Dated this

_____ day



of _____ 2020 Signature _____

Name _____ Designation _____ Seal

Duly Authorised to sign bid for and on behalf of _____

Note:

1. This letter should be on the letterhead of the Bidder and should be signed by a person competent and having the authority to bind the Bidder as per Power of Attorney. Power of Attorney shall be submitted as per Cl. No.5.0 of ITB.
2. In case the person who has the Power of Attorney to sign the bid, is not bidding himself and has authorized another person whose DSC is mapped in the name of bidder, to bid online on his behalf, then the further authorization on non-judicial stamp paper duly notarized (as per [Annexure-1.8] by the person having the Power of Attorney to sign the Bid in favour of person bidding online is required to be submitted. In case of Consortium, similar authorization by each Consortium member is to be submitted.

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS PREAMBLE TO SCHEDULE OF RATE	PC-176/E-4001/P-I/ Annx-1.2	0	
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PREAMBLE TO SCHEDULE OF RATE/BOQ

1.0 Pricing formula for Products/Feed and Utilities

1.1 Feed (RoM Coal) and Utilities (Power and Raw Water) shall be provided free of cost to the Bidder during the execution of the Contract Agreement. Accordingly, bidders to quote the Conversion Charges of these Feed and utilities into Methanol.

1.2 Feed and Utilities

The supply of Feed and Utilities by Owner shall be considered at the following rates for evaluation. Bidder is required to quote Guaranteed Consumption figures of Feed & Utilities per MT of Methanol as detailed in Design basis, Technical Part of NIT. However, the same shall be supplied free of cost during execution of the Contract Agreement.

Sl. No.	Feed / Utility	Unit	Unit Rate
1.0	ROM COAL	MT	@ Rs 5127 /MT
2.0	POWER	kwh	@ Rs 5.77 per KWH
3.0	RAW WATER	m ³	@ Rs.4.50 /M³

1.3 Conversion Charges quoted by Bidder shall be exclusive of Taxes and Duties.

2.0 Bidders should submit bid in Indian Rupees only and receive payment in Indian Rupees only.

3.0 A copy of BOQ, uploaded by Bidder in the CPP Portal keeping price blank (hiding the price) and in place indicating "Quoted" or "√", as a confirmation of price quoted against each head, shall be submitted in Cover-2 Part-II of Bid.

4.0 Conversion Charges for Methanol:

The Conversion Charges shall comprise of the following two components ;

- a) Fixed Monthly Charge for Methanol;
- b) Variable charge per MT of Methanol

4.1 Fixed Monthly charge for Methanol



The Fixed Monthly charge shall have three components;

- 1) Constant amount (towards ROI of the BOO Operator);
- 2) Component related to WPI for manufactured Products (towards maintenance cost & other overheads).
- 3) Component related to CPI for industrial workers (towards manpower cost).

Fixed Monthly Charge shall be calculated on the basis of the following formula:

$$FMC_M = FMC_{BM} \times [X_{M_{ROI}} + X_{M_{WPI}} \times WPI_N / WPI_O] + (X_{M_{CPI}} \times CPI_N / CPI_O)$$

Where,

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS PREAMBLE TO SCHEDULE OF RATE	PC-176/E-4001/P-I/ Annx-1.2	0	
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FMC_M = Fixed Monthly Charge computed on account of Methanol delivered to Owner and will remain valid for that month, it will be released on pro-rata basis from first delivery date upto the end

of the month and thereafter on monthly basis every month (e.g. If the first delivery date is 15th January than FMC_M will be computed on pro-rata basis from 15th January to 31.01.2020.and from February onwards it will be computed in Calendar monthly basis)

FMC_{BM} = Base monthly charge as per the Letter of Award

XM_{ROI} = Constant Component on account of Return On Investment (which will not be adjusted due to inflation)

XM_{WPI} = Constant Component related to “Wholesale Price Index for Manufactured Products”

XM_{CPI} = Constant Component related to “Consumer Price Index for Industrial Labour”

WPI_N = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to Billing month or latest available as on that date.

WPI_O = Average Wholesale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date.

CPI_N = Average Consumer Price Index for Industrial workers as last declared by Reserve Bank of India for the month prior to billing month.

CPI_O = Consumer Price Index for Industrial workers for the month of Letter of Acceptance or last published month before LOA.

The Constant Component - XM_{ROI} , XM_{WPI} & XM_{CPI} to be quoted by the Bidder in the Schedule of Rate / BOQ .

The Bidder will quote FMC_{BM} , XM_{ROI} , XM_{WPI} and XM_{CPI} for Methanol in the Price Bid/BOQ,

Table-1: Table for values for Fixed Monthly charge for Methanol
(To be indicated in the Price Bid)

S.No	Price Factors	Values to be quoted by the Bidder	
1.0	FMC_{BM} (Rs./ Month)	To be indicated in the Schedule of Rate /BOQ	
2.0	XM_{ROI} (Note-1)		
3.0	XM_{WPI} (Note-1)		
4.0	XM_{CPI} (Note-1)		

Note:



$$XM_{ROI} + XM_{WPI} + XM_{CPI} = 100\%$$

4.2 Variable charge per MT of Methanol

$$\text{Variable Charge per MT of Methanol} = A_{BM} \times (WPI_N / WPI_O)$$

Where,

A_{BM} = is to be submitted in the Price Bid, as per Schedule of Rate /BOQ

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WPI_N = Average Wholesale Price Index as per RBI for Manufactured Products for the month prior to

Billing month or latest available as on that date.

WPI_O = Average Wholesale Price Index as per RBI for Manufactured Products for the month of submission of Bid or latest available as on that date.

Table-1: Table for values for Variable charge per MT of Methanol



S.No	Price Factors	Values to be quoted by the Bidder	
1.0	A_M (Rs./ MT of Methanol)	To be indicated in the Schedule of Rate /BOQ	



5.0 FEED & UTILITIES PROVIDED BY Owner

Bidder to indicate the Guaranteed Quantity of Feed & Utilities in the Price Bid


FEED & UTILITIES	QUANTITY
1. ROM Coal	To be indicated in the Schedule of Rate /BOQ
2. Power	
3. Raw Water	

Note : Values for Guaranteed Consumption Figures to be quoted upto 4th decimal place.

	<p>COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS</p> <p>PREAMBLE TO SCHEDULE OF RATE</p>	PC-176/E-4001/P-I/ Annx-1.2	0	
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1.0

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SUBJECT : COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

Note:

- 1) The Bidder shall submit reply to each query.
- 2) The Bidder's reply/ confirmation as furnished in the Commercial Questionnaire (CQ) shall supersede the stipulation mentioned else where in the bid.

Sl. No.	OWNER'S/PDIL'S QUERY	BIDDER'S REPLY / CONFIRMATION
1.	Complete Bidding Document and all technical and commercial amendments/addendums if any issued, digitally signed as a token of having received and read all parts of the bidding document and having accepted and considered the same in preparing their bid	
2.	Please confirm that all pages of the Bid have been signed and Stamped as per NIT requirement and numbered in sequential manner.	
3.	Please confirm that you have studied complete Bidding Document i.e. Technical and Commercial Part including PQ criteria (Volume-I, Commercial, Section-2.0), and your Bid is in accordance with the requirements of the Bidding Document.	
4.	Please confirm that PQC Documents/Bid, Techno-Commercial Bid has been submitted as specified in Clause 13.0 of Instructions to Bidders.	
5.	Please confirm that the Price Part does not include any terms and condition and Unpriced BOQ/ Schedule of Price, duly signed and stamped, and indicating "Quoted/Included" against each head has been submitted in Cover-2 In case any terms and condition is mentioned in the price part, the same shall be treated as null and void.	
6.	Please confirm your compliance to total scope of work mentioned in the Bidding Document.	
7.	Please confirm your acceptance for Time Schedule as mentioned in Instructions to Bidders.	
8.	Please confirm that your bid is valid for 9 (nine) months from the <u>date of opening of Technical and Unpriced commercial Bids.</u>	
9.	Please confirm EMD Validity for the period of Bid Validity plus 9 (nine) months.	
10.	Please confirm that the prices are quoted INR only.	

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC-176/E-4001/ Annx-1.3	0	
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Sl. No.	OWNER'S/PDIL'S QUERY	BIDDER'S REPLY / CONFIRMATION
11.	Please confirm that your Bid is substantially responsive to the requirements of the Bidding Document and you have not stipulated any material deviation and submitted all details as specified in the Bidding Document.	
12.	Please confirm that you have proposed adequate project / site organisation with qualified supervisory personnel having sufficient experience.	
13.	Please confirm that all costs resulting from safe execution of Work, such as safety induction, use of protective clothing, safety glasses and helmet, safety precaution taken during monsoon, or any other safety measures to be undertaken by the CONTRACTOR for execution of Work are considered.	
14.	Please confirm that all safety rules & regulations as mentioned in Bidding Document or notified at later date by Owner during execution shall be adhered by CONTRACTOR .	
15.	The safety measures as mentioned in Bidding Document shall not be considered as limitative. The CONTRACTOR will be required to develop their stringent safety measures and submit the same to Engineer-in - Charge with the provision of a dedicated safety group closely monitoring the construction activities in all workingshifts.	



For and on behalf of

Stamp & Signature :

Name :

Designation :

Date :

	COAL GASIFICATION BASED METHANOL PLANT COAL INDIA LIMITED	PNMM/PC-176/E-4001/ Annx-1.4	0	
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CONTENTS OF BID AND CHECK LIST				

SUBJECT : COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

Bidder is requested to fill this check list and ensure that all details /documents have been furnished under relevant section as called for in the Bidding Document duly filled in, signed & stamped.



Please mention (Submitted / Not Submitted) against each head under Bidders' Response and ensure compliance:

PART-I : Pre-Qualification Bid: (Refer Section 2.0 of Volume-I, COMMERCIAL)



Sl. No.	Description	Bidder's Response
i.	Letter of submission and synopsis of the proposal (Submitted / Not Submitted)	
ii.	Organization Profile (Submitted / Not Submitted)	
iii.	Article of Association of the Company or Board Resolution (Submitted / Not Submitted)	
iv.	Consortium Agreement as per Annexure-1.12 (if applicable). (Submitted / Not Submitted)	
v.	MOU/ letter of undertaking by the Process Licensor(s) (Submitted / Not Submitted)	
vi.	Exhibit-1 for Technology Criteria (Submitted / Not Submitted)	
vii.	Exhibit-2 for Experience Criteria (Submitted / Not Submitted)	
viii.	Exhibit-3 for Financial criteria (Submitted / Not Submitted)	
ix.	Solvency Certificate (Submitted / Not Submitted)	
x.	A declaration shall be submitted to the effect Bidder/JV/Consortium members shall not be under liquidation, court receivership or similar proceedings as per Annexure-1.13. (Submitted / Not Submitted)	
xi.	Power of Attorney of Bid Signatory as per Annexure-1.11 (Submitted / Not Submitted)	
xii.	Undertaking from TPIA as per Annexure-1.15. (Submitted / Not Submitted)	
xiii.	Format for Financial Details of Holding Company as per Annexure-1.22 (Submitted / Not Submitted)	

PART-II : Technical and Unpriced Commercial Bid:

<u>SECTION-I</u>		
i.	Bid Form as per Annexure-1.1 (Submitted / Not Submitted)	

	COAL GASIFICATION BASED METHANOL PLANT COAL INDIA LIMITED	PNMM/PC-176/E-4001/ Annx-1.4	0	
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CONTENTS OF BID AND CHECK LIST				

ii.	Preamble to SOR (BOQ / Price Bid/Price Schedule) as per annexure 1.2 (Submitted / Not Submitted)	
iii.	Commercial Questionnaire as per Annexure-1.3 (Submitted / Not Submitted)	
iv.	Contents of Bid and Check List as per Annexure-1.4. (Submitted / Not Submitted)	
v.	Format for BIDDER's queries for Pre Bid Discussion as per Annexure-1.5. (Submitted / Not Submitted)	
vi.	Letter of Waiver of Conditions/Deviations as per Annexure-1.6 (Submitted / Not Submitted)	
vii.	Bidder's Proposed Schedule as per Annexure-1.7 (Submitted / Not Submitted)	
viii.	Authorization to DSC Holder , if applicable as per Annexure-1.8. (Submitted / Not Submitted)	
ix.	A copy of BOQ, uploaded by Bidder in the Portal keeping price blank (hiding the price) and in place indicating "Quoted" or "✓", as a confirmation of price quoted against each head, shall be submitted. (Submitted / Not Submitted)	
x.	Certificate of Non-Involvement of Indian Agent as per Annexure-1.9 (Submitted / Not Submitted)	
xi.	Public Procurement (Preference To Make In India) Policy Undertaking as per Annexure 1.10. (Submitted / Not Submitted)	
xii.	Provision for Procurement from a Bidder which shares a land border with India as per Annexure1.23 (Submitted / Not Submitted)	
xiii.	Complete Bidding Document and all technical and commercial amendments/addendums if any issued, digitally signed as a token of having received and read all parts of the bidding document and having accepted and considered the same in preparing theirbid (Submitted / Not Submitted)	
<u>SECTION-II</u>		
i.	Technical Details/ documents specified under "Technical Information Required along with Bid". (Submitted / Not Submitted)	
iii.	Any other information required in the Bidding Documents or considered relevant by the Bidder. (Submitted / Not Submitted)	

	COAL GASIFICATION BASED METHANOL PLANT COAL INDIA LIMITED FORMAT FOR BIDDER'S QUERIES FOR PRE BID DISCUSSION	PNMM/PC-176/E-4001/ Annx- 1.5	0	
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SUBJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

SL. NO.	REFERENCE OF BIDDING DOCUMENT				BIDDER'S QUERY	OWNER'S / PMC REPLY
	Section	Page No.	Clause No.	Subject		

NOTE: The Pre-Bid Queries shall be sent through e-mail to prsahu@pdilin.com, anjali@pdilin.com, tanzin@pdilin.com, ssen2.cil@coalindia.in

For and on behalf of

Stamp & Signature :

Name :

Designation :

Date :

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS LETTER OF WAIVER OF CONDITIONS/DEVIATIONS	PNMM/PC-176/E-4001/Annx-1.6	0	
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(ON COMPANY'S LETTERHEAD)

SUBJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

(NIT NO : PNMM/PC-176/E-4001 DATED 24.09.2020)

We * hereby agree to fully comply with, abide by and accept without variation, deviation or reservation all technical, commercial and other condition whatsoever of the Bidding Documents and all Addenda / Corrigenda / Clarifications issued by Owner.

We further hereby waive, withdraw and abandon any and all deviations, variations, objections or reservations whatsoever hereto set out, given or indicated in our offer, clarifications, correspondence, communications, or otherwise with a view that the price bid submitted may be treated to conform to, in all respects, with the terms and conditions of the said tender documents including all Addenda / Corrigenda/Clarifications.

For and on behalf of*

Stamp&Signature** :



Name :

Designation :

Date :

* Here fill in the name of Bidder.

** The Letter of Waiver must be signed by the person (s) authorised to sign.

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC-176/E- 4001/Annx-1.7	0	
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SUBJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

BIDDER'S PROPOSED SCHEDULE

Bidder shall provide a bar-chart type schedule for the execution of the WORK and shall show the main activities with duration, their sequences, and the milestone events specified.

For and on behalf of :
Stamp & Signature :
Name :
Designation :
Date :

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC-176/E- 4001/Annx-1.8	0	
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**FORMAT FOR AUTHORISATION TO DSC HOLDER BIDDING ONLINE BY THE PERSON
WHO HAS SIGNED LETTER OF BID**

(On NON JUDICIAL STAMP PAPER)

We do hereby authorise M/s. /Mr..... Address.....
whose DSC is mapped in the name of the Bidder, for online bidding on behalf of us for Tender
No. Dated invited by CIL on <https://eprocure.gov.in/eprocure/app> (CPP e- tender portal).

Name, Signature & Seal of the person who has signed the Bidding Document and is Authorising
the DSC Holder for online bidding.

Name, Signature & Seal of the DSC Holder having DSC mapped in the name of the Bidder,
Authorised for online bidding

Signature & Seal of the PUBLIC NOTARY

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC-176/E- 4001/Annx-1.9	0	
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PROFORMA OF CERTIFICATE OF NON-INVOLVEMENT OF AGENT

Where Indian Agent/Consultant/Representative/Retainer/Associates is not involved, the Bidder shall certify in the proforma given below on its letterhead.

This is to certify that we have not engaged/involved any Indian agent/representative/consultant/retainer/Associates who is not our employee for the purposes of accompanying bid or any resultant contract and therefore, no Agent's/Retainer's/ representative's/consultant's/associate's commission is payable in India or abroad against or in connection with any resultant contract.

For and on behalf of

Stamp & Signature :

Name :

Designation :

Date :

No. P-45021/2/2017-PP (BE-II)
Government of India
Ministry of Commerce and Industry
Department for Promotion of Industry and Internal Trade
(Public Procurement Section)

Udyog Bhawan, New Delhi
Dated: 04th June, 2020

To

All Central Ministries/Departments/CPSUs/All concerned

ORDER

Subject: Public Procurement (Preference to Make in India), Order 2017– Revision; regarding.

Department for Promotion of Industry and Internal Trade, in partial modification [Paras 2, 3, 5, 9(a), 9(b) and 10(b) modified and Para 3A added] of Order No.P-45021/2/2017-B.E.-II dated 15.6.2017 as amended by Order No.P-45021/2/2017-B.E.-II dated 28.05.2018 and Order No.P-45021/2/2017-B.E.-II dated 29.05.2019, hereby issues the revised 'Public Procurement (Preference to Make in India), Order 2017" dated 04.06.2020 effective with immediate effect.

Whereas it is the policy of the Government of India to encourage 'Make in India' and promote manufacturing and production of goods and services in India with a view to enhancing income and employment, and

Whereas procurement by the Government is substantial in amount and can contribute towards this policy objective, and

Whereas local content can be increased through partnerships, cooperation with local companies, establishing production units in India or Joint Ventures (JV) with Indian suppliers, increasing the participation of local employees in services and training them,

Now therefore the following Order is issued:

1. This Order is issued pursuant to Rule 153 (iii) of the General Financial Rules 2017.
2. **Definitions:** For the purposes of this Order:

'Local content' means the amount of value added in India which shall, unless otherwise prescribed by the Nodal Ministry, be the total value of the item procured (excluding net domestic indirect taxes) minus the value of imported content in the item (including all customs duties) as a proportion of the total value, in percent.

'Class-I local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content equal to or more than 50%, as defined under this Order.

'Class-II local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content more than 20% but less than 50%, as defined under this Order.

.....Contd. p/2

'Non - Local supplier' means a supplier or service provider, whose goods, services or works offered for procurement, has local content less than or equal to 20%, as defined under this Order.

'L1' means the lowest tender or lowest bid or the lowest quotation received in a tender, bidding process or other procurement solicitation as adjudged in the evaluation process as per the tender or other procurement solicitation.

'Margin of purchase preference' means the maximum extent to which the price quoted by a "Class-I local supplier" may be above the L1 for the purpose of purchase preference.

'Nodal Ministry' means the Ministry or Department identified pursuant to this order in respect of a particular item of goods or services or works.

'Procuring entity' means a Ministry or department or attached or subordinate office of, or autonomous body controlled by, the Government of India and includes Government companies as defined in the Companies Act.

'Works' means all works as per Rule 130 of GFR- 2017, and will also include 'turnkey works'.

3. Eligibility of 'Class-I local supplier'/ 'Class-II local supplier'/ 'Non-local suppliers' for different types of procurement

(a) In procurement of all goods, services or works in respect of which the Nodal Ministry / Department has communicated that there is sufficient local capacity and local competition, only 'Class-I local supplier', as defined under the Order, shall be eligible to bid irrespective of purchase value.

(b) In procurement of all goods, services or works, not covered by sub-para 3(a) above, and with estimated value of purchases less than Rs. 200 Crore, in accordance with Rule 161(iv) of GFR, 2017, Global tender enquiry shall not be issued except with the approval of competent authority as designated by Department of Expenditure. Only 'Class-I local supplier' and 'Class-II local supplier', as defined under the Order, shall be eligible to bid in procurements undertaken by procuring entities, except when Global tender enquiry has been issued. In global tender enquiries, 'Non-local suppliers' shall also be eligible to bid along with 'Class-I local suppliers' and 'Class-II local suppliers'.

(c) For the purpose of this Order, works includes Engineering, Procurement and Construction (EPC) contracts and services include System Integrator (SI) contracts.

3A. Purchase Preference

(a) Subject to the provisions of this Order and to any specific instructions issued by the Nodal Ministry or in pursuance of this Order, purchase preference shall be given to 'Class-I local supplier' in procurements undertaken by procuring entities in the manner specified here under.

.....Contd. p/3

(b) In the procurements of goods or works, which are covered by para 3(b) above and which are divisible in nature, the 'Class-I local supplier' shall get purchase preference over 'Class-II local supplier' as well as 'Non-local supplier', as per following procedure:

- i. Among all qualified bids, the lowest bid will be termed as L1. If L1 is 'Class-I local supplier', the contract for full quantity will be awarded to L1.
- ii. If L1 bid is not a 'Class-I local supplier', 50% of the order quantity shall be awarded to L1. Thereafter, the lowest bidder among the 'Class-I local supplier' will be invited to match the L1 price for the remaining 50% quantity subject to the Class-I local supplier's quoted price falling within the margin of purchase preference, and contract for that quantity shall be awarded to such 'Class-I local supplier' subject to matching the L1 price. In case such lowest eligible 'Class-I local supplier' fails to match the L1 price or accepts less than the offered quantity, the next higher 'Class-I local supplier' within the margin of purchase preference shall be invited to match the L1 price for remaining quantity and so on, and contract shall be awarded accordingly. In case some quantity is still left uncovered on Class-I local suppliers, then such balance quantity may also be ordered on the L1 bidder.

(c) In the procurements of goods or works, which are covered by para 3(b) above and which are not divisible in nature, and in procurement of services where the bid is evaluated on price alone, the 'Class-I local supplier' shall get purchase preference over 'Class-II local supplier' as well as 'Non-local supplier', as per following procedure:

- i. Among all qualified bids, the lowest bid will be termed as L1. If L1 is 'Class-I local supplier', the contract will be awarded to L1.
- ii. If L1 is not 'Class-I local supplier', the lowest bidder among the 'Class-I local supplier', will be invited to match the L1 price subject to Class-I local supplier's quoted price falling within the margin of purchase preference, and the contract shall be awarded to such 'Class-I local supplier' subject to matching the L1 price.
- iii. In case such lowest eligible 'Class-I local supplier' fails to match the L1 price, the 'Class-I local supplier' with the next higher bid within the margin of purchase preference shall be invited to match the L1 price and so on and contract shall be awarded accordingly. In case none of the 'Class-I local supplier' within the margin of purchase preference matches the L1 price, the contract may be awarded to the L1 bidder.

(d) "Class-II local supplier" will not get purchase preference in any procurement, undertaken by procuring entities.

4. **Exemption of small purchases:** Notwithstanding anything contained in paragraph 3, procurements where the estimated value to be procured is less than Rs. 5 lakhs shall be exempt from this Order. However, it shall be ensured by procuring entities that procurement is not split for the purpose of avoiding the provisions of this Order.
5. **Minimum local content:** The local content requirement to categorize a supplier as 'Class-I local supplier'/ 'Class-II local supplier'/ 'Non-local supplier' shall be as defined in the Para "2" of the Order. No change is permissible on this account. However, if any nodal Ministry/ Department finds that for any particular item, pertaining to their nodal ministry/department, the definition of Local Content, as defined in the Order, is not workable/ has limitations, it may notify alternate suitable mechanism for calculation of local content for that particular item.
6. **Margin of Purchase Preference:** The margin of purchase preference shall be 20%.
7. **Requirement for specification in advance:** The minimum local content, the margin of purchase preference and the procedure for preference to Make in India shall be specified in the notice inviting tenders or other form of procurement solicitation and shall not be varied during a particular procurement transaction.
8. **Government E-marketplace:** In respect of procurement through the Government E-marketplace (GeM) shall, as far as possible, specifically mark the items which meet the minimum local content while registering the item for display, and shall, wherever feasible, make provision for automated comparison with purchase preference and without purchase preference and for obtaining consent of the local supplier in those cases where purchase preference is to be exercised.
9. **Verification of local content:**
 - a. The 'Class-I local supplier'/ 'Class-II local supplier' at the time of tender, bidding or solicitation shall be required to indicate percentage of local content and provide self-certification that the item offered meets the local content requirement for 'Class-I local supplier'/ 'Class-II local supplier', as the case may be. They shall also give details of the location(s) at which the local value addition is made.
 - b. In cases of procurement for a value in excess of Rs. 10 crores, the 'Class-I local supplier'/ 'Class-II local supplier' shall be required to provide a certificate from the statutory auditor or cost auditor of the company (in the case of companies) or from a practicing cost accountant or practicing chartered accountant (in respect of suppliers other than companies) giving the percentage of local content.
 - c. Decisions on complaints relating to implementation of this Order shall be taken by the competent authority which is empowered to look into procurement-related complaints relating to the procuring entity.

- d. Nodal Ministries may constitute committees with internal and external experts for independent verification of self-declarations and auditor's/ accountant's certificates on random basis and in the case of complaints.
- e. Nodal Ministries and procuring entities may prescribe fees for such complaints.
- f. False declarations will be in breach of the Code of Integrity under Rule 175(1)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for up to two years as per Rule 151 (iii) of the General Financial Rules along with such other actions as may be permissible under law.
- g. A supplier who has been debarred by any procuring entity for violation of this Order shall not be eligible for preference under this Order for procurement by any other procuring entity for the duration of the debarment. The debarment for such other procuring entities shall take effect prospectively from the date on which it comes to the notice of other procurement entities, in the manner prescribed under paragraph 9h below.
- h. The Department of Expenditure shall issue suitable instructions for the effective and smooth operation of this process, so that:
 - i. The fact and duration of debarment for violation of this Order by any procuring entity are promptly brought to the notice of the Member-Convenor of the Standing Committee and the Department of Expenditure through the concerned Ministry /Department or in some other manner;
 - ii. on a periodical basis such cases are consolidated and a centralized list or decentralized lists of such suppliers with the period of debarment is maintained and displayed on website(s);
 - iii. in respect of procuring entities other than the one which has carried out the debarment, the debarment takes effect prospectively from the date of uploading on the website(s) in the such a manner that ongoing procurements are not disrupted.

10. Specifications in Tenders and other procurement solicitations:

- a. Every procuring entity shall ensure that the eligibility conditions in respect of previous experience fixed in any tender or solicitation do not require proof of supply in other countries or proof of exports.
- b. Procuring entities shall endeavour to see that eligibility conditions, including on matters like turnover, production capability and financial strength do not result in unreasonable exclusion of 'Class-I local supplier'/ 'Class-II local supplier' who would otherwise be eligible, beyond what is essential for ensuring quality or creditworthiness of the supplier.
- c. Procuring entities shall, within 2 months of the issue of this Order review all existing eligibility norms and conditions with reference to sub-paragraphs 'a' and 'b' above.

- d. If a Nodal Ministry is satisfied that Indian suppliers of an item are not allowed to participate and/ or compete in procurement by any foreign government, it may, if it deems appropriate, restrict or exclude bidders from that country from eligibility for procurement of that item and/ or other items relating to that Nodal Ministry. A copy of every instruction or decision taken in this regard shall be sent to the Chairman of the Standing Committee.
- e. For the purpose of sub-paragraph 10 d above, a supplier or bidder shall be considered to be from a country if (i) the entity is incorporated in that country, or (ii) a majority of its shareholding or effective control of the entity is exercised from that country; or (iii) more than 50% of the value of the item being supplied has been added in that country. Indian suppliers shall mean those entities which meet any of these tests with respect to India."

10A. Action for non-compliance of the Provisions of the Order: In case restrictive or discriminatory conditions against domestic suppliers are included in bid documents, an inquiry shall be conducted by the Administrative Department undertaking the procurement (including procurement by any entity under its administrative control) to fix responsibility for the same. Thereafter, appropriate action, administrative or otherwise, shall be taken against erring officials of procurement entities under relevant provisions. Intimation on all such actions shall be sent to the Standing Committee.

11. Assessment of supply base by Nodal Ministries: The Nodal Ministry shall keep in view the domestic manufacturing / supply base and assess the available capacity and the extent of local competition while identifying items and prescribing minimum local content or the manner of its calculation, with a view to avoiding cost increase from the operation of this Order.

12. Increase in minimum local content: The Nodal Ministry may annually review the local content requirements with a view to increasing them, subject to availability of sufficient local competition with adequate quality.

13. Manufacture under license/ technology collaboration agreements with phased indigenization: While notifying the minimum local content, Nodal Ministries may make special provisions for exempting suppliers from meeting the stipulated local content if the product is being manufactured in India under a license from a foreign manufacturer who holds intellectual property rights and where there is a technology collaboration agreement / transfer of technology agreement for indigenous manufacture of a product developed abroad with clear phasing of increase in local content.

14. Powers to grant exemption and to reduce minimum local content: The administrative Department undertaking the procurement (including procurement by any entity under its administrative control), with the approval of their Minister-in-charge, may by written order, for reasons to be recorded in writing,

- a. reduce the minimum local content below the prescribed level; or
- b. reduce the margin of purchase preference below 20%; or

- c. exempt any particular item or supplying entities from the operation of this Order or any part of the Order.

A copy of every such order shall be provided to the Standing Committee and concerned Nodal Ministry / Department. The Nodal Ministry / Department concerned will continue to have the power to vary its notification on Minimum Local Content.

15. **Directions to Government companies:** In respect of Government companies and other procuring entities not governed by the General Financial Rules, the administrative Ministry or Department shall issue policy directions requiring compliance with this Order.

16. **Standing Committee:** A standing committee is hereby constituted with the following membership:

Secretary, Department for Promotion of Industry and Internal Trade—Chairman
Secretary, Commerce—Member
Secretary, Ministry of Electronics and Information Technology—Member
Joint Secretary (Public Procurement), Department of Expenditure—Member
Joint Secretary (DPIIT)—Member-Convenor

The Secretary of the Department concerned with a particular item shall be a member in respect of issues relating to such item. The Chairman of the Committee may co-opt technical experts as relevant to any issue or class of issues under its consideration.

17. **Functions of the Standing Committee:** The Standing Committee shall meet as often as necessary, but not less than once in six months. The Committee
 - a. shall oversee the implementation of this order and issues arising therefrom, and make recommendations to Nodal Ministries and procuring entities.
 - b. shall annually assess and periodically monitor compliance with this Order
 - c. shall identify Nodal Ministries and the allocation of items among them for issue of notifications on minimum local content
 - d. may require furnishing of details or returns regarding compliance with this Order and related matters
 - e. may, during the annual review or otherwise, assess issues, if any, where it is felt that the manner of implementation of the order results in any restrictive practices, cartelization or increase in public expenditure and suggest remedial measures
 - f. may examine cases covered by paragraph 13 above relating to manufacture under license/ technology transfer agreements with a view to satisfying itself that adequate mechanisms exist for enforcement of such agreements and for attaining the underlying objective of progressive indigenization
 - g. may consider any other issue relating to this Order which may arise.

18. **Removal of difficulties:** Ministries /Departments and the Boards of Directors of Government companies may issue such clarifications and instructions as may be necessary for the removal of any difficulties arising in the implementation of this Order.

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19. **Ministries having existing policies:** Where any Ministry or Department has its own policy for preference to local content approved by the Cabinet after 1st January 2015, such policies will prevail over the provisions of this Order. All other existing orders on preference to local content shall be reviewed by the Nodal Ministries and revised as needed to conform to this Order, within two months of the issue of this Order.
20. **Transitional provision:** This Order shall not apply to any tender or procurement for which notice inviting tender or other form of procurement solicitation has been issued before the issue of this Order.





(Rajesh Gupta)

Director

Tel: 23063211

rajesh.gupta66@gov.in



	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS	PNMM/PC-176/E-4001/Annx-1.10	0	
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Annexure-1.10

PUBLIC PROCUREMENT (PREFERENCE TO MAKE IN INDIA) POLICY

Salient Points

Sr.	Description	Parameter / Document
1	Minimum Local Content (LC) for Availing Preference under this Policy	50%
2	Margin of Purchase Preference	20%
3	Local Content (LC) % declared by bidder (Documents to be submitted as per Sr. No. 4 below)	[Tick (✓) whichever is applicable] a) LC Equal to or more than 50% <input type="checkbox"/> b) LC More than 20% but less than 50% <input type="checkbox"/> c) LC Equal to or less than 20% <input type="checkbox"/>
4	Documents to be submitted by bidder for availing Purchase Preference under this Policy	Certificate from the statutory auditor or cost auditor of the company (in case of companies) or from a practicing cost accountant or practicing chartered accountant as per <u>Form-1 (enclosed)</u> to be submitted by bidder having Local content % more than or equal to 50%.
5	Whether tender is divisible or not divisible	Not Divisible; Clause No. 3A (c) of revised Policy dated 04.06.2020 shall be applicable

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FORM – 1

CERTIFICATE FROM STATUTORY AUDITOR OR COST AUDITOR OF THE COMPANY (IN THE CASE OF COMPANIES) OR FROM A PRACTICING COST ACCOUNTANT OR PRACTICING CHARTERED ACCOUNTANT (IN RESPECT OF SUPPLIERS OTHER THAN COMPANIES) TOWARDS MINIMUM LOCAL CONTENT

(TO BE SUBMITTED BY BIDDER HAVING LOCAL CONTENT EQUAL TO OR MORE THAN 50%)

To,

M/s COAL INDIA LIMITED,
Coal Bhawan, Action Area-1A,
New Town,
Kolkata - 700 156 (W.B.)

SUB:

TENDER NO:

Dear Sir

A. We the Statutory Auditor / Cost Auditor / Practicing Cost Accountant / Practicing Chartered Accountant) have verified relevant records of M/s **(Name of the bidder)** and certify that M/s **(Name of the bidder)** meet the mandatory minimum Local content requirement of 50% specified in tender document no..... for claiming purchase preference under Public Procurement (Preference to Make in India) Policy.

B. The **details of the location** at which the local value addition is made as follows:

Item Description	Details of the Location(s) where the local value addition is made

Name of Audit Firm / Chartered Accountant:

[Signature of Authorized Signatory]

Date:

Name:
Designation:
Seal:
Membership No.:
UDIN:

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**POWER OF ATTORNEY (POA)
(To be submitted on the Non-Judicial stamp paper)**

Bid NO:
Description of work:

Name of Bidder: _____

“The undersigned _____ (Name of LEGAL PERSON, i.e. CEO/C&MD/Company Secretary/Partners) is lawfully authorized to issue this POA* on behalf of the company M/s _____ (Name of bidder) whose registered address is _____ and does hereby appoint Mr./Ms _____ (name of authorized person signing the bid document) _____ (Designation) of _____ M/s _____ (Name of bidder) whose signature appears below to be the true and lawful attorney/(s) and authorize him/her to sign the bid (both physically & digitally on CPP Portal), conduct negotiation, sign contracts and execute all the necessary matter related thereto, in the name and on behalf of the company in connection with the PQ no. _____.

The signature of the authorized person/(s) herein constitutes unconditional obligations of M/s _____ (Name of bidder). This Power of Attorney (POA) shall remain valid and in full force and effect before we withdraw it in writing (by fax, or mail or post). All the documents signed (within the period of validity of the Power of Attorney) by the authorized person herein shall not be invalid because of such withdrawal.

- (*)
- (I) In case of a single Bidder, the power of Attorney shall be issued as per the constitution of the bidder as below.
- a) **In case of Proprietorship:** By Proprietor
 - b) **In case of Partnership:** by all Partners or Managing Partner.
 - c) **In case of Limited Liability Partnership:** by any bidder's employee authorized in terms of Deed of LLP.
 - d) **In case of Public /Limited Company:** POA in favour of authorized employee(s) by Board of Directors through Board Resolution or by the designated officer authorized by Board to do so. Such Board Resolution should be duly countersigned by Company Secretary / MD / CMD / CEO.

SIGNATURE OF THE LEGAL PERSON

(Name of person with Company Seal)

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(Format for Consortium Agreement)

(Following Consortium Agreement is for Execution on Non-Judicial Stamp Paper of Rs.100/-)

THIS CONSORTIUM AGREEMENT ("CA") is made at (Place)____on thisday of__(month) of 2020 amongst:-

- 1) M/S----- incorporated under the Laws of, ----- with its Registered Office at-----, (hereinafter referred to as "Lead Bidder/Member-I" which expression shall, unless repugnant to the context or meaning thereof, include its successors and permitted assigns); AND
- 2) M/S ----- incorporated under the Laws of, ----- with its Registered Office at,----- (hereinafter referred to as "Consortium Member-II/Member-II" which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns); AND
- 3) M/S-----incorporatedundertheLaws of-----withitsRegisteredOfficeat,----- (hereinafter referred to as "Consortium Member-III/Member-III)" which expression shall, unless repugnant to the context or meaning thereof, include its successors and permitted assigns); AND

Note: (Hereinafter wherever reference or context requires "Lead Bidder/Member-I" and "Consortium Members (II/III)" are collectively referred to as "PARTIES" and "PARTY" shall mean any member of the Consortium (Member I / Member II / MemberIII).

For the purpose of making a bid and entering into a Contract Agreement (in case of award) in response to **Tender No. _____ dated _____** for COAL GASIFICATION BASED METHANOL PLANT, at DANKUNI, WEST BENGAL (India) of M/s COAL INDIA LIMITED (hereinafter called the "Owner")

AND WHEREAS

- (1) Owner is proposing COAL GASIFICATION BASED METHANOL PLANT on BOO Basis AT DANKUNI, WEST BENGAL, India (hereinafter referred to as "PROJECT") vide **Tender No. _____ Dated _____** and award the above work to a experienced, qualified and selected contractors on a lump sum turnkey (LSTK) basis with proper technical back-up of reputed Process Licensors and requisiteexperience.
- (2) Lead Bidder and Other Consortium Members (PARTIES) are competent and vide their **Tender No. _____** desire to forge a strategic business alliance to combine their skills and work under the leadership of Lead Bidder who will, on awarding the contract, assume theresponsibilityforitselfandvicariouslyforalltheconsortiummembersandallthe

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PARTIES will work with one another/each other in the performance of the contract that may be entered into with the Owner in pursuance of the bid and assume joint and several liabilities for their execution/performance of the said contractual obligation towards the Owner including Technical Guarantees.

NOW, THEREFORE, THE PARTIES HERETO AGREE TO WORK TOGETHER AND BIND THEMSELVES AS FOLLOWS:-

1. In consideration of the bid submission by us to the Owner and the award of contract by the Owner to the Consortium (if selected by the Owner), we the members of the Consortium hereby agree that the Member-I(M/s _____) shall act as the lead bidder for self and on behalf of Member-II and Member-III and further declare and confirm that we shall jointly and severally be bound unto the Owner for execution of the contract in accordance with the contract terms and shall jointly and severally be liable to the Owner to perform all contractual obligations including technical guarantees. Further, the Lead Bidder/Member-I is authorized to incur liabilities and receive instructions for and on behalf of other members of the Consortium during the entire execution of the contract.
2. The terms and conditions contained in these presents constitutes a full statement of the contractual rights and obligations of Lead Bidder and other Consortium Members in relation to the PROJECT and supersedes all prior negotiations, agreements and documents unless specific reference has been made in the text of this Agreement to any such negotiations, agreements and documents.
3. This Agreement defines and fixes the responsibilities governing the relations of the Lead Bidder and other Consortium Members in preparation of the Bid and subsequent execution of the Contract Agreement with Owner.
4. Notwithstanding anything containing hereinbefore, Owner has got the right to fix the responsibility and accountability on any and/or all Members of the Consortium of this Agreement with or without Lead Bidder.
5. The Lead Bidder shall be responsible for:
 - (a) Preparation of BID.
 - (b) Making the final decision on all strategy for the PROJECT, including performance of the PROJECT.
 - (c) Co-ordination responsibility for execution of the contract
 - (d) All negotiation and communications with the Owner
 - (e) Any other aspect/issue as described in this Agreement and/or Appendix-I

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of this Agreement.

6. All Costs incurred with regard to the Bid shall be borne amongst the members of the Consortium. Each party agrees to render complete assistance for providing to the other PARTY sufficient Data/information required for preparation of the Bid in its entirety.
7. At the time of submission of the bid, the PARTIES have jointly agreed to all Schedules, programs, terms and conditions, and all other matters whatsoever necessary for the submission of bid. The division of responsibilities of Scope of Work among different Consortium members is as per APPENDIX-I (Responsibility Matrix) (Appendix –I of this agreement is to be submitted by PARTIES) of this agreement, which shall form part of this CA. In case of award of the contract, each PARTY shall perform their respective scope of work and division of responsibilities in accordance with the scope indicated in APPENDIX-I (Responsibility Matrix). It is further agreed that the sharing of responsibilities and obligations shall not in any way be a limitation of the joint and several responsibilities of the Members under the Contract Agreement.
8. PARTIES declare and undertake to Owner that:
 - (a) It shall be the joint and several responsibility of Members of the Consortium to fulfil all obligations as are required under the CONTRACT entered into between Owner and PARTIES in furtherance of PQ Booklet issued by Owner vide **TenderNo. [●]**.
 - (b) Each PARTY shall be jointly and severally liable to fully discharge their obligations and co-operate with one another with respect to the PROJECT during the term of this agreement and act at all times in such a way to further the common interest of the Consortium. Without limit to the foregoing, each PARTY reaffirms not to bid for the PROJECT separately or in combination with any thirdparty.
 - (c) In case of any breach of the Contract Documents by any PARTY, the remaining Members of the Consortium hereby agree to be fully responsible for the successful execution/performance of the contract in accordance of the terms of the Contract Documents.
 - (d) Further, if the Owner suffers any loss or damage on account of any breach of the contract or any shortfall in the completed equipment/plant, meeting the guaranteed performance parameters as per the technical specifications/contract documents, each Member of the Consortium undertakes to promptly make good such loss or damage caused to the Owner, on the Owner's demand without any demur. It shall neither be necessary nor obligatory on the part of the Owner to proceed against the Lead Member to these presents before proceeding against other members of the Consortium.

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- (e) The financial liability of the Member(s) to this CA, to the Owner with respect to the any or all claims arising out of the performance or non-performance of the Contract shall, however be not limited in any way so as to restrict or limit the liabilities of either of the Member.
- (f) In case of award of contract, PARTIES do hereby agree that the Security cum Performance Guarantee shall be submitted in favour of the Owner from the bank acceptable/approved by the Owner for the value as stipulated in the award of Contract and such guarantee shall be arranged by the Lead Bidder.

9. Each Party hereby represents and warrants that:

- (a) [it is duly organized and validly existing under the laws of the jurisdiction of their organization, and]¹ it has full power, authority and capability to enter into this CA and to perform all acts and obligations contemplated herein;
- (b) this CA has been duly signed and delivered by it and its obligations described in this CA are legal, valid and binding obligations of such Party; and
- (c) the execution, delivery and performance of this CA has been authorised by all necessary and appropriate [corporate or]² governmental action and the entry into and performance of this CA:
- (i) [will not conflict with or violate any provision of any of its constitutional documents / charters or other organizational document;]³
- (ii) will not require any notice to or filing with, or any approval of, any authority or the consent of any third party;
- (iii) will not conflict with, result in a breach of, or constitute (with or without due notice or lapse of time or both) a default under, result in the acceleration of obligations under, create in any person the right to terminate, modify or cancel, or require any notice, consent or waiver under, any contract or instrument to which such Party is a party or by which such Party is bound or to which any of such Party's assets are subject; and


¹*Note to draft:* To be retained in the event any Party to the CA is a body corporate.

²*Note to draft:* To be retained in the event any Party to the CA is a body corporate.

³*Note to draft:* To be retained in the event any Party to the CA is a body corporate.

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- (iv) will not violate any Applicable Law or any order, writ, injunction, or decree applicable to it.
- (d) there is no litigation pending or, threatened to which it or any of its affiliates is a party that presently affects or which would have a material adverse effect on the financial condition or prospects or business of such Party in the fulfillment of its obligations under this CA.
10. Any changes or amendments to this agreement shall be made after obtaining approval of the Owner and are valid only when these are set out in writing as such amendments and signed by the PARTIES.
11. Notwithstanding the Lead Bidder's liability in terms of this Agreement, each PARTY shall be fully responsible, liable and accountable for all financial transactions under this Agreement and each PARTY shall pay its own taxes and make other statutory and mandatory payments / taxes / duties. The PARTIES herein further undertake to ensure that all applicable laws & compliances are observed, appropriate records are kept of all financial transactions and appropriate documentation, including, but not limited to contracts, orders and confirmations, receipts and invoices, time sheets of staff and payroll calculations are retained for all matters pertaining to this Agreement. In case there is contradiction in any terms & conditions between Consortium agreement & the main Tender document/Contract Documents, the terms and conditions of the main Tender Document/Contract Documents shall prevail.
12. This agreement shall become valid upon execution and shall come to an end on the occurrence of any of the events stated hereinbelow;
- (a) Cancellation of PROJECT by Owner or award of PROJECT by Owner to a third party; OR
- (b) Owner informing that no award of contract for this project will be made to any Bidder; OR
- (c) End of Defect Liability Period (in case of award of contract).
13. This agreement shall in no way restrict any PARTY from engaging in any activities, which are not connected with this PROJECT and are not in direct competition to the activities of the PROJECT.
14. The PARTIES agree to keep confidential all information and data obtained from each other during the course of this agreement for a period of Three years from the effective date of this agreement.
15. No PARTY shall have the right to assign or in any way transfer any of its rights or obligations under this agreement to any other Company, firm or person(s) without prior consent in writing of the other members

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of the Consortium and Owner.

16. The PARTIES agree that as and when called upon by Owner, the PARTIES shall execute all further deeds, documents and agreements as may be required by Owner.
17. It is further agreed that this CA shall be irrevocable and shall form an integral part of the Contract Agreement and shall continue to be enforceable till such time as mentioned in Clause no. 11 above.
18. This CA supersedes and replaces any previous agreement or understanding between the Parties, whether oral or written, on the subject matter hereof, prior to the date of this CA. For the avoidance of doubt, this CA shall not supersede, and shall at all times be subject to, the Contract Agreement.
19. The Parties shall not assign or delegate its rights, duties or obligations under this CA and the Contract Agreement in any manner whatsoever, except with prior written consent of the Owner.
20. This agreement shall in all respects shall be governed, construed and interpreted in accordance with the applicable laws of India and Courts at Kolkata shall have exclusive jurisdiction in all matters arising under this CA.
21. Any dispute or difference arising between or amongst the PARTIES under or out of this agreement which cannot be settled amicably within sixty days, shall be finally decided by arbitration in accordance with the provisions of the Arbitration and Conciliation Act, 1996 (as may be amended from time to time). The place of Arbitration shall be New Delhi, India and the language of Arbitration shall be English. The arbitration award given by the arbitral tribunal shall be final and binding on all the members of the Consortium.

IN WITNESS WHEREOF, the Parties have, through their authorised representatives, executed these presents and affixed the common seals of their respective companies on the day, month and year first mentioned above at (Place)..

For and on Behalf of

For and on Behalf of

For and on Behalf of

(Lead Bidder/Member-I)
III)

(Member-II)

(Member-III)

Signature of Auth. Signatory

Signature of Auth. Signatory

Signature of Auth. Signatory

With Company Seal

With Company Seal

With


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CompanySeal

(1)

(2)

(3)

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**DECLARATION REGARDING BANNED/BLACKLISTED/DELISTING AND LIQUIDATION, COURT
RECEIVERSHIP (On Bidder's Letter Head)**

To,

**M/s COAL INDIA LIMITED,
Coal Bhawan, Action Area-1A,
New Town,
Kolkata - 700 156 (W.B.)**

SUB: COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL.

Dear Sir,

We hereby confirm that we have not been banned or blacklisted or de-listed or put on Holiday by any Government / Quasi-Government / Public Sector Undertaking / Private Firm / Financial Institutions on due date of submission of bid.

We also confirm that we are not under any liquidation, court receivership or similar proceedings or 'bankruptcy'.

If it is found at a later date that the Contractor has secured the contract by furnishing wrong information or by suppressing facts in the bid submitted, Coal India Limited (CIL) reserves the right to cancel the contract and forfeit the EMD/ Security cum Performance Guarantee and put the CONTRACTOR on Holiday / Banned / Blacklist list of CIL. Further, we also confirm that in case there is any change in status of the declaration prior to award of contract, the same will be promptly informed to CIL by us.

Place:



Signature of Authorized Signatory of Bidder]

Date:

Name:

Designation:

Seal:

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(FORMAT FOR SOLVENCY CERTIFICATE)

(on Bank's Letter Head)

REF NO:..... DATE:.....

To Whomsoever Concerned



This is to certify that to the best of our knowledge and information, M/s_____ (Bidders name with complete address), a customer of our Bank, is respectable, and is capable of executing orders to the extent of Rs. _____ (Rupees_____). M/s _____ have been our customers since _____ to date and has been granted the following limits, at present, against various facilities granted by the Bank:

.....
.....

This certificate is issued without any guarantee, risk or responsibility on behalf of the Bank or any of its officials.

This certificate is issued at the specific request of the customer. Yours faithfully,

(Bank Official's signature & stamp)

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**Format for Undertaking from Third Party Inspection Agency (TPIA)
(on TPIA letter head duly stamped & signed)**

Ref.:

Date:

To,

**M/s COAL INDIA LIMITED,
Coal Bhawan, Action Area-1A,
New Town,
Kolkata - 700 156 (W.B.)**

Subjects: Verification and certification of documents pertaining to Technical Bid Evaluation (BEC)

Ref: Bid No.....for.....

M/shaving Registered office at intend to participate in above referred tender of Coal India Limited (CIL) having registered office at Coal Bhawan, Action Area-1A, New Town, Kolkata - 700 156 (W.B.), India.

The tender conditions stipulated that the Bidder shall submit documents pertaining to Technical PQC duly verified and certified by designated independent TPIA.

In this regard, this is to certify that copies of documents pertaining to Technical PQC submitted to us by the Bidder have been verified and certified by us with the originals and found to be genuine. We have signed and stamped on the copies of all the verified and certified documents.

(Signature of a person duly authorized to Sign on behalf of the TPIA)

(seal of the Company)

Name.....

Contact No.....

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PRE-CONTRACT INTEGRITY PACT

General

This pre-bid pre-contract Agreement (hereinafter called the Integrity Pact) is made on.....day of the month of20..., between, on one hand, Coal India Limited/Subsidiary Cos. acting through Shri, Designation of the officer, (hereinafter called the “BUYER”, which expression shall mean and include, unless the context otherwise requires, his successors in office and assigns) of the First Part and M/s.represented by Shri....., Chief Executive Officer (hereinafter called the “BIDDER/Seller” which expression shall mean and include, unless the context otherwise requires, his successors and permitted assigns) of the Second Part.

WHEREAS the BUYER proposes to procure(Name of the Stores/Equipment/Item) and the BIDDER/Seller is willing to offer/has offered the stores and

WHEREAS the BIDDER is a private company/public company/Government undertaking/partnership/registered export agency, constituted in accordance with the relevant law in the matter and the BUYER is a Central Public Sector Unit.

NOW, THEREFORE,

To avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to :-

Enabling the BUYER to obtain the desired said stores/equipment at a competitive price in conformity with the defined specifications by avoiding the high cost and the distortionary impact of corruption on public procurement, and

Enabling BIDDERS to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that their competitors will also abstain from bribing and other corrupt practices and the BUYER will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows :

2. Commitments of the BUYER

- 1.1 The BUYER undertakes that no official of the BUYER, connected directly or indirectly with the contract, will demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the BIDDER, either for themselves or for any person, organization or third party related to the contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the contract.
- 1.2 The BUYER will, during the pre-contract stage, treat all BIDDERS alike and will provide to all BIDDERS the same information and will not provide any such information to any particular BIDDER which could afford an advantage to that particular BIDDER in comparison to other BIDDERS.
- 1.3 All the officials of the BUYER will report to the appropriate Government office any attempted or completed breaches of the above commitments as well as any substantial suspicion of such a breach.
2. In case any such preceding misconduct on the part of such official(s) is reported by the BIDDER to the BUYER with full and verifiable facts and the same is prima facie found to be correct by the BUYER, necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by the BUYER and such a person shall be debarred from further dealings related to the contract process. In such a case while an enquiry is being conducted by the BUYER the proceedings under the contract would not be stalled.

3. Commitments of BIDDERS

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3. The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract or in furtherance to secure it and in particular commit itself to the following :-
- 3.1 The BIDDER will not offer, directly or through intermediaries, any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the BUYER, connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.
- 3.2 The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of the BUYER or otherwise in procuring the Contract or forbearing to do or having done any act in relation to the obtaining or execution of the contract or any other contract with the Government for showing or forbearing to show favour or disfavour to any person in relation to the contract or any other contract with the Government.
- 3.3 FOREIGN BIDDERS shall disclose the name and address of agents and representatives in India and Indian BIDDERS shall disclose their foreign principals or associates.
- 3.4 BIDDERS shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid /contract.
- 3.5 The BIDDER further confirms and declares to the BUYER that the BIDDER is the original manufacturer/integrator/authorized government sponsored export entity of the defence stores and has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to the BUYER or any of its functionaries, whether officially or unofficially to the award of the contract to the BIDDER, nor has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or recommendation.*
- 3.6 The BIDDER, either while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of the BUYER or their family members, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.
- 3.7 The BIDDER will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract.
- 3.8 The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.
- 3.9 The BIDDER shall not use improperly, for purposes of competition or personal gain, or pass on to others, any information provided by the BUYER as part of the business relationship, regarding plans, technical proposals and business details, including information contained in any electronic data carrier. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.
- 3.10 The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.
- 3.11 The BIDDER shall not instigate or cause to instigate any third person to commit any of the actions mentioned above.

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- 3.12 If the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of the BUYER, or alternatively, if any relative of an officer of the BUYER has financial interest/stake in the BIDDER's firm, the same shall be disclosed by the BIDDER at the time of filing of tender.

The term "relative" for this purpose would be as defined in Section 6 of the Companies Act 1956.

- 3.13 The BIDDER shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of the BUYER.
- 3.14 The BIDDER shall not approach the Courts for legal remedy while their representations are under consideration of the IEMs and they shall wait for the decision of the IEMs in the matter before seeking legal remedy.
- 3.15 In case of sub-contracting, the Principal contractor shall take the responsibility of the adoption of IP by the sub-contractor.

4. Previous Transgression

- 4.1 The BIDDER declares that no previous transgression occurred in the last three years immediately before signing of this Integrity Pact, with any other company in any country in respect of any corrupt practices envisaged hereunder or with any Public Sector Enterprise in India or any Government Department in India that could justify BIDDER's exclusion from the tender process.
- 4.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

5. Earnest Money (Security Deposit)

As mentioned in the Tender Document.

6. Sanctions for Violations

- 6.1 Any breach of the aforesaid provisions by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle the BUYER to take all or any one of the following actions, wherever required:
- To immediately call off the pre contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.
 - The Earnest Money Deposit (in pre-contract stage) and/or Security Deposit/Performance Bond (after the contract is signed) shall stand forfeited either fully or partially, as decided by the BUYER and the BUYER shall not be required to assign any reason therefore.
 - To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.
 - To recover all sums already paid by the BUYER, and in case of an Indian BIDDER with interest thereon at 2% higher than the prevailing Prime Lending Rate of State Bank of India, while in case of a BIDDER from a county other than India with interest thereon at 2% higher than the LIBOR. If any outstanding payment is due to the BIDDER from the BUYER in connection with any other contract for any other stores, such outstanding payment could also be utilized to recover the aforesaid sum and interest.
 - To encash the advance bank guarantee and performance bond/warranty bond, if furnished by the BIDDER, in order to recover the payments, already made by the BUYER, along with interest.
 - To cancel all or any other Contracts with the BIDDER. The BIDDER shall be liable to pay compensation for any loss or damage to the BUYER resulting from such cancellation/rescission and the BUYER shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.

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- (vii) To debar the BIDDER from participating in future bidding processes of the Coal India Ltd. for a period upto three years, which may be further extended at the discretion of the BUYER.
- (viii) To recover all sums paid in violation of this Pact by BIDDER(s) to any middleman or agent or broker with a view to securing the contract.
- (ix) In cases where irrevocable Letters of Credit have been received in respect of any contract signed by the BUYER with the BIDDER, the same shall not be opened.
- (x) Forfeiture of Performance Bond in case of a decision by the BUYER to forfeit the same without assigning any reason for imposing sanction for violation of this Pact.

6.2 The BUYER will be entitled to take all or any of the actions mentioned at Para 6.1(i) to (x) of this Pact also on the Commission by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.

6.3 The decision of the BUYER to the effect that a breach of the provisions of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER. However, the BIDDER can approach the Independent Monitor(s) appointed for the purposes of this Pact.

7. **Fall Clause**

To be incorporated as per Price Fall Clause of this Manual.

8. **Independent Monitors**

8.1 The BUYER has appointed Independent Monitors (hereinafter referred to as Monitors) for this Pact in consultation with the Central Vigilance Commission (Names and Addresses of the Monitors as given in the Tender document).

8.2 The task of the Monitors shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.

8.3 The Monitors shall not be subject to instructions by the representatives of the parties and perform their functions neutrally and independently.

8.4 Both the parties accept that the Monitors have the right to access all the documents relating to the project/procurement, including minutes of meetings.

8.5 As soon as the Monitor notices, or has reason to believe, a violation of this Pact, he will so inform the Authority designated by the BUYER.

8.6 The BIDDER(s) accepts that the Monitor has the right to access without restriction to all Project documentation of the BUYER including that provided by the BIDDER. The BIDDER will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to Subcontractors. The Monitor shall be under contractual obligation to treat the information and documents of the BIDDER/Subcontractor(s) with confidentiality.

8.7 The BUYER will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the parties. The parties will offer to the Monitor the option to participate in such meetings.

8.8 The Monitor will submit a written report to the designated Authority of BUYER within 8 to 10 weeks from the date of reference or intimation to him by the BUYER/BIDDER and, should the occasion arise, submit proposals for correcting problematic situations.

9. **Facilitation of Investigation**

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In case of any allegation of violation of any provisions of this Pact or payment of commission, the BUYER or its agencies shall be entitled to examine all the documents including the Books of Accounts of the BIDDER and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

10. Law and Place of Jurisdiction

This Pact is subject to Indian Law. The place of performance and jurisdiction is the seat of the BUYER.

11. Other Legal Actions.

The actions stipulated in this Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

12. Validity

12.1 The validity of this Integrity Pact shall be from date of signing the IP and extend till complete execution of the contract to the satisfaction of both the BUYER and the BIDDER/Seller. Issues like warranty/ guarantee shall be outside the purview of IEMs. In case, BIDDER is unsuccessful, this Integrity Pact shall expire after six months from the date of the signing of the contract.

12.2 Should one or several provisions of this Pact turn out to be invalid, the remainder of this Pact shall remain valid. In this case, the parties will strive to come to an agreement to their original intentions.

13. The parties hereby sign this Integrity Pact at.....on.....

For the BUYER

For the BIDDER

Name of the Officer.....
Designation.....
Coal India Limited

Name of the Officer.....
Designation.....
Name of the company.....

Witness:-

1. Name
Designation.....
Name of the company.....

2. Name
Designation.....
Name of the company.....

Witness:-

1. Name
Designation.....
Name of the company.....

2. Name.....
Designation.....
Name of the company.....

*In case of non-applicability of this clause, the bidder will mention “not applicable”.

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Annexure-1.17

PROFORMA OF "BANK GUARANTEE"
FOR "EARNEST MONEY / BID SECURITY"
 (To be stamped in accordance with the Stamp Act)

To, M/s COAL INDIA LIMITED, Coal Bhawan, Action Area-1A, New Town, Kolkata - 700 156 (W.B.)	Bank Guarantee No.	
	Date of BG	
	BG Valid up to	
	Claim period up to (There should be three months gap between expiry date of BG & Claim period)	
	Stamp Sl. No. / e-Stamp Certificate No.	

Dear Sir(s),

In accordance with Letter Inviting Tender under your reference No _____ M/s. _____ having their Registered / Head Office at _____ (hereinafter called the Tenderer), wish to participate in the said tender for _____

As an irrevocable Bank Guarantee against Earnest Money for the amount of _____ is required to be submitted by the Tenderer as a condition precedent for participation in the said tender which amount is liable to be forfeited on the happening of any contingencies mentioned in the Tender Document.

We, the _____ Bank at _____ having our Head Office _____ (Local Address) guarantee and undertake to pay immediately on demand without any recourse to the tenderers by Coal India Limited (CIL), the amount _____ without any reservation, protest, demur and recourse. Any such demand made by CIL, shall be conclusive and binding on us irrespective of any dispute or difference raised by the Tenderer.

This guarantee shall be irrevocable and shall remain valid up to _____ [this date should be Nine (09) months beyond the validity of the bid]. If any further extension of this guarantee is required, the same shall be extended to such required period on receiving instructions from M/s. _____ whose behalf this guarantee is issued.

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In witness whereof the Bank, through its authorized officer, has set its hand and stamp on this _____ day of _____ 20__ at _____.

Notwithstanding anything contained herein:

- a) The Bank's liability under this Guarantee shall not exceed (currency in figures)_____ (currency in words only)_____
- b) This Guarantee shall remain in force upto _____ (this expiry date of BG should be Nine months beyond the validity of bid) and any extension(s) thereof; and
- c) The Bank shall be released and discharged from all liability under this Guarantee unless a written claim or demand is issued to the Bank on or before the midnight of(indicate date of expiry of claim period which includes minimum three months from the expiry of this Bank Guarantee) and if extended, the date of expiry of the last extension of this Guarantee. If a claim has been received by us within the said date, all the rights of CIL under this Guarantee shall be valid and shall not cease until we have satisfied that claim.

WITNESS:

(SIGNATURE)
(NAME)

(SIGNATURE)
(NAME)
Designation with Bank Stamp

(OFFICIAL ADDRESS)

Attorney as per
Power of Attorney No. _____
Date: _____

INSTRUCTIONS FOR FURNISHING "BID SECURITY / EARNEST MONEY" BY "BANK GUARANTEE"

1. The Bank Guarantee by Bidders will be given on non-judicial stamp paper as per "Stamp Duty" applicable. The non-judicial stamp paper should be in the name of the issuing Bank. In case of foreign Bank, the said Bank's Guarantee to be issued by its correspondent Bank in India on requisite non-judicial stamp paper.
2. The expiry date should be arrived at in accordance with "ITB: Clause-15.1".
3. The Bank Guarantee by bidders will be given from Bank as specified in "ITB".
4. A letter from the issuing Bank of the requisite Bank Guarantee confirming that said Bank Guarantee / all future communication relating to the Bank Guarantee shall be forwarded to the Employer at its address as mentioned at "ITB".

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5. Bidders must indicate the full postal address of the Bank along with the Bank's E-mail / Phone from where the Earnest Money Bond has been issued.
6. If a Bank Guarantee is issued by a commercial Bank, then a letter to Employer confirming its net worth is more than Rs. 1,000,000,000.00 [Rupees One Hundred Crores] or equivalent along with documentary evidence.

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Annexure-1.17 (A)

MATTER TO BE MENTIONED IN COVERING LETTER TO BE SUBMITTED BY VENDOR ALONG WITH BANK GUARANTEE (BG)

1. Bank Guarantee No.				
2. Vendor Name				
3. Nature of Bank Guarantee [Please Tick (✓) whichever is applicable]	<table border="1"> <tr> <td>Contract Performance Security (CPS)</td> <td>Earnest Money Deposit (EMD)</td> <td>Advance</td> </tr> </table>	Contract Performance Security (CPS)	Earnest Money Deposit (EMD)	Advance
	Contract Performance Security (CPS)	Earnest Money Deposit (EMD)	Advance	
4. Purchase Order (PO) / Fax of Acceptance (FOA) / Detailed Letter of Acceptance (DLOA) No.				
5. Details of Bank issuing Bank Guarantee (BG)				
(A) Name of Contact Person				
(B) E-mail ID				
(C) Address				
(D) Phone No. / Mobile No.				

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Annexure-1.18

Security Deposit Bank Guarantee Format

..... (name & address of the Purchaser
..... Company)

Re : Bank Guarantee in respect of Agreement dated Day of 20
.....between....(Name of Purchaser Company) and..... (Name
of Supplier Company)

Messers a Company / Firm having its office at No.
..... hereinafter called the Contractor has entered into an agreement dated
..... (hereinafter called 'the said agreement') with (Name of the
Purchaser Company) hereinafter called ('the Company') to supply..... stores/materials
amounting to Rs.on the terms and conditions contained in the said agreement.

It has been agreed that (..... percent) payment of the value of the
stores/materials will be made to the Contractor in terms of the said agreement on the contractors
furnishing to the company a bank guarantee for the sum of Rs.....as security for due
repayment of the said sum in terms of the said agreement, and also interest as therein provided.

The (Name of the Bank) having its Office at has a the request of
the Contract or agreed to give the guarantee as herein after contained.

We (Name of the Bank) (hereinafter called 'the Bank') do hereby
unconditionally agree with the Company that if the Contractor shall in any way fail to observe or
perform the terms and condition of the said agreement regarding repayment of the said sum of Rs
.....or any of them including the term for payment of interest for delay in deliveries or
shall commit any breach of its obligations there under, the Bank shall on demand and without any
objection or demur pay to the Company the said sum of Rs or such portion as shall
then remain unpaid with interest without requiring the company to have recourse to any legal remedy
that may be available to it to compel the Bank to pay the same, or calling on the company to compel
such payment by the contractor.

Any such demand shall be conclusive as regards the liability of the Contractor to the company and as
regards the amount payable by the Bank under this guarantee. The Bank shall not be entitled to
withhold, payment on the ground that the contractor has disputed its liability to pay or has disputed the
quantum of the amount or that any arbitration proceeding or legal proceeding is pending between the
Company and the contractor regarding the claim.

We, the Bank- further agree that the guarantee shall come into force from the date hereof and shall
remain in full force and effect till the period that will be taken for the performance of the said
agreement which is likely to be the day of but if the period of agreement is extended either
pursuant to the provisions in the said agreement or by mutual agreement between the contractor and the
Company the Bank shall renew the period of the guarantee failing which it shall pay to the Company
the said sum of Rs..... or such lesser amount out of the said sum of Rs..... as may be due



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to the Company and as the Company may demand. This guarantee shall remain in force until the dues of the Company in respect of the said sum of Rs..... and interest are fully satisfied and the company certifies that the agreement regarding re-payment of the said sum of Rs..... has been fully carried out by the contractor and discharges the guarantee,.

The Bank further agrees with the Company that the Company shall have the fullest liberty without the consent of the Bank and without affecting in any way the obligations hereunder to vary any of the terms and conditions of the said agreement or to extend the time for performance of the said agreement from time to time or to postpone for any time or from time to time any of the powers exercisable by the Company against the contractor and to forbear to enforce any of the terms and conditions relating to the said agreement and the Bank shall not be relieved from its liability by reason of such failure or extension being granted to the contractor or through any forbearance, act or omission on the part of the Company or any indulgence by the Company to the contractor or any other matter or thing whatsoever which under the law relating to sureties would butfor this provisions have the effect of relieving or discharging the Guarantor.

The Bank further agrees that in case this guarantee is required for a longer period and it is not extended by the Bank beyond the period specified above the Bank shall pay to the Company the said sum of Rs..... or such lesser sum as may then be due to the Company out of the said advance of Rs..... and as the Company may require. Notwithstanding anything herein contained the liability of the Bank under this guarantee is restricted to Rs..... only. The guarantee shall remain in force till the day ofand unless the guarantee is renewed or a claim is preferred against the Bank within 3 months from the said date all rights of the company under this guarantee shall cease and the Bank shall be released and discharged from all liability hereunder except as provided in the preceding clause.

The Bank has under its constitution power to give this guarantee and (Name of the person) who has signed it on behalf of the Bank has authority to do so.

The details of beneficiary bank for sending details of BG under SFMS Platform is furnished below

Name of the Bank: -

Branch: -

IFSC: -

A/c No: -

Customer ID :

Dated this Day of20...

Place

Signature of the authorized person

For and on behalf of the Bank

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Annexure-1.19

LIST OF CIL APPROVED BANKS

The Performance Guarantee shall be in the form of a Bank Guarantee issued by a RBI scheduled bank in India in the prescribed format on a non-judicial stamp paper.

The PBG will be submitted through Structured Financial Management System (SFMS) as per following procedure:

- a) The Issuing bank will receive application for BG along with the details of the bank of the beneficiary/ an Advising Bank for the Bank Guarantee
- b) The issuing bank will issue the BG on SFMS Platform. The message will be sent to the Beneficiary's bank/ Advising Bank through SFMS.
- c) A hard copy of the Bank Guarantee marked as "COPY ONLY" may be handed over to the applicant for submission to the Purchaser.
- d) The Beneficiary's bank / Advising Bank receives the SFMS and print the BG on stamp paper with required value and deliver to the Beneficiaries and claim for reimbursement of the cost incurred from issuing bank.

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DRAFT FOR CONDITIONS OF AGREEMENT

CONDITIONS OF AGREEMENT

This Contract Agreement (hereinafter referred to as the “**Contract Agreement**”) is, made and entered into on the _____ day of _____ 2020 between:

- Coal India Limited, a company incorporated in India under the provisions of the Companies Act, 1956 and having its registered office at Coal Bhawan, Premises No. 04-MAR, Plot-AF-III, Action Area-1a, New Town, Rajarhat, Kolkata-700156 (hereinafter referred to as the "**Owner**", which expression shall, unless repugnant to the context or meaning thereof, include its successors and assigns), of One Part¹;



AND

- [●], a company incorporated in India under the provisions of the Companies Act, 1956/ 2013 and having its registered office at [●], (hereinafter referred to as the "**BOO Operator**", which expression shall, unless repugnant to the context or meaning thereof; include its successors, administrators, executors and permitted assigns) of the Other Part.

WITNESSETH:

WHEREAS

- Owner has decided to diversify into a new “Coal to Chemical” business domain by converting the high calorific value, low ash thermal coal into synthesis gas (CO+H₂) and downstream chemicals and accordingly, intends to set up a Coal to Methanol Complex on Build Own Operate (BOO) basis. In pursuit of implementing this new strategy, the premises of the existing Dankuni Coal Complex (DCC) have been identified as the geo- strategic location for setting up a Coal to Methanol Complex on Build Own Operate basis (BOO) by using the good quality Indian coal from Raniganj coalfields.
- In order to meet the requirement of Methanol, Owner issued Tender No.-----
---- for supply of Methanol at Dankuni Coal Complex (DCC), West Bengal (India) ON BUILD-OWN-OPERATE (BOO) Basis (hereinafter referred to as the “Tender”) for the Construction, Commissioning and thereafter, for Operating and Maintaining a new Methanol Plant referred to as “Production Plant” and which is more specifically defined in the Tender) in a designated plot), within the premises of Dankuni Coal Comple (DCC).
- During the course of tendering process, ----- its bid and on acceptance-----
awarded Letter of Award No.-----dated -----and subsequent Detailed letter of Acceptance No. _____ dated _____ to _____
- The BOO Operator agrees to Build, Own, Operate and Maintain the "Production Plants" with all brand new equipment, items, accessories and auxiliaries, designed and capable of steadily operating, by making its own investment, for the production of Methanol as Product to meet Owner’s requirements to be set up on the land allocated to by Owner under lease for use from which ----- will supply Methanol to Owner.

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- D The BOO Operator is having requisite experience and competence in the business, inter-alia of, production and supply of Methanol and intends to produce and supply Methanol of specified parameters on continuous, reliable and long term basis by building, owning, operating and maintaining the Methanol Plant (hereinafter referred to as Production Plant) located inside the Dankuni Coal Complex of Owner.
- E The BOO Operator has presently satisfied itself to the Project site conditions and has acquainted itself in general with all local conditions and all its responsibilities for compliance to applicable laws and regulations and has obtained all other information on its own both as to risk, contingencies & other circumstances which may influence or affect the work and other requisites for proper installation, operation and maintenance of the Production Plant after due inspection of site and surrounding and scrutiny of other related factors.

NOW, THEREFORE, in consideration of the foregoing and the mutual promises contained herein, Owner and -----intending to be legally bound, hereby agree as follows:

ARTICLE 1


CONTRACT DOCUMENT

- 1.1 The Contract Documents shall comprise the following:
- i. Contract Agreement
 - ii. Land Lease Agreement
 - iii. The Detailed Letter of Acceptance (DLOA) including Statement of Agreed Variations, if any, and accepted Price-Schedule
 - iv. The Notification of Award/Letter of Award.
 - v. Amendments, if any, issued to the Bidding Documents.
 - vi. Original Bidding Documents (including the Conditions to Contract) issued with its enclosures.
 - vii. Integrity Pact (IP) signed between the Owner and the Bidder/BOO Operator.

ARTICLE 2

JURISDICTION & GOVERNING LAW

- 2.1.1 Notwithstanding any other court or courts, having jurisdiction to decide the question(s) forming the subject matter of the reference if the same had been the subject matter of a suit, any and all actions proceeding arising out or relative to the contract or any award arising there from, shall lie only in the Court of competent civil jurisdiction in this behalf at Kolkata (where this contract has been signed on behalf of Owner and only the said Court(s) shall have jurisdiction to entertain and try any such action(s) and/ or proceeding(s) to the exclusion of all other Courts.
- 2.1.2 This Contract Agreement shall be governed in all aspects by the law of the Republic of India, without application of the doctrine of Renvoi.

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ARTICLE 3

ENTIRE CONTRACT

- 3.1 The Contract Documents mentioned in Article-1 hereof embody the entire agreement between the parties hereto, and the parties declare that in entering the Contract Documents they do not rely upon any previous representation, whether expressed or implied and whether written or oral, or any inducement, understanding or agreements of any kind not included within this Contract Agreement documents and all prior negotiations, representations, contracts and/or agreements and understandings are hereby cancelled.
- 3.2 All additions, supplements, amendments or variations to this agreement shall be in writing and shall be signed by the duly authorised representatives of Owner and BOO Operator.

ARTICLE 4


NOTICES

- 4.1 Subject to any provisions in the Contract Documents to the contrary, any notice, order or communication sought to be served by the BOO Operator on the Owner with reference to the Contract Agreement shall be deemed to have been sufficiently served upon the Owner notwithstanding any enabling provisions under any law to the contrary, only if delivered by hand or by Courier to the Owner at the address mentioned in this Agreement.
- 4.2 Without prejudice to any other mode of service provided for in the Contract Documents or otherwise available to the Owner, any notice order or other communication sought to be served by the Owner on the BOO Operator with reference to the Contract Agreement, shall be deemed to have been sufficiently served if delivered by hand or through Courier to the principal office of the BOO Operator at ----- (Lead Bidder in case of Consortium), or other address for service subsequently notified by ----- to the Owner in this behalf in writing.

ARTICLE 5

WAIVER

- 5.1 No waiver by either Owner or BOO Operator of any default by the other in the performance of the Agreement (i) shall be effective unless recorded in a document duly executed by an authorised representative of such Party; (ii) shall operate or be construed as a waiver or any other or further default whether of a similar or different character.
- 5.2 No failure or delay by Owner in enforcing any right or remedy of Owner in terms of the contract or any obligation or liability of the BOO Operator in terms thereof shall be deemed to be a waiver of such right, remedy, obligation, or liability, as the case may be, by Owner and notwithstanding such failure or delay, Owner shall be, entitled at any time to enforce such right, remedy, obligation or liability, as the case may be.
- 5.3 No failure or delay by the BOO Operator in enforcing any right or remedy of the BOO Operator in terms of the Agreement or any obligation or liability of Owner in terms thereof

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shall be deemed to be a waiver of such right, remedy, obligation, or liability, as the case may be, by the BOO Operator and notwithstanding such failure or delay, the BOO Operator shall be entitled at anytime to enforce such right, remedy, obligation or liability, as the case maybe.

- 5.4 The grant of additional time or order indulgence by one party to the other, or acceptance of any variation in performance, shall not constitute a waiver.

ARTICLE 6

LANGUAGE OF CONTRACT AND COMMUNICATION

- 6.1 The language of the Contract Agreement shall be English and all communications, drawings, design, data, information, codes specifications and other document whatsoever supporting the bid or otherwise exchanged under the Contract Agreement shall be in English. In the event that any technical documentation is in any language other than English, the document should be translated and presented to the Owner in English and English document/ translated document shall be regarded as the only authentic document.

ARTICLE 7

GOVERNMENT OF INDIA NOT LIABLE

- 7.1 It is expressly understood and agreed by and between the BOO Operator and the Owner that the Owner is entering into this agreement solely on its own behalf and not on behalf of any other person or entity. In particular, it is expressly understood and agreed that the Government of India is not a party to this agreement and has no liabilities, obligations or rights there under. It is expressly understood and agreed that the Owner is an independent legal entity with power and authority to enter into contracts, solely in its behalf under the Applicable Laws, of India and general principles of contract law. The BOO Operator expressly agrees, acknowledges and understands that the Owner is not an agent, representative or delegate of the Government of India. It is further understood and agreed that the Government of India is not and shall not be liable for any acts, omissions, commissions, breaches or other wrongs arising out of the Contract Documents. Accordingly, BOO Operator hereby expressly waives, releases and foregoes any and all actions or claims, including cross claims, impleader claims or counter claims against the Government of India arising out of this Contract and covenants not to sue the Government of India on any matter, claim, cause of action or thing whatsoever arising out of or under this Contract Agreement.

ARTICLE 8

NON-ASSIGNABILITY

The contract and benefits and obligations thereof shall be strictly personal to the BOO Operator and Owner and shall not on any account be assignable or transferable to third party by the BOO Operator or Owner without having obtained in writing the prior approval of Owner or BOO Operator.

ARTICLE 9

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NO LIABILITY ON DIRECTOR AND EMPLOYEE

No Director, employee, consultant or agent of the Owner or other person representing the Owner or acting on behalf of the Owner in or pursuant to the Contract Agreement or in the discharge of any obligation to the Owner under the Contract Documents or otherwise in relation to the Contract Agreement shall have any personal liability to the or any Sub-Contractor, agent, representative, director or employee of the ----- or to any other person acting for or on behalf of the ----- and the ----- on its own behalf and on behalf of its Sub-Contractors, directors, employees, agents and representatives, hereby waives, and disclaims any and all right of action which it or they may have whether under tort or contract or otherwise against any director, employee, agent, consultant or representative of the Owner for act of omission or commission done or omitted to be done.

ARTICLE 10

GENERAL

10.1 In this Contract Agreement, capitalized words and expressions used herein without having been defined, shall have the same meanings as are respectively assigned to them in the Conditions of Contract or the other Contract Documents, and they shall be deemed to form and be read and construed as part of this Contract Agreement.

IN WITNESS WHEREOF THE PARTIES hereto have executed this Contract Agreement in duplicate at the place, day and year first above written.

SIGNED AND DELIVERED
For and on behalf of
M/s-----

SIGNED AND DELIVERED
For and on behalf of
M/s-----

BY _____

BY _____

(THIS DAY OF _____ 2020)

IN THE PRESENCE OF:

IN THE PRESENCE OF:


1.

1.

2.

2.

Person (s) authorised to sign.

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FORMAT OF LAND LEASE

LEASE DEED

(To be executed between CIL and BOO Operator)

THIS DEED OF Lease executed on this day of two thousand and between Coal India Limited, a Government Company registered under the Indian Companies Act, 1956 and a, having its Registered Office at 10, Netaji Subhas Road, Kolkata-700001, (hereinafter referred to as 'CIL' or 'Lessor' which expression shall, unless it be repugnant to the context or meaning thereof, be deemed to mean and include its successors and permitted assigns) on the one part, and

(Name of BOO Operator), a Body constituted under _____, (hereinafter referred to as "" or 'Lessee' which expression shall, unless it be repugnant to the context of meaning thereof, be deemed to mean and include its successors and permitted assigns) on the otherpart

WHEREAS

1. TheLessoristheabsoluteownerofthepieceoflandtotallymeasuring(SurveyNos. Separately shown in the schedule)situated in _____ Dankuni _____ villageof _____ Taluka more particularly described in the schedule hereunder written hereafter referred to as the Land to be leased out by the Lessor to theLessee.
2. In terms of an Agreement dated _____ entered into between CIL and "____", CIL shall provide on lease the presently required land based on the detailed engineering of the plant/connected facilities being build, own and operate by "_____" subject to a maximum of land admeasuring less than Acres, as is where is condition, near _____ At Dankuni.
3. In terms of the said Agreement, the Lessor has agreed to grant by way of lease to the Lessee in respect of the said Land for a period of 25 years subject to the terms and conditions laid down below w.e.f. _____.

NOW THIS DEED WITNESSETH that the Lessor does in consideration of the lease rent to be paid as herein referred and other terms and conditions on the part of the Lessee to be observed, hereby grant to the Lessee, a lease of ALL THAT piece of land containing by admeasurement

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less than Acres or thereabouts, situated at Dankuni more particularly described in the Schedule hereunder written and for greater clarity delineated with the boundaries thereof on the Plan annexed (Plan No. dated) hereto TO HOLD the same for the term of LESS THAN TWENTY FIVE (25) YEARS from (hereinafter referred to as the "said term") subject to the following conditions:-

1. The Lessor has agreed to provide the property described in the schedule hereunder on lease for a period of 25 years with an option to renew the lease for a further period on mutual consent and on executing a fresh deed to the Lessee on a nominal rent of Re. 1/- (Rupee ONE) per Acre per Annum and the Lessor hereby grant and express permission to the Lessee to build, own and operate plant for production Methanol and Sulphur (By- product) at their cost and expenditure in the said property.
2. The Lessee shall pay to the Lessor during the said terms as yearly lease rent at a fixed rate of Rs...../- (Rupees) per Acre per Annum only alongwith applicable statutory levies (hereinafter referred to as the "said lease rent") for the entire term of less than Twenty Five (25) years. The Lessee shall pay the Lessor the Lease rent on an yearly basis on or before March of previous year.
3. The Lessee shall use the said land for construction of Plant premises to build, own and operate and other structures on the property described in Schedule at their cost for the purpose as provided in the said Agreement, unless otherwise agreed to by the Lessor in writing. The construction shall be according to and in conformity with the plans which has already been sanctioned by the appropriate authorities. The development and other protective measures for the said land shall be on the Lessee's account.
4. The Lessee shall have the liberty to use the said land for purposes connected with its trade or business. The land shall be used by the BOO Operator/ Lessee for installation, commissioning and operation of Coal to Methanol Plant.
5. The Lessee hereby agrees that the Lessor still holds the ownership of the said property and shall have rights to access their other properties through the pathway which will be used by both parties. Similarly, the Lessor shall use the pathways, approach roads only to access the Plant proposed to be constructed and structures thereon freely without distance by the Lessor.
6. The Lessor shall not be responsible to the Lessee or any other person(s) for any loss or damage or injury to life or property arising directly or indirectly from the use of the said

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land or the activities the Lessee is engaged in on the said land during the period of lease. The Lessee shall also indemnify the Lessor against all loss or damage or injury to life or property of any one including third parties or claims and costs thereof, arising directly or indirectly from the use of the leased land and the activities the Lessee is engaged in on the said land during the period of lease subject to Article 28.9 of SCC.

7. Lessee shall be responsible to insure and to keep its plant and other facilities constructed on the land against the loss or damages by fire, earthquake, riot or affray with the insurance company and towards loss of public property and to public if any and Lessor shall not be responsible for any such losses described above or towards any other losses not mentioned above.
8. The Lessee shall not assign transfer, sublet or underlet the demised land without the consent in writing of the Lessor.
9. The Lessee shall not create any charge in respect of the leasehold interest relating to the property described in the schedule hereto vested in it as well as the building constructed on the same without the prior written consent of the Lessor, it being clearly understood that such consent will not be granted, except in the case of charges in favour of commercial Banks and State/ Central Government financial institutions. However, BOO Operator/ Lessee shall have right to create lien on its Plant/Facility.
10. If the Lessee makes default in payment of the lease rent or any other dues related to lease rent to the Lessor and/or interest as provided hereinbefore, the Lessor shall be entitled to revoke this agreement and cancel the lease forthwith. The Lessee shall thereupon forfeit all its rights there under and shall remain liable for any sum then due by the lessee and also for any loss which may be caused to the Lessor by reasons of such default.
11. The Lessor shall from time to time and at all times during the said term pay and discharge all rates, taxes, charges and assessments of every description now subsisting, excluding arrears, if any, accrued due before the date of commencement of the term of the Lease related to the property leased or which may at any time hereafter during the said term be imposed, charged or assessed upon the said premises hereby demised of the building(s)/ structure(s) to be erected thereon, whether it be payable by the Lessor or the Lessee.
12. The Lessee shall use the said land for installation and commissioning of Coal to Methanol plant for the construction of the building(s) / structure(s) for which , the land has been leased, unless otherwise approved by the Lessor and shall not make unnecessary



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excavation or remove or appropriate any minerals, mineral substances of any description, sand or clay, from the said land. Any such materials obtained from the site should be placed or disposed of as directed by the Lessor or its authorized representative.

13. It is made clear that the Lessee should utilise the maximum permissible area of the land leased for the construction of Plant as per the agreement and the Lessor reserves the right to re-possess without any claim to compensation whatsoever, the whole or part of the portion left un-utilised and use the same in any manner deemed expedient by the Lessor. In case, there is any dispute regarding the extent of land that should be utilized for the construction or the extent to be re-possessed, the decision of the Lessor shall be final and binding.
14. The lessee shall erect or construct any building/ structures for installation and commissioning of Coal to Methanol Plant. However, the Lessee shall not at any time without the previous consent in writing of the Lessor erect or suffer to be erected on the said land any building(s)/ structure(s) nor permit the same to be used for any purpose other than that specified above. In case, Lessee fails to do so the lease shall be liable for termination.
15. The Lessee shall at all times during the subsistence of the lease maintain the premises in good sanitary condition and repair and keep the building(s)/ structure(s) erected and/or to be erected on the said land in good and tenantable condition.
16. Hoarding or advertisement boards shall not be erected in the leased premises by the Lessee without the written permission of the Lessor. However, BOO Operator can put its sign board/ nameplate capacity of the facility.
17. The Lessor hereby agrees that the Lessee observing all the aforesaid conditions, shall peacefully hold and enjoy the said land during the said term without any interruption by the Lessor or any one claiming under the Lessor, provided that upon any breach or non-observance by the Lessee or by a person claiming through or under the Lessee of any of the aforesaid covenants or conditions the Lessor may notwithstanding the waiver of any previous cause or right of re-entry enter upon the said premises and re-possess it, as if this lease had not been granted and thereupon this demise shall absolutely determine and the Lessee shall be entitled within 3 (three) months from the date of such re-entry to remove all building and fixtures which at any time during the currency of this lease shall have been erected for affixed by the Lessee upon the said land without any claim to any compensation whatsoever.

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18. It is also distinctly agreed that the Lessee shall deliver up the demised premises at the expiration or sooner determination of tenancy restored to its former condition.
19. The Lessor shall be entitled to allow any public utility services such as electric posts, or cables, water supply sewer lines, drains, sanitary lines or telegraph post or cables, to be taken through the said land and the Lessee shall not be entitled to any compensation in respect of the same including compensation, if any, relating to the space occupied by such public utility services to be taken through the said land, only the minimum possible hindrance shall be caused to other structures in the said land.
20. It is further agreed that if the Lessee does not remove the building and fixtures as allowed above, or restore the demised premises to its original condition as required above within the time prescribed in the said clauses, the Lessor shall have the right to remove the said building and fixtures and restore the demised premises to its original condition and the cost of such removal and restoration shall be realized by the Lessor by the sale of materials recovered and the balance if any from the Lessee. In case, there is any amount left from the sale price of the materials so removed, after realization of the cost of removal and restoration preferred to herein, the same may be utilized by the Lessor for recovery of any other amounts that may be due to the Lessor from the Lessee.
21. Notwithstanding anything contained hereinbefore, it is expressly agreed and understood that the Lessor shall be entitled to terminate the lease at the risk and cost of the lessee in the event of violation of any of the provisions hereof by the lessee which is not rectified with in a period of 90 (ninety) days of receipt of a notice issued in this behalf by the Lessor.
22. The Lessor shall sign necessary papers and application forms for getting plan sanction or for granting permission / rights for enabling the Lessee to build, own and operate the Plant.
23. The Lessee shall not use the property for construction of any structures not associated with the construction of the Plant without prior consent of the Lessor.
24. The Lessor is absolutely seized and possessed or otherwise well and sufficiently entitled to the demised property and is having full power and absolute authority to demand up to the Lessee the demised property.
25. The Lease Deed shall be executed induplicate. The original shall be retained by the Lessor and the duplicate by the Lessee.
26. The stamp duty and all other expenses in respect of this Lease Deed and duplicate thereof shall be borne and paid by the Lessee.
27. In respect of the terms and conditions not specifically mentioned herein the Lessor and

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Lessee shall mutually decide and agree in writing.

SCHEDULE OF PROPERTY LEASED OUT TO THE LESSEE BY THE LESSOR

District :

Sub District :

Taluk :

Firka :

Panchayat :

Village :

Kara :

Tenure :

Survey

No.

Sub

Division

:

Extent in Ares :

In Cents :

DESCRIPTION

All that pieces and parcels of land admeasuring to _____ cents (ares) made up of (ares) in Sy No. () cents (----ares) in Sy.No. () cents (ares) in Sy No.() owned by the Lessor with the right of way through the metres wide pathway at the.



BOUNDARIES

East :

Sough:

West:

North:

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IN WITNESS WHEREOF THE Lessor and the Lessee have their respective hands on the original and a duplicate thereof the day and year first above writings in the presence of the following witnesses :

Signed and delivered by within named Lessor _____

CIL

BOO Operator

(Lessor)

(Lessee)



Witness :

1.

1.

2.

2.

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Format for Financial Details of Holding Company

(Details pertaining to Financial Criteria as per Clause No. 2.3 of PQC)

Since we do not satisfy the Financial Criteria stipulated at **Clause No. 2.3 of PQC** on our own, we give below the following details of our Holding Company in terms of **Note ii & iii of Clause 2.3 of PQC of ITB** who meet the stipulated turnover requirements of INR.....USD and whose Net Worth as on the last day of the preceding financial years is at least equal to or more than the paid up share capital of the Holding Company.

- Name and Address of the Holding Company: M/s.....
- Annual Turnover of the Holding Company with following details:

ANNUAL TURNOVER OF LAST 3 FINANCIAL YEARS OF THE HOLDING COMPANY:

Year	Amount (Currency)
Year 1 (FY 2019-20 or Calendar year 2019)	
Year 2 (FY 2018-19 or Calendar year 2018)	
Year 3 (FY 2017-18 or Calendar year 2017)	
Average Annual Turnover of the Holding Company for the preceding three (3) Financial Years as on date of Techno- Commercial Bid Opening	
We have enclosed Audited Balance sheet and Profit and Loss Account (financial statements) for the last Three (3) financial years	Yes*/No*

Note: Other income shall not be considered for arriving at annual turnover.

(*) Bidder to strike-off whichever is not applicable

NET WORTH DETAILS OF THE HOLDING COMPANY :

Sl. No.	Description	As on last day of the preceding financial year
1.	Paid-up Share Capital	
2.	Net Worth of the Holding Company	
3.	%age of Net worth to Paid-up Share Capital of the Holding Company	
4.	Documentary evidence like Annual Report/Audited Balance sheet and Profit and Loss Account (financial statements) for the last preceding financial year	
5.	A Letter of Undertaking from the Holding Company, supported by Board Resolution, pledging unconditional and irrevocable financial support for execution of the Contract Agreement by the Bidder in case of award is enclosed as per the format at Appendix- A & B to this Attachment. A Power of Attorney of the person signing on behalf of Holding Company shall also be enclosed.	

Note:

Net worth means the sum total of the paid up share capital and free reserves. Free reserve means all reserves credited out of the profits and share premium account but does not include reserves credited out of the revaluation of the assets, write back of depreciation provision and amalgamation. Further any debit balance of Profit and Loss

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account and miscellaneous expenses to the extent not adjusted or written off, if any, shall be reduced from reserves and surplus.

We further confirm that notwithstanding anything stated above, the Employer reserves the right to assess the capabilities and capacity of the Bidder/subsidiaries/group companies/Holding company to perform the contract, should the circumstances warrant such assessment in the overall interest of the Employer.

[Signature of Authorized Signatory]

Name:

Designation:

Seal:

Date:

Place:

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APPENDIX-A

**PROFORMA OF CERTIFICATE FROM THE CEO/CFO OF THE HOLDING COMPANY
IN ACCORDANCE WITH CLAUSE NO. OF PQC**

(To be submitted by Bidder alongwith the Techno-Commercial Bid)

Ref. :

Date:

To,

M/s COAL INDIA LIMITED,
Coal Bhawan, Action Area-1A,
New Town,
Kolkata - 700 156 (W.B.)

Ref: Tender no.

Dear Sir,

- 1) I, M/s (CEO of the company / CFO of the company) declare that
M/s (Name of the Holding Company) is the
Holding Company of M/s (Name of the Bidder)
- 2) I hereby confirm and undertake that the unaudited unconsolidated
financial statements (Balance sheet and Profit & Loss Account) submitted in
respect of the bidder as part of the Bid Reference No... ..dated... .. have been
considered for the purposes of the finalisation of Consolidated financial
statements of the Holding Company (Balance sheet and Profit & Loss
Account)as part of the Annual Reports.
- 3) I further, certify that the figures in the unaudited unconsolidated financial
statements (Balance sheet and Profit & Loss Account) are true and correct and
same have been duly reflected in the audited consolidated financial statements
and/or Annual Report of the Holding Company.

Yours faithfully,

(Signature)

(Name & Designation)

(Name of the Holding Company)
(Seal of Holding Company)

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APPENDIX-B

**PROFORMA OF LETTER OF UNDERTAKING
(TO BE FURNISHED ON NON-JUDICIAL STAMP PAPER OF APPROPRIATE VALUE)**

[To be executed by the Holding Company Supported by Board Resolution and submitted by the Bidder alongwith the Techno-Commercial Bid, in case financial support is being extended by the Holding Company to the Bidder for meeting the stipulated Financial Qualifying Requirement as per Clause No. 2.3 of PQC]

Ref. :

Date:

To,

M/s COAL INDIA LIMITED,
Coal Bhawan, Action Area-1A,
New Town,
Kolkata - 700 156 (W.B.)

Dear Sir,

- 1) We, M/s (Name of the Holding Company) declare that we are the Holding Company of M/s. (Name of the Bidder) and have controlling interest therein therein.

M/s..... (Name of the Bidder) proposes to submit the bid for the package (Name of the package) for TFL under bid reference no... ..dated..... and have sought financial strength and support from us for meeting the stipulated Financial Qualifying Requirement as per **Clause 2.3 of PQC.**

- 2) We hereby undertake & pledge our unconditional & irrevocable financial support for the execution of Contract Agreement for the said package to M/s. (Name of the Bidder), in case they are awarded the contract for the said package, at the end of the bidding process. We further agree that this undertaking shall be without prejudice to the various liabilities that M/s (Name of Bidder) would be required to undertake in terms of the Contract Documents including the Performance Security as well as other obligations of the Bidder/Contractor.
- 3) This undertaking is irrevocable and unconditional, and shall remain in force till the successful execution and performance of the entire contract and/or till it is discharged by CIL.
- 4) We are herewith **enclosing a copy of the Board Resolution** in support of this undertaking.

Yours faithfully,

(Signature of Authorised Signatory)
on behalf of the Holding Company)
(Name & Designation)
(Name of the Holding Company)
(Seal of Holding Company)

Witness :

- (1)
(2)

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Annexure-1.23

**CLAUSE REGARDING PROVISION FOR PROCUREMENT FROM A BIDDER
WHICH SHARES A LAND BORDER WITH INDIA**

1. Order (Public Procurement No. 1) dated 23.07.2020, Order (Public Procurement No.2) dated 23.07.2020 and Order (Public Procurement No. 3) dated 24.07.2020, Department of Expenditure, Ministry of Finance, Govt. of India refers. The same are available at website <https://doe.gov.in/procurement-policy-divisions>.
2. Any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Competent Authority. For details of competent authority refer to Annexure I of Order (Public Procurement No. 1) dated 23.07.2020.

Further the above will not apply to bidders from those countries (even if sharing a land border with India) to which the Government of India has extended lines of credit or in which the Government of India is engaged in development projects. Updated lists of countries to which lines of credit have been extended or in which development projects are undertaken are given in the website of the Ministry of External Affairs, Govt. of India

3. "Bidder" (including the term 'tenderer', 'consultant' 'vendor' or 'service provider' in certain contexts) for purpose of this provision means any person or firm or company, including any member of a consortium or joint venture (that is an association of several persons, or firms or companies), every artificial juridical person not falling in any of the descriptions of bidders stated hereinbefore, including any agency, branch or office controlled by such person, participating in a procurement process.
4. "Bidder from a country which shares a land border with India" for the purpose of this:
 - a) An entity incorporated, established or registered in such a country; or
 - b) A subsidiary of an entity incorporated, established or registered in such a country; or
 - c) An entity substantially controlled through entities incorporated, established or registered in such a country; or
 - d) An entity whose beneficial owner is situated in such a country; or
 - e) An Indian (or other) agent of such an entity; or
 - f) A natural person who is a citizen of such a country; or
 - g) A consortium or joint venture where any member of the consortium or joint venture falls under any of the above

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5. "Beneficial owner" for the purpose of above (4) will be as under:

- i) In case of a company or Limited Liability Partnership, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person(s), has a controlling ownership interest or who exercises control through other means.
Explanation-
 - a) "Controlling ownership interest" means ownership of, or entitlement to, more than twenty-five per cent of shares or capital or profits of the company;
 - b) "Control" shall include the right to appoint the majority of the directors or to control the management or policy decisions, including by virtue of their shareholding or management rights or shareholders agreements or voting agreements;
- ii) In case of a partnership firm, the beneficial owner is the natural person(s) who, whether acting alone or together, or through one or more juridical person, has ownership of entitlement to more than fifteen percent of capital or profits of the partnership;
- iii) In case of an unincorporated association or body of individuals, the beneficial owner is the natural person(s), who, whether acting alone or together, or through one or more juridical person, has ownership of or entitlement to more than fifteen percent of the property or capital or profits of such association or body of individuals;
- iv) Where no natural person is identified under (i) or (ii) or (iii) above, the beneficial owner is the relevant natural person who holds the position of senior managing official;
- v) In case of a trust; the identification of beneficial owner(s) shall include identification of the author of the trust, the trustee, the beneficiaries with fifteen percent or more interest in the trust and any other natural person exercising ultimate effective control over the trust through a chain of control or ownership.

6. "Agent" for the purpose of this Order is a person employed to do any act for another, or to represent another in dealings with third persons

7. **SUBMISSION OF CERTIFICATE IN BIDS:**

Bidder shall submit a certificate in this regard as Form-1.

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If such certificate given by a bidder whose bid is accepted is found to be false, this would be a ground for immediate rejection of the bid/termination and further action as per "Procedure for Action in case of Corrupt/Fraudulent/ Collusive / Coercive Practices" of tender document.

8. The registration, wherever applicable, should be valid at the time of submission of bids and at the time of acceptance of bids. In respect of supply otherwise than by tender, registration should be valid at the time of placement of order. If the bidder was validly registered at the time of acceptance / placement of order, registration shall not be a relevant consideration during contract execution.
9. **PROVISION TO BE IN WORKS CONTRACTS, INCLUDING TURNKEY CONTRACTS:**

The successful bidder shall not be allowed to sub-contract works to any contractor from a country which shares a land border with India unless such contractor is registered with the Competent Authority. The definition of "contractor from a country which shares a land border with India" shall be as in Para 4 herein above. A Certificate to this regard is to be submitted by bidder is placed at Form-II

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Form-I of Annexure-1.23

UNDERTAKING ON LETTERHEAD

To,

M/s COAL INDIA LIMITED,

SUB:

TENDER NO:

Dear Sir

We have read the clause regarding Provisions for Procurement from a Bidder which shares a land border with India, we certify that, bidder M/s _____ (Name of Bidder) is:

- (i) Not from such a country []
- (ii) If from such a country, has been registered with the Competent Authority. (Evidence of valid registration by the Competent Authority shall be attached) []

(Bidder is to tick appropriate option (✓ or X) above).

We hereby certify that bidder M/s _____ (Name of Bidder) fulfills all requirements in this regard and is eligible to be considered against the tender.

Place: [Signature of Authorized Signatory of Bidder]
Name:

Date: Designation:
Seal:

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Form-II of Annexure-1.23

**CERTIFICATE FOR TENDERS FOR WORKS INVOLVING POSSIBILITY OF
SUB-CONTRACTING**

To,

M/s COAL INDIA LIMITED

SUB:
TENDER NO:

Dear Sir

We have read the clause regarding Provisions for Procurement from a Bidder of a country which shares a land border with India and on sub-contracting to contractors from such countries; we certify that, bidder M/s _____ (Name of Bidder) is:

- (i) not from such a country []
- (ii) if from such a country, has been registered []
with the Competent Authority.
(Evidence of valid registration by
the Competent Authority shall be
attached)

(Bidder is to tick appropriate option (✓ or X) above).

We further certify that bidder M/s _____ (**Name of Bidder**) will not sub-contract any work to a contractor from such countries unless such contractor is registered with the Competent Authority.

We hereby certify that bidder M/s _____ (**Name of Bidder**) Fulfills all requirements in this regard and is eligible to be considered.

Place: [Signature of Authorized Signatory of Bidder]

Name:

Date: Designation:

Seal:



**COAL TO METHANOL PROJECT AT DANKUNI COAL
COMPLEX, WEST BENGAL ON BUILD OWN
OPERATE (BOO) BASIS, CIL**

DOC. NO.

REV

PNMM/ PC-176/E-4001

0

SHEET 1 OF 1



COAL INDIA LIMITED, KOLKATA

**TENDER DOCUMENT
(PART-II, TECHNICAL)**

FOR SETTING-UP OF

**COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-
OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA**

(TENDER NO.: PNMM/PC-176/E-4001)



PREPARED & ISSUED BY



**PROJECTS & DEVELOPMENT INDIA LTD.
(A Govt. Of India Enterprise)**

**PDIL BHAWAN, A-14, SECTOR-1,
NOIDA-201301 U.P. (INDIA).**

24.09. 2020

	COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, WEST BENGAL ON BUILD OWN OPERATE (BOO) BASIS MASTER INDEX	PNMM/PC176/E-4001	0	
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**SUBJECT : COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON
BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA**

(NIT NO: P PNMM/PC176/E-4001 DATED 24.09.2020)

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VOLUME - II: TECHNICAL


SECTION - 1.1

PROJECT DESCRIPTION

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA

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	PROJECT DESCRIPTION COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.1	0	
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2.0	Plot Area	3

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1.0 INTRODUCTION

Coal India Limited (CIL) as an organized state owned coal mining corporate came into being in November 1975 with the government taking over private coal mines. With a modest production of 79 Million Tonnes (Mt) at the year of its inception CIL today is the single largest coal producer in the world. Operating through 82 mining areas CIL is an apex body with seven wholly owned coal producing subsidiaries and one mine planning and Consultancy Company spread over eight provincial states of India. CIL also fully owns a mining company in Mozambique christened as 'Coal India Africana Limitada'. It has core competence across the entire gamut of the coal business value chain. The business domain includes exploration, planning and design of mines, coal mining operations, coal beneficiation and marketing. CIL meets 42% of the nation's primary energy demand and caters 84% of the nation's coal requirement.

M/s Coal India Limited has decided to build a world class Coal based Methanol Complex. The Coal to Methanol complex is to be built at **existing premises of Dankuni Coal Complex at Dankuni West Bengal (India)** and will consist of Coal Gasification Plant, Methanol Plant, along with Offsite and Utility Plants. Coal India Limited, intend to invite quotations from eligible contractors on BOO basis for building of Whole Complex for production of Methanol.

1.1 Projects & Development India Ltd. (PDIL) has been retained by **M/s Coal India Limited** as Technical Consultant for selection of a suitable BOO Operator for execution of the project on a Build-Own-Operate basis with Single point responsibility.

1.2 BOO Operator is advised to visit and examine the site conditions and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into the Contract. Claims of any kind due to variation or ignorance of site conditions and environmental conditions will not be eligible in any circumstances.



2.0 Plot Area:

Coal to Methanol Complex shall be built in the earmarked area as given in the overall site plan for Coal to Methanol Project. **BOO Operator** should ensure that the available area should be used in the most optimum way. The plot may be required to be changed considering utilization of occupied area of existing plant. The decision for which will be intimated before bidding.

2.1 Plant Site:

A brief status of infrastructure at "**Dankuni Coal Complex**" Site is furnished below:

- The proposed project will be located within the premises of existing premises of Dankuni Coal Complex.

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- Total land area of the site is 121 acre but 43 acre in 6 patches is available for proposed Coal to Methanol plant. Plant site will be made ready after 12 months from award of work.
- The proposed project is situated by the side of Durgapur Expressway in the north and Janai Road railway station of the grand chord in the south at Dankuni village of Hooghly district of West Bengal. The project site, adjacent to the Kolkata –Durgapur Expressway, at a distance of about 25 km by road from Kolkata. Kolkata Airport is the nearest Airport to the proposed project site which is about 20 km.
- **Existing Township & other facilities:** It is proposed that following facilities may be handed over after refurbishment to BOO OPERATOR and BOO operator may utilize them on chargeable basis which can mutually discussed between CIL and BOO Operator at a later stage. Alternatively, BOO Operator may carry out refurbishment themselves and shall be liable to pay nominal charges which can mutually discussed between CIL and BOO Operator at a later stage.



Residential houses: DCC Township has about 344 quarters. Out of 344 quarters, A-type quarters are 172 no, B-type are 90 nos., C-type are 72 nos. And D-type-10 Nos. Including one no. G.M. Bungalow. Presently some quarters of various types (A/B/C/D) are occupied by staff of DCC. Condition of these occupied quarters is better than the unoccupied quarters. Required no. of unoccupied quarters of different types, which are in better condition can be refurbished and converted to a good looking self contained modern township.

Public Buildings and Other Facilities: The following public building and other facilities are available but require proper refurbishing before any further use.

1. VIP Guest House
2. Officers Club Building
3. Community Centre
4. Two nos. High School
5. Apprentice Hostel
6. Health Centre
7. Overhead Tank & Water Supply System
8. Road, Drainage & Sewerage of Township
9. Small Shopping Complex

2.2 Process Technology: Coal Gasification

The process for coal gasification shall be based on one of the Technologies, as mentioned in Pre Qualification Criteria

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BOO Operator shall procure license & basic engineering package and assistance during construction, commissioning & operation from selected technology providers for the proposed plant.

Methanol Plant

Methanol Plant shall be based on one of the Technologies, as mentioned in Pre Qualification Criteria

BOO Operator shall procure license & basic engineering package and assistance during construction, commissioning & operation from the selected technology provider for the proposed plant.

Process units:

List of probable process units for the Methanol Complex along with their capacities:

S.N.	Process Unit	Capacity	Designer/ Licensor
1.	Feed Coal Preparation based on ROM Coal supply at Battery Limit (B.L.)	BOO Operator to Fill	Coal Gasification Licensor / BOO Operator
2.	Coal Gasification, Gas Cooling & Cleaning	BOO Operator to Fill	Coal Gasification Licensor
3.			
4.	Gas Purification, Air Separation Unit and Methanol Synthesis Gas Generation	BOO Operator to Fill	BOO Operator Based on Basic Engineering / Design from respective reputed system suppliers (Licensor) (with assistance of coal gasification licensor, if required).
5.	Sulphur Recovery Unit	BOO Operator to Fill	
6.	Methanol Syn. Gas Compression and Methanol Synthesis & Purification Plant	2050 MTPD	Basic Design Engineering from respective reputed system suppliers
7.	Steam Generation Plant	As per Requirement	BOO Operator to finalize
8.	Ash Handling	BOO Operator to Fill	Licensor/ BOO Operator
9.	Offsite & Utilities	As per Requirement	BOO Operator to finalize



Coal Gasification Plant shall be capable of handling high ash in the range of about 18% to 30% in Raniganj Coal Field (Indian coal) (ROM).

2.3 Utility & Other Facilities:

Major facilities are described as under: All utilities & offsite Facilities required for the Coal to methanol project Complex shall be in the scope of BOO Operator.

2.3.1 Raw water Source & supply

Raw water shall be supplied by the owner in water reservoir at plant site. Further treatment of raw water as per requirement in treatment plant shall be in the scope of BOO Operator. Construction water during construction period shall be provided by owner on chargeable basis. Charges for construction water will be intimated before submission the bid.

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2.3.2 Demineralised water system

DMW Plant and Condensate polishing unit are in the BOO Operator's scope. BOO Operator shall arrange its own DM water requirement during construction, pre-commissioning & Commissioning, if required. Condensate generated within B/L shall be treated in Condensate Polishing Unit in complex for recycle and reuse.

2.3.3 Drinking and Service water system

Treated water from the raw water treatment system is used as make-up to the drinking and service water systems. The service water system takes treated raw water for supply to hose stations, etc. by dedicated service water pumps and a distribution pipe network. Water for gardening is also supplied from this system. BOO Operator shall arrange its own Drinking water requirement during construction period.

2.3.4 Cooling water system

Process water make-up shall be used for cooling tower. If any further treatment is required for usage as cooling water, the same shall be in the scope of BOO Operator. BOO Operator shall consider the total CW system (concrete cooling tower, pumps, fans, piping network, chemical dosing and side stream filtration system etc.) required for Coal Gasification Plant, downstream Gas processing units to make Methanol Synthesis Gas & Entire Methanol Production unit including Methanol storage, Steam generation plant and any other requirement.

2.3.5 Steam and Power generation

Power: It is envisaged that entire power for BOO Operator B/L will be met from the grid supply.

Construction Power required for whole complex shall be provided by owner on chargeable basis. Charges for construction power will be intimated before submission the bid.

Power required for Plant start-up & operation for whole Complex shall be supplied by Electricity grid at a single point in substation located at BOO Operator B/L.



Steam: H.P steam requirement for Process use as well as drives shall be generated in Coal based Steam Generation Plant & same shall be in the scope of BOO Operator BOO Operator to maximise the use of generated steam inside process plants BOO Operator is required to optimize the use of steam & electric Power.

2.3.6 Plant and Instrument air system

Plant air and Instrument air will be generated by BOO Operator. Proper instrument air storage and Plant air & Instrument air distribution network shall be envisaged for the complex. Please refer Section-1.5 of Part-II Technical for plant and instrument air specification.

2.3.7 Nitrogen & Oxygen system

BOO Operator shall generate Nitrogen and Oxygen of desired specification to meet requirement of Nitrogen and Oxygen in the Coal Gasification Plant. Proper Nitrogen and

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Oxygen storage and distribution network shall be envisaged for the Coal Gasification Plant. In addition to this, provision for supplying of gaseous Nitrogen to other process plants along with separate Liquid Nitrogen storage to be used as utility Nitrogen as per requirement shall be under BOO Operator's scope.

2.3.8 Sulphur Recovery Unit (SRU) & Sulphur Storage

Recovery of Sulphur from H₂S generated in Acid Gas Removal Unit and transportation of liquid Sulphur to storage area shall be in BOO Operator's scope. BOO Operator shall construct the sulphur storage area. Liquid Sulphur gets solidified during storing and same shall be dispatched through trucks by owner.

2.3.9 Ash Handling System

BOO Operator shall construct the Slag/ Ash Handling System suitable for Slag, Slag-fines & fly ash and recycling/ transfer to Ash pond/ Storage for disposal by Owner.

2.3.10 Solid Waste Disposal

BOO Operator shall provide the disposal procedure for hazardous solid waste generated in their B/L. and shall also provide enabling infrastructure to dispose off the solid waste.

2.3.11 Effluent Treatment Plant

The effluent treatment system should be designed for a ZLD (Zero Liquid Discharge) concept & under BOO Operator's scope. Treatment system should be such that all liquid discharge shall meet the state and central pollution Control board's latest norms. Any changes for up-gradation/ modification is under scope of BOO Operator.

2.3.12. Other facilities available in DCC. (BOO Operator may review for possible utilisation (if any) and interact with Owner regarding any clarifications if required.)

- Fire Stations including all fire fighting facilities
- Administrative Building
- Training Centre
- Security Barack
- Railway Line for transportation

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PART - II: TECHNICAL



SECTION – 1.2

SCOPE OF WORK

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA



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1.0 GENERAL

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The Scope of Work for BOO OPERATOR shall include installation of Coal Gasification based Methanol plant including all offsite & Utilities at Dankuni Coal Complex owned by Coal India Limited, as per the requirements and specifications mentioned in the technical portion of the NIT. BOO OPERATOR shall install the facilities, own and operate the same under the terminology and conditions commonly known as BUILD-OWN-OPERATE (BOO).

BOO OPERATOR shall take care of all men and material and infrastructural facilities so as to operate and maintain the plant for uninterrupted supply of Methanol as defined in Design basis.



Scope of work of the BOO Operator shall include supply of Process License from respective licensors, Basic Design and Detailed Engineering, Procurement, Supply, Fabrication, Inspection by Third Party Inspection Agency (TPI) as applicable, Expediting, Route survey for Over Dimensional Consignments (ODCs), Insurance, Transportation of all equipment / materials to work site, Storage, Construction of Temporary facilities, temporary work construction and erection of all civil, mechanical, electrical and instrumentation works, assembly and Installation, obtaining all necessary statutory approvals, painting, insulation, fire proofing, Testing, Mechanical Completion, Pre-Commissioning, Commissioning, Sustained Load Test Run, Performance Guarantee Test Run (PGTR) including Total Project Management so as to complete the Coal Gasification Based Methanol Plant in all respect and operate the plants and supply Methanol of specified quantity and quality to Coal India Limited (CIL) as per technical requirements defined in the bid document and as per defined in scope of work. The works shall be carried out as per the specifications, standards, codes etc.

2.0 OTHER REQUIREMENTS:

- 2.1 Perform construction management and supervision of all equipments, material and works.
- 2.2 Provide and perform comprehensive quality assurance, quality control and inspection of all equipments, materials works - both in manufacturing shop and at work site.
- 2.3 Provide all manpower, materials, consumables, construction equipment / machines, tools, instruments, storage, fabrication, facility and all other services and inputs etc. necessary to perform the work and complete the plant.
- 2.4 Comply with all Central, State & Local Govt. regulations, laws and requirements applicable to the work and seek and obtain approval/ clearance/ renewal from such statutory bodies/ agencies, as required. CIL's scope in this regard will be only to provide authorization in favor of BOO OPERATOR for which necessary paper work will be done by BOO OPERATOR subject to indemnity. Payment for any penalty is under scope of BOO Operator.
- 2.5 Provide necessary temporary construction facilities like construction water, fabrication,

	SCOPE OF WORK COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.2	0	
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- storage, illumination etc.
- 2.6 Comply with all safety practices for and during work.
 - 2.7 Strictly comply with applicable codes and standards of Engineering, Fabrication, Inspection, Construction etc.
 - 2.8 Arrange services of Manufacturer's installation, commissioning Engineer(s) at Site during Mechanical Completion, Pre-commissioning, Commissioning of all the major equipment and systems.
 - 2.9 Provide all the temporary connections, supplies required for testing, pre-commissioning activities and also to provide all instrument metering systems required for measurements of various parameters, testing during test runs.
 - 2.10 Arrange spare parts for start up, pre-commissioning, commissioning, PGTR, operation of plants. All such spares are to be available at site prior to commissioning/start up of the plant including various test runs.
 - 2.11 Perform testing, flushing, cleaning and pre-commissioning, start-up/commissioning including guarantee performance runs of plant. Detail procedures in respect of these shall be submitted by BOO OPERATOR for CIL/ PMC's approval before commencement of such work.
 - 2.12 Submission of final As Built drawings and manufacturers, sub-vendor, vendor's documents, data, unit books in requisite copies soft & hard, duly catalogued and bound folders as per Final Document philosophy spelt out elsewhere in the Bid Document.
 - 2.13 Project Management and planning, scheduling and monitoring/comprehensive reporting services, periodic reviews, meeting notes with CIL/ PMC.
 - 2.14 The scope of work as described above shall be supplementary to the scope of work mentioned under various parts of Tender Document. In case of any contradiction between the two, the stipulations mentioned under various disciplines shall be governing. In this regard, CIL's interpretation shall be final and binding to BOO OPERATOR.
 - 2.15 Transportation of all the materials supplied by CIL, if any from CIL's store to BOO OPERATOR's Store/ work site including loading/ unloading and transportation of all materials including under BOO OPERATOR's Scope of Supply to work site.
 - 2.16 Total painting including for special paints, colour coding, insulations, refractory, CS / SS name plates etc.
 - 2.17 Any other work not specifically mentioned above but required to complete the work in all respects as per tender specifications, drawings and instruction of Engineer-in-Charge and also to result in an fully operable and maintainable plant. As spelt out elsewhere in this Tender, for all Civil Works, BOO OPERATOR's scope shall include removal of existing underground and / or rerouting above ground interferences as applicable. It is possible that underground cables, foundations, other services may be located during Construction Phase. The same shall be rerouted / protected by BOO OPERATOR using half cut pipes, and

	SCOPE OF WORK COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.2	0	
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adequate care shall be taken of the same during Engineering & Construction phases. BOO OPERATOR shall provide Metal Analyzer at Site for In-Situ Metallurgical Analysis of Metal, during the Project Execution Stage. BOO OPERATOR shall comply with the requirements of Positive Materials Identification, enclosed elsewhere in this Tender. PMI shall be carried out by BOO OPERATOR for all pressure components of Mechanical (including Rotary, Static & Package equipment, Piping Items & Instruments). For Metal gaskets & welding PMI shall be carried out on Sample Basis.

- 2.18 BOO OPERATOR shall implement the requirements if any, of HAZOP, HAZAN, SIL Study without any additional cost / time schedule implication to OWNER / PMC.
- 2.19 BOO OPERATOR shall adhere to Design Control exactly as per latest provisions of ISO 9001. BOO OPERATOR shall submit required records as evidence for review by CIL / PMC as and when required, and shall carry out changes based on CIL / PMC review.

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VOLUME-II: TECHNICAL

SECTION – 1.3

PROJECT EXECUTION PLAN

**PROJECT: COAL TO METHANOL (C2M) PROJECT
THROUGH COAL GASIFICATION ROUTE AT
DANKUNI COAL COMPLEX WEST BENGAL,
INDIA**

	PROJECT EXECUTION PLAN COAL GASIFICATION BASED METHANOL PLANT COAL INIDA LIMITED ON BUILD-OWN-OPERATE	PC176/E/4001/P- II/ SEC-1.3	0	
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	PROJECT EXECUTION PLAN COAL GASIFICATION BASED METHANOL PLANT COAL INDA LIMITED ON BUILD-OWN-OPERATE	PC176/E/4001/P- II/ SEC-1.3	0	
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1.0 PURPOSE:

This procedure has been prepared with the objective of

- Defining systematic and orderly administrative relationship amongst related parties during the execution and the operation of the plant.
- Progress reporting and review of progress of work.

2.0 COMMUNICATION AND GENERAL CORRESPONDENCE:

Project Manager of CIL is the sole contract for all activities of the project. Therefore all the correspondence between CIL and BOO OPERATOR shall be directly done with/ by Project Manager or by his authorized representative. The Name, Address, Telephone no, Fax, e-mail id shall be intimated during the kick off meeting.

3.0 PROJECT MANAGEMENT & EXECUTION:

3.1 Kick-Off Meeting:

Immediately after the award of job, a kick-off meeting will be held to finalise and establish the modalities and procedures to be adopted for execution of the contract based on the enquiry document, commitments made by BOO OPERATOR and subsequent agreements reached between CIL/PMC and BOO OPERATOR during negotiations. The kick-off meeting will be attended by key members of CIL/PMC and BOO OPERATOR. These will address the following details between CIL/PMC and BOO OPERATOR:

- i) Execution Methodology/ Philosophy, in the line with project requirement.
- ii) Project execution schedule
- iii) Progress Reporting
- iv) Project Co-ordination Procedures.
- v) Organization Chart
- vi) Construction Site related issues.

3.2 Project Procedures and Methodology:

Detailed Technical Requirements along with the Detailed Scope of Work and overall proposed implementation schedule shall be prepared by BOO OPERATOR. These will form the basis for formulation of the overall Project schedule of the plant by BOO OPERATOR. BOO OPERATOR is required to organise his services in a systematic manner to ensure execution and completion of the unit as per the schedule. BOO OPERATOR is required to submit along with his bid the methodology/procedure proposed by him for this unit together with the organisational set up proposed and bio-data of Key-personnel.

In order to achieve uniformity in execution of various activities of the Methanol Plant, BOO OPERATOR shall develop Engineering Design Basis and Project Procedures/ Methodologies to be adopted by the executing agency. BOO OPERATOR is required to carry-out his supply of Know-How, Process Package, detailed engineering, procurement, tendering, construction supervision and management, planning scheduling, monitoring, reviewing, reporting, and Overall Project Management activities in accordance with the job specifications / procedures developed by BOO OPERATOR based on the methodologies / procedures. All activities to be performed/services to be rendered by BOO OPERATOR under this contract shall be monitored by CIL/PMC and will be subject to periodic reviews by the PMC. BOO OPERATOR shall facilitate such reviews/monitoring by CIL/ PMC.

3.2.1. BOO OPERATOR's service for engineering, procurement, tendering, construction,

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supervision and management, planning, scheduling, monitoring, reporting, and overall project management shall meet the requirements given in this section.

- 3.2.2. English language and Metric Units shall be used in all documents, drawings, reports, correspondences etc. under this contract.
- 3.2.3 Critical drawings/documents prepared by BOO OPERATOR/Sub-bidders/Vendors shall be submitted to CIL/PMC for review. Such review by CIL/PMC shall, however, not relieve BOO OPERATOR of his responsibilities.
- 3.2.4 For achieving the Project schedule it may be necessary in some cases to prepare the drawings in stages and release it for construction so as to take up simultaneous execution of detail engineering and construction. Any revision involved for the above is included in the scope of work of BOO OPERATOR. Also any change required to meet the site conditions/statutory requirements shall have to be carried by BOO OPERATOR at no extra cost.
- 3.2.5 BOO OPERATOR is required to organise a Task Force of dedicated specialists from each discipline under a Project Engineering Manager who will be assisted by Engineering Coordinator. An engineering schedule will be prepared and submitted to CIL/PMC for review. This schedule shall be used for all engineering activities. The engineering coordinator shall coordinate all design and engineering activities and interact with Purchase, Inspection, expediting, C&T, tendering, planning, construction and project groups. His responsibilities shall include.

3.3. **Procurement:**

3.3.1 The procurement services to be provided by BOO OPERATOR shall cover the purchasing, inspection, expediting, Custom clearance and transportation activities & transportation activities and demurrage charges if any.

3.3.2 Purchase:

The Purchase activities will cover all equipments and materials required for completion of the Methanol plant.

3.3.3 Inspection and Expediting:

BOO OPERATOR is required to organise a proper inspection and expediting system so as to ensure timely delivery of all the items/equipment meeting the specified quality criteria. This function has to be carried out by appropriate deployment of qualified personnel who have wide experience in their respective fields. CIL/PMC will reserve the right to inspect items deemed necessary by them without any additional cost to BOO OPERATOR/Sub-bidder/vendor.

3.3.4 Customs Clearance and Transportation:

BOO OPERATOR is required to organise a custom clearance and transportation (C&T) system to ensure prompt clearance of imported equipments from customs and transportation of equipments/materials to project site from Ports/Vendors works.

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4.0 PROJECT PLANNING, SCHEDULING & MONITORING SYSTEM:

BOO OPERATOR is required to institute and maintain a proper planning; scheduling and monitoring system and employ professionally qualified and experienced planning Engineer(s) for the Project. The system shall have latest state-of-the-art technique; to this effect BOO OPERATOR shall implement this system through the Prima Vera Project Planner. The system developed should be capable to support and enforce proper control mechanism in the project. It should be based on hierarchical breakdown of works with elaborate level of detailing and control. The levels of controls should be such that it supports and foster controls at activity level, function level and management level with greater emphasis on target, scope and commitment at various stages of contract for accountability and action planning. Such multi-level/multi-tier system of planning, scheduling and monitoring, supports, effective information generation, assimilation, summarisation and reporting in proper and adequate manner. The system shall be predictive type and should constitute pre-warning mechanism to diagnose and anticipate the problem well in advance and provide preventive features/measures. It is required that work breakdown structure should consist of details of systems, work packages, functions, work items and activities from monitoring point of view at micro level and summarisation at higher levels. It is expected that the work breakdown structure coding system / methodology to be followed shall be informed / discussed with the successful BOO OPERATOR during the kick-off Meeting.

Following schedules documents/reports shall be prepared and submitted by BOO OPERATOR for CIL's/PMC's review at various stages of the Project:

- List of critical drawings.
- Breakdown of work packages to work items level.
- Input requirements of each work item/activity. s
- Schedule start and finish dates of all milestone/activities in line with overall schedule of the project.
- Overall system-wise, discipline-wise weightages for each item/activity.
- 3 month front end schedule within a week of award.

In this kick-off meeting, it will be endeavored to reach complete understanding with BOO OPERATOR on activities, inputs and logic to establish Planning Documents for Monitoring. Venue of the Kick-off Meeting to be held between the successful BOO OPERATOR, PMC & CIL, shall be either at PMC's Office or CIL's Office preferably at Noida / Kolkata and the same would be informed subsequently.

4.1 Overall Project Schedule:

BOO OPERATOR shall submit within 30 days of Fax of Intent, the work breakdown structure showing Project work load i.e. preparation of Process Package, tenders, Material Requisitions, Construction Drawings equipments etc. alongwith a sufficiently detailed overall project schedule in the activity network form, clearly indicating the major milestones, inter relationship / interdependencies between various activities such as process, engineering, procurement tendering, manufacture / delivery, construction etc. together with a computer analysis of critical path and floats as well as quantum of work for major activities.

The schedule will be reviewed by CIL/PMC and the comments if any shall be incorporated in

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the network issued for implementation within 2 weeks from receipt of comments. The network thus finalised shall form part of the Contract and will become the basis for developing further detailed activity Network. This schedule shall not be revised without the prior permission from CIL/PMC during the entire period of contract. The changes made during revision of the contract shall be approved by CIL/PMC in writing.

4.2 Detailed Activity Network:

BOO OPERATOR should develop detailed activity networks for various systems/plant/ unit of the Project, based on approved overall project schedule within 2 months of fax of intent. Such networks would be computerised for further monitoring and reporting.

4.3 Progress Measurement Methodology

BOO OPERATOR is required to submit during the Kick off Meeting, the detail methodology of progress measurement of Engineering, Procurement, Manufacturing / Delivery, computation of total service/physical progress at the unit-wise level and on the overall basis. The progress basis shall be physical realisation of work such as in terms of deliverables and construction quantity/volume accomplished. The amalgamation of such output across the project to compute overall progress shall be suitably established with proper rational and norms and maintained throughout the project. CIL/PMC reserves the right to modify the methodology in part or in full.

4.4 Vendor Scheduling and Monitoring

BOO OPERATOR shall establish schedules for pre-ordering and post ordering for follow up. The vendor monitoring preferably should be on logical networks and commitments atleast on critical items in order to monitor them on regular basis for effective control. CIL/PMC may demand such follow up procedure and logical networks for the various critical equipment at any time during the course of order execution. The manufacturing schedule shall be established and agreed with the vendors and acceptance shall be brought to the notice of CIL/PMC in time.

4.5 Construction Network

BOO OPERATOR shall prepare and submit a detailed construction network with full consideration of logistics, construction studies and method for CIL/PMC. BOO OPERATOR shall describe the resources required and special construction equipments, Tools & Tackles to be mobilized. The network shall be developed subsequent of substantial progress of engineering and ordering with fairly known construction workload and quantities.

4.6 As indicated elsewhere, Project Schedules as above shall be developed/evolved using the latest version of the Prima Vera Project Planner Software Package.

4.7 Progress Reporting:

BOO OPERATOR shall submit the following progress reports on a regular basis for CIL/PMC information/review.

4.7.1 Monthly Progress Report:

This report shall be submitted on a monthly basis within 7 calendar days from cutoff date, or as agreed upon, covering overall scenario of the project. The report shall include, but not limited, to the following:

- Executive summary - Summary of major events/activities.

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- Schedule v/s actual percentage progress and progress curves for detailed Engineering, sub-ordering, Manufacturing/Delivery, Contracting, construction commissioning and overall. Areas of concern/problem/hold-ups, impact and recovery action plans/catch-up plan. Activities executed achievements during the months and targets for the following month. Analysis of critical activities and impact on overall completion. Chronological achievements of key events indicating schedules and actual occurrence date. Annexure giving status summary for drawings material requisitions, equipment and materials delivery, contracting & construction, Resource requirement & deployment status.

5.0 PROJECT TIME CONTROL METHODOLOGY:

5.1 The time for completion of the complete scope of work shall be strictly as per the time schedule given in the tender document.

5.2 BOO OPERATOR shall furnish the following documents along with the bid.

5.2.1 An overall schedule in the form of Network, clearly indicating all important milestones in design, engineering, fabrication, procurement construction, testing and commissioning for the plant commensurate with the overall time schedule.

5.2.2 Resource deployment schedule indicating mobilisation of all critical resources including manpower and machinery for the smooth execution of the job at engineering offices, fabrication shops & construction site. The resource schedule shall also contain various construction aids envisaged to be deployed for execution.

5.2.3 Organization structure for effective project management and control, clearly indicating the responsibility center as well as bio-data of the key personnel, who are permanent employees of BOO OPERATOR, shall be identified for the project.

5.3 Within 30 days of issue of Fax / letter of intent BOO OPERATOR shall finalize with CIL/PMC the following as:

5.3.1 Overall Project Schedule:

Overall Project Schedule in line with the agreed milestone and detailed to adequate work breakdown structure level covering all phases of the work such as supply of Know-how, Process Package, design engineering, procurement manufacturing, shipment, tendering & field erection. This schedule shall also include the interface activities to be provided by CIL/PMC and the dates by which such facilities are needed. BOO OPERATOR shall get the scheduled submitted & reviewed by CIL/PMC and the agreed schedule shall form part of the Contract monitoring document based on which performance would be reported and evaluated. This document shall be signed by both the parties. CIL/PMC shall also review the weightage allotted to various activities and method of reporting to be adopted by BOO OPERATOR. During the progress of the contract if in the opinion of CIL/PMC, desired progress as physically/sequentially is not maintained, it would be obligatory on BOO OPERATOR to re-programme the work schedule in order to accommodate the backlog and/or provide work front to other agency, without any obligation to CIL / PMC.

5.3.2 BOO OPERATOR at any point of time of operating would be permitted to revise the accepted schedule/control documents with CIL/PMC without changing the contractual completion date, subject to prior approval by CIL/PMC in writing.

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- 5.3.3 The review of the performance of work would be made at different levels of management and BOO OPERATOR is expected to ensure proper participation for effective reviewing and action plan.
- 5.3.4 BOO OPERATOR should ensure availability of professionally qualified planning Engineer both at H.O and site deemed adequate by CIL/PMC.
- 5.3.5 BOO OPERATOR at his own cost should maintain a control room at site highlighting all the features, schedule and achievements of the project.
- 5.3.6 Weighted percentage of each discipline/group of work shall be mutually agreed to between BOO OPERATOR and CIL/PMC after the award of contract to facilitate compilation of progress.

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SECTION 1.4

DESIGN BASIS

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA

0	24.09.2020	24.09.2020	Issued for Tender Purpose	SK	SKK	MN
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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ANNEXURES

SL. NO.	DESCRIPTION	NUMBER OF SHEETS

1.0 GENERAL

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This document (Design basis) indicates the requirements for design of Coal Gasification based Methanol Plant and all associated facilities such as Boiler, Raw water treatment Plant, DM Plant, Instrument Air Plant and ETP to be constructed by BOO Operator on BOO basis.

2.0 REQUIREMENT PERTAINING TO COAL GASIFICATION BASED METHANOL PLANT:

- 2.1 The Coal Gasification based Methanol Plant shall be designed to meet the following quantity requirement of Methanol. However, BOO operator shall specify the supply quantities of other by-products.

Methanol Plant (2050 MTPD):

Continuous Normal requirement:	85.4 Mt/hr	(100%)
Maximum requirement:	94 Mt/hr	(110%)
Minimum requirement:	42.7 Mt/hr	(50%)

By- products

Sulphur:

Continuous Normal supply:	----- Kg/hr (To be specified by BOO operator)
Minimum supply:	----- Kg/hr (To be specified by BOO operator)

Ash/ Slag/ Slag-fine:



Continuous Normal supply:	----- Kg/hr (To be specified by BOO operator)
Minimum supply:	----- Kg/hr (To be specified by BOO operator)

2.2 QUALITY SPECIFICATION

Product Methanol produced from the Methanol plant shall cater to the following minimum specification:

Sl. No.	Components	Composition
1.	Methanol, wt% (min.) / Grade	99.85 / AA
2.	Water, wt% (max.)	0.1
3.	Acetone & Aldehyds, wt% (max.)	0.003
4.	Acetone, wt% (max.)	0.002
5.	Acidity (as acetic acid), wt% (max.)	0.003
6.	Appearance	Free of opalescence, suspended matter, and sediment
7.	Carbonizable impurities, colour.pt.co max.	No. 30 of ASTM D1209
8.	Colour, Pt-co maximum	No.5 of ASTM D1209
9.	Distillation ranges at 760mm Hg, max	10.0 °C (and shall include 64.6 °C ±0.1 °C)
10.	Ethanol, wt% (max.)	0.001
11.	Non-volatile matter, mg per 100ml maxi.	10
12.	Odor	Characteristic. Non- residual
13.	Permanganate time	No discharge of colour in 50 min.
14.	Specific gravity at 20 ⁰ / 20 ⁰ C, maximum	0.7928
15.	Alkalinity (as ammonal), wt% (max.)	0.003
16.	Pressure @ B.L of Methanol Plant, kg/cm ² a (Min.)	BOO Operator to decide
17.	Temperature, °C (max.)	41 Max.

By-product Sulphur (solid) produced from the plant shall cater to the following minimum specification:

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Parameter	Unit	Value
Sulphur(S)	Wt. %(min, dry)	99.9
Hydrogen Sulphide (H ₂ S)	Wt.ppm(max, dry)	10
Ash	Wt.ppm (max)	200
Colour		Bright Yellow
Pressure	Kg/Cm ² abs	Not Relevant
Temperature	°C	Ambient
Physical Appearance		Solid lumps

By Product Fly Ash/slag (solid) / Slag-fine produced from the plant shall cater to the following minimum specification:

Parameter	Unit	Value
Fly-ash/ Slag/ Slag-fines	Wt. %/ Wt. %/ Wt. %	(To be specified by BOO Operator)
Moisture (H ₂ O)	Wt. %/ Wt. %/ Wt. %	(To be specified by BOO Operator)
Carbon Content	Wt. %	Fly Ash: <5 Slag: <2 Slag fines: <30
Pressure	Kg/cm ² a	Atmospheric
Temperature	°C	<80
Physical appearance		(To be specified by BOO Operator)

2.3 Feed stock:



Specification of ROM Coal fed to Coal Gasification Plant for production of Methanol Synthesis Gas is as follows: Available coal analysis mentioned in the Clause no. 1.1 of Section-1.5 (Raw Material & Utility Specification) Technical.

24% ash content in coal shall be the basis of design for Coal Gasification plant along with all associated facilities to generate Methanol Syn. gas, Methanol Plant (2050 MTPD), Steam Generation Plant and all associated offsite & utilities etc. Bidder shall also furnish the Guaranteed specific coal consumption (in Metric Tonnes of coal per tonne of Methanol) at different levels of ash content as per table given below:-

Sr. No.	Ash Content in Coal (%)	Guaranteed specific coal consumption per tonne of Methanol* (MT)
1.	18.0 < Ash% < 20.0	
2.	20.0 ≤ Ash% < 22.0	
3.	22.0 ≤ Ash% < 24.0	
4.	24.0 < Ash% < 26.0	
5.	26.0 < Ash% < 28.0	
6.	28.0 ≤ Ash% < 30.0	
7.	18.0 ≤ Ash% < 20.0	

*In case the ash content in the supplied coal is beyond the above range (i.e. beyond 18 < Ash% < 30), the guaranteed specific coal consumption on either side shall be derived mathematically through extrapolation at multiple of 2.0% intervals.

Required Raw Coal shall be supplied at the unloading hopper from BOBRN type wagon by the owner.

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To ensure continuous feed supply at a constant rate at coal gasification plant & Steam Generation Plant through conveyor belts, proper facility shall be put up by BOO operator for storage / transfer of coal from BOO Operator B.L. to gasification plant & Steam Generation Plant.

Sulphur storage/ operation/ maintenance: Details of offsite storage facility for Sulphur that shall be provided by BOO operator:

- Storage Capacity = Seven day's production
- Storage area = ----- m² (To be specified by BOO operator)
- Storage pressure = Atmospheric
- Operated/maintained by = BOO Operator
- Unloading facility from pipeline = by BOO operator at B.L. of OWNER.

Fly Ash/ Slag/ Slag-fine storage/ disposal: Details of offsite storage facility for Ash/ Slag/ Slag-fine shall be provided by BOO operator:

- Storage Capacity = Fifteen day's production
- Storage area = ----- m² (To be specified by BOO operator)
- Storage pressure = Atmospheric
- Operated/ maintained by = BOO Operator.
- Disposal of Fly ash/ slag/ Slag Fine from inter-mediate storage located at BOO B.L. shall be the responsibility of BOO operator.



Methanol Storage & Loading Gantry

Methanol Storage Tanks of 2X 10000Mt capacities & Transfer Pump along with Methanol loading gantry for Tank Truck and Rail wagon shall be in the scope of BOO Operator. Tank Truck loading gantry shall be designed for loading of 10% of total Methanol production per day. Rail wagon loading gantry shall be designed for loading of total methanol production per day.

3.0 Guarantee

BOO Operator shall guarantee performance of Coal Gasification based Methanol Plant as specified in this Clause under the following heads.

1. Capacity mentioned in clause no. 2.1
2. Quality of the product mentioned in clause no. 2.2
3. Works cost
4. Noise Level
5. Gaseous Emission
6. Liquid Effluent

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Failure to meet capacity of the plants, quality of the products, specific consumption of raw material/ utilities, pollution levels and noise levels shall be breach of contract requiring corrective action by BOO Operator irrespective of the cost involved.

For penalty clauses, please refer Part-1 Commercial Section.



BOO Operator shall guarantee overall consumption of ROM Coal (refer clause no. 2.3 of this section), Fluxant, Power, make-up water for generating Methanol Grade-AA at 100% plant capacity.

BOO Operator shall furnish all data and shall guarantee the Total Works Costs per day for production of Methanol meeting the quality and conditions in the following manner.

Sl. No	Raw Materials/ Utilities	Consumption per day (Q)	Cost per day (Q*R) INR
1.	ROM Coal, MT		
2.	Fluxant, MT		
3.	Make-up Water, M ³		
4.	Power, KWh		
5.	Guaranteed Total Works Cost "A"/Day = $\sum(Q \times R)$ {Sl.No.1-4}		
6.	Production figures (per day): Methanol Grade-AA "N" (MTPD)		
7.	Guaranteed Specific Work Cost/ MT of Methanol Grade-AA "S" = A/N)		

Notes:

- i) The guaranteed works cost shall include cost of materials and utilities required and power consumption for building cooling/ heating, lighting, ventilations, air conditioning and consequent costs of such materials which are in the usual operation of the plant
- ii) For Bid submission purpose, BOO Operator shall furnish consumption and generation figures of ROM Coal, Fluxant, Power, Make-up Water respectively whose actual works cost shall be calculated on the basis of Unit Price mentioned in the above table
- iii) For the purpose of calculating specific works cost of Methanol Grade-AA; ROM Coal, Fluxant, Make up water and Power
- iv) No meter tolerances are allowed
- v) Steam venting is not allowed

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4.0 GENERAL REQUIREMENTS:

4.1 Plant On-stream factor:

BOO OPERATOR may require from time to time to shutdown the production facilities of the Production Plant for such period of time as may be necessary for BOO OPERATOR to make ordinary repairs and for maintenance consistent with proper operation. However, such planned shutdown (turn-around) shall be limited to about 35 (thirty five) days at a stretch once in every year.

In addition, the Coal Based Methanol plant will be planned for shutdown to meet the requirements of regulatory bodies (such as Indian Boiler Regulations) at intervals as specified by those respective regulatory bodies. BOO OPERATOR will be allowed to undertake such shutdown as per statutory requirements. BOO OPERATOR will make all endeavours to utilise these shutdown on account of statutory requirements for other maintenance of plant as may be necessary from time to time as well as for replacement of catalyst.

4.2 Turn-Down ratio:

The Coal based Methanol Plant shall be designed to operate with turn-down ratios as given below:

- Coal Gasification Plant: 50% of plant design capacity
- Methanol Plant: 50% of plant design capacity
- Ash / Slag: 50% of plant design capacity

4.3 Capacity Utilization

Name plate capacity of Methanol Complex is 2050 MTPD i.e. 100%. However, rated capacity of Methanol complex shall be 110%.

4.4 Plant Availability:

Plant availability factor for all the Coal Based Methanol Plant should be 98.5% (min) excluding the planned shutdowns.



4.5 Flare:

Flare system shall be in the BOO operator's scope. All the flaring requirement for the Coal Based Methanol Plant shall be provided by the BOO operator within the battery limit to cater to the discharge of mitigated flare load from the unit.

All hydrocarbon / combustible gases and vapours shall be relieved to the flare through a knock out drum. Flare stake shall be in the scope of BOO Operator.

Quantity:

Provision for mitigated HP flare load from Coal Based Methanol	To be specified by
--	--------------------

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Plant	BOO Operator
Provision for mitigated LP flare load from Coal based Methanol Plant	To be specified by BOO Operator

4.6 Reliability:

In order to install a high degree of confidence and reliability of the offered plant, the following shall be taken care of by BOO OPERATOR:

- a) Providing adequate redundancy and standby requirements both for equipment and control systems based on their experience of operating similar BOO plants.
- b) Maintaining adequate inventory of spare parts – BOO OPERATOR shall maintain adequate inventory for the spare parts required for routine maintenance.
- c) 2 out of 3 voting logic to be considered for major plant trip logic functions.
- d) Providing catalyst volumes in the reactors with minimum catalyst life of 3 years, standby reactors to be considered wherever catalyst life is less than 3 years.

5.0 Catalysts, Chemicals, Adsorbents and Absorbents:

BOO OPERATOR to arrange/ consider all facilities for receiving, sorting, loading and unloading Catalyst/ additive/ adsorbents/ chemicals & passivation facilities within ISBL of the BOO facility as required in their scope. Consumables and chemicals required by BOO Operator will not be supplied and same shall be sourced by BOO Operator directly.

6.0 Effluents from Coal Based Methanol plant

Basis of design of Coal based Methanol Plant shall be for Zero effluent discharge. All type of effluent i.e. Process Waste Water, Boiler Blow Down water, Cooling water Blow-Down, oily water etc. from all the units within Complex during Normal, start-up, Shut down and upset conditions shall be routed to Effluent Treatment Plant through oily water sewer (OWS):-

▪ Liquid Effluent Parameter from ETP Outlet



As per Central Pollution Control Board/ State Pollution Control Board norms for effluent discharge.

▪ Oily water

Parameter	Unit	Value
Oil	mg/lit (max)	10
Quantity	M ³ /Hr (max)	(To be specified by BOO operator)
Frequency of discharge per year		(To be specified by BOO operator)
Duration of each discharge	Hrs.	(To be specified by BOO operator)

▪ Boiler Blow-down

Parameter	Unit	Value
pH		9 – 11

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Silica (as SiO ₂)	ppm	< 0.5
Conductivity	μS/cm	<50
Phosphate (PO ₄ ³⁻)	ppm	2 - 5
Quantity	M ³ /Hr (max)	(To be specified by BOO operator)
Frequency of discharge per year		(To be specified by BOO operator)
Duration of each discharge	Hrs.	(To be specified by BOO operator)

▪ Sour water

Parameter	Unit	Value
H ₂ S	Wt. %	< 1
Quantity	M ³ /Hr (max)	(To be specified by BOO operator)
Frequency of discharge per year		(To be specified by BOO operator)
Duration of each discharge	Hrs.	(To be specified by BOO operator)

BOO OPERATOR has to confirm compliance to above rates and specifications.

7.0 Specific Process Design Guidelines:



- 7.1 BOO Operator has to design the unit for maximum energy efficiency, meeting benchmark numbers of international bench marking agencies. Process and equipment design should incorporate features for maximizing energy efficiency.
- 7.2 Special safety requirements such as Methanol/H₂S leak detectors and snuffing rings around leak prone flanges, etc., shall be provided, wherever necessary.
- 7.3 Standards proposed by Central Pollution Control Board & State pollution Control Board of India for emissions from the methanol plant to be followed w.r.t. BOO units and periodic reports needs to be submitted to Coal India.
- 7.4 Design of units shall incorporate various safety features in line with international safety standards and design practices. BOO Operator shall furnish brief write-up in the proposal highlighting such safety features.
- 7.5 Flare relief from production plant shall be kept as minimum as possible. Flare mitigation required to meet minimum flaring as per applicable API code shall be adopted.

8.0 SAFETY, HEALTH & ENVIRONMENT:

8.1 General

BOO OPERATOR & his employees shall –

1. Comply with the conditions of the EC (Environmental Clearance), NOC/ Consent to Establish, Air & Water Consents, Hazardous Waste Authorization and the standards stipulated in the Gazette Notifications for the concerned industry.
2. Follow all the relevant rules & regulations like The Factories Act, The Environment (Protection) Act etc.
3. Implement recommendations of EIA Report & Risk Analysis Report.

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8.2 Safety

BOO OPERATOR & his employees shall –

1. Observe own safety rules & regulations in the Production plant and rules & regulations of the refinery outside the Production plant.
2. Observe 'No Smoking' strictly in the BOO premises except the earmarked place (smoking booth). Any person who is found smoking or in the possession of match box or lighter or any other means of ignition in the Complex or in the Production plant shall be turned out of the Complex gate. Suitable action as decided by the OWNER's management shall also be taken.
3. Maintain good standards of housekeeping.
4. Take all safety precautions and obtain permission from the Fire & Safety Department of the Complex before carrying out any hot job.
5. Deploy a qualified safety officer to monitor the safety performance.
6. Obtain permission from the Fire & Safety Department of the Complex before drawing water from the fire water network of the Complex.
7. Report all accidents to the Fire & Safety Department of the Complex and fulfill all legal formalities.
8. Enlist all chemicals on stock with their respective MSDS.
9. Be a part of the OWNER's Emergency Response Team and shall participate in mock drills, rescue operations organized by the OWNER.
10. Take due insurance cover for affecting neighbour hood (damage, loss & injury to people, property & environment) due to any untoward incident.

8.3 Traffic Safety



BOO Operator & his employees shall –

1. Maintain the speed limit of 25 Km/hr inside the Complex premises.
2. Avoid traffic congestion and abide by the traffic rules by deploying trained and licensed drivers.

8.4 Environment

BOO Operator & his employees shall –

1. Shall avoid wastage of drinking water, etc. (Utilities supplied free of cost by OWNER)
2. Transfer only neutralized effluent to the Effluent Treatment Plant as specified in cl.4.0 above
3. Install Hydrocarbon (HC) leak detectors at strategic locations in the plant area.

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4. Install SO₂, NO_x, CO analyzers in all the stacks for computerized monitoring as stipulated in the EC. Stack heights shall be as per standard/ codes and stacks shall have proper sampling & monitoring facilities.

Stack Emission Limit

SO ₂	100 mg/ Nm
NO _x	100 mg/ Nm ³
Particulate Matter	10 mg/ Nm ³
CO	100 mg/ Nm ³
Methanol	< 50 mg/Nm ³
Sulphur	< 20 PPMv
Pressure	Atmospheric

Carbon Mono-oxide emission limit shall be 650 PPMv (max) for Shift Conversion Section.

Boo Operator to follow the latest norm of CPCB/ WBSPCB. State PCB or Central PCB norms whichever is more stringent shall be complied by BOO Operator

5. Monitor fugitive emission of Hydrocarbon (HC) / VOC & Benzene through Portable Monitor at periodicity as per the latest Gazette Notification.

Limit of VOC & Benzene Concentration

	VOC ppm	Benzene ppm
Pump/ Compressor	5000	2000
Valves/ Flanges	3000	1000
Other Components	3000	1000

6. **Ground Level Concentration:**

The BOO Operator shall guarantee the ground level concentration in the atmospheric air of within plant area and shall not exceed the limits given below:



TLV (for 8 hrs working)

Parameter	Value
Carbon monoxide	2 ppm
PM ₁₀	100 µg/m ³
PM _{2.5}	60 µg/m ³
SO _x	80 µg/m ³
NO _x	80 µg/m ³

TLV for 8 hours shall be as per latest OHSAS/ ACGIH

7. **Noise Level:**

BOO Operator shall guarantee the noise level within the ISBL Plant premises. Noise nuisance from machinery is normally specified as sound pressure level which for standard design shall not exceed, in work areas, 85dBA at 1m distance from each source. However, Maximum allowable noise limit shall not exceed higher values of noise level (115 dBa) as per OSHA standard during any upset conditions.

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8. Monitor noise level at a periodicity of 3 months.
9. Send all monitoring reports to the OWNER.
10. Allow access to the OWNER and their monitoring agencies in the Production plant and take action on any observation/ deficiency found within the timeframe directed by the OWNER.
11. Arrange for disposal of solid waste like spent catalyst, etc. through 3rd parties following all the applicable rules.
12. Maintain records of solid waste generation & disposal and send report to the OWNER.
13. Take adequate measures for protection of land & ground water and shall also be responsible for land reclamation. No waste, regardless of composition, shall be drained to sewers, trenches, ditches or channels.
14. Allow access to the statutory bodies for inspection in the Production plant and implement recommendations, if any within the stipulated timeframe.
15. Take the OWNER's consent before doing any modification/ alteration/ deletion in the Production plant and if required, take necessary approval from the statutory authorities on behalf of the OWNER.

9.0 UTILITIES:

Refer Section-1.5 Part-II Technical

10.0 CLIMATIC DATA

10.1 Wind:



Wind Load Design: as defined in IS: 875 Part 3

10.2 Air Temperature:

Parameters	Temperature, °C	Remarks
Dry bulb (Summer)		
Dry bulb (Winter)		
Average Temperature		
wet bulb		
Max for Mechanical / Civil / Structural		
Minimum for winterization (Average)		

Atmospheric Air Composition:

Parameters	Value	Remarks
SO _x		
NO _x		
NH ₃		
SPM ₁₀		
HC (methane)		
HC (non methane)		
CO		

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VOC		
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NOTE: Bidder to take correction factors and worst atmospheric condition on above.

10.3 Relative Humidity:

Relative Humidity	RH%
Relative Humidity	

10.4 Rainfall:

Rainfall	Value
Annual	_____ mm
Design rainfall (per hour)	_____ mm

Note: - Civil philosophy is to be referred

10.5 Barometric Pressure:

Barometric Pressure	Value
Average	_____ mbar

10.6 Seismic Design Code:

Refer Section-1.12 (Design Philosophy – Civil & Structural Works) Part II-Technical.

10.7 Plant Elevation:

The final plant elevation shall be established in consultation with owner / consultant based on overall project requirement.

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SECTION – 1.5

RAW MATERIAL AND UTILITY SPECIFICATIONS

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA

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1.0	OWNER'S SCOPE	3
2.0	BOO OPERATOR'S SCOPE	3

LIST OF ATTACHMENT

Attachment number	Description	Number of Sheets

1. OWNER'S SCOPE

	RAW MATERIAL, PRODUCT AND UTILITY SPECIFICATIONS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.5	0	
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Owner shall provide the followings Raw material and utilities on chargeable basis as mentioned in below clauses:-

1.1 RUN OF MINE (ROM) COAL

Specification of ROM Coal fed to Coal Gasification Plant for production of Methanol Synthesis Gas is as follows:

Sr. No.	% Ash	% Moisture	% Volatile Matter	Gross cal. Value
1.	19.5	4.88	29.98	6010
2.	28.53	5.31	27.80	5097

Further, please refer clause no. 2.3 of Section-1.4 (Design Basis) Technical.

1.2 RAW WATER

Sr. No.	Raw water supply at Plant B.L.	
1.	pH	6.8
2.	Hardness (PPM)	200
3.	Free Mineral Acid (PPM)	---
4.	Chloride (PPM)	210
5.	Iron as Fe (PPM)	5
6.	TDS (PPM)	705

1.3 POWER

Power shall be provided from state grid. Further, Refer Section-1.10 Design Philosophy Electrical.

2.0 BOO OPERATOR'S SCOPE

2.1	H.P Steam		
		Operating	Design
	Pressure, kg/cm ² g (Min/ Nor/ Max)	*	*
	Temperature, °C (Min/ Nor/ Max)	*	*
	Silica as SiO ₂ , ppm	< 0.02	
	pH	9-9.5	
	Conductivity, μS/cm (at 25 deg.C)	< 0.2	
	Total Iron (Fe) mg/kg	<0.01	
	Na+K mg/kg	<0.01	
	Copper mg/kg	0.003	
	* Above Figure shall be filled by BOO Operator		
2.2	M.P Steam		
		Operating	Design
	Pressure, kg/cm ² g (Min/ Nor/ Max)	*	*
	Temperature, °C (Min/ Nor/ Max)	*	*



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	*Above Figure shall be filled by Boo Operator		
2.3	L.P Steam		
		Operating	Design
	Pressure, kg/cm ² g (Min/Nor/Max)	*	*
	Temperature, °C (Min/ Nor/ Max)	*	*
	*Above Figure shall be filled by Boo Operator		
2.4	Cooling Water (Added with suitable chemicals)		
	Supply Header Pressure, kg/cm ² g (Min/ Nor/ Max)	BOO Operator to decide	
	Return Header Pressure, kg/cm ² g (Min/ Nor/ Max)	BOO Operator to decide	
	Mechanical Design Pressure, kg/cm ² g	8.0	
	Supply Header Temperature, °C	33	
	Return Header Temperature, °C	By BOO Operator	
	Mechanical Design Temperature, °C	70	
	Design wet Bulb temperature , °C	29.0	
	ΔT	10 °C max.	
	Relative Humidity at Dankuni	100% (max.)	
	COC	5	
	Drift losses and evaporation loss (% of circn.)	By BOO Operator	
	Analysis of Cooling Water	By BOO Operator	
	pH		
	Conductivity, μ mho/cm		
	Turbidity, NTU		
	Total Alkanity as CaCO ₃ , ppm		
	P. Alkanity as CaCO ₃ , ppm		
	Total Hardness as CaCO ₃ , ppm		
	Ca Hardness as CaCO ₃ , ppm		
	Mg Hardness as CaCO ₃ , ppm		
	Chloride as Cl, ppm		
	TDS, ppm		
	Total iron as Fe, ppm		
	Corrosion Rate, ppm		
	Silica as SiO ₂ , ppm		
	Nitrate as NO ₃ , ppm		
	Sulphate as SO ₄ , ppm		
	SRB count		
	Total Suspended solids (TSS)		
	Manganese as Mn		
	Free Chlorine, ppm		
	Phosphate as PO ₄ (Orth), ppm		



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	Total Phosphate, ppm			
2.5	Nitrogen Gas (Utility)			
	Pressure, kg/cm ² g (Min/Nor/Design)	6.0/8.0/9.0		
	Temperature	Ambient		
	N ₂ , Vol %, min	99.99%		
	O ₂ , Vol ppm	< 10		
2.6	Nitrogen Liquid (Utility)			
	Nitrogen (N ₂) Vol. %, Min.	99.99%		
	Oxygen (O ₂) Vol. ppm	< 10		
	Pressure (Min/Nor/Max.) Kg/Cm ² abs	BOO Operator to specify		
	Temperature °C	BOO Operator to specify		
2.7	Instrument Air	Min.	Nor.	Max.
	Pressure, kg/cm ² g	6.0	8.0	10.0
	Supply Temperature, °C	Ambient	Ambient	50
	Mech. Design Pressure, kg/cm ² g	10.5		
	Mech. Design Temperature, °C	65		
	Dew point	-40 °C at atm. pressure		
	Quality	Free of dust, water drops & oil		
	Storage Capacity (10 to 6 Kg/Cm ² g depressurization) at each unit	15 minute		
	Storage Capacity (40 to 6 Kg/cm ² g depressurization) at Instrument Air Plant	15 minute		
2.8	Demineralised Water			
	Pressure @ B/L, kg/cm ² g (Min/ Nor/ Max)	4.0/ 5.5/ 6.0		
	Temperature, °C (Normal)	Ambient/ 40 (max)		
	Mech. Design Pressure, kg/cm ² g	10		
	Mech. Design Temperature, °C	70		
	pH	6.5-8.5		
	Total Hardness, ppm wt.	Zero		
	Total Dissolved Solids, ppm wt (max.)	0.1		
	Conductivity at 20 deg C, micro mho/cm (max.)	<0.2		
	M Alkanity as CaCO ₃ , ppm wt.	Nil		
	Chlorides, ppm wt.	Nil		
	Iron as Fe, ppm wt. (max.)	0.01		
	Copper , mg/l	<0.003		
	Silica as SiO ₂ , ppm wt. (max.)	0.02		
	Oil, ppm wt.	Nil		
	Sodium as Na, ppm wt. (max.)	< 0.1		

	RAW MATERIAL, PRODUCT AND UTILITY SPECIFICATIONS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.5	0	
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2.9 Boiler Feed Water	
Total Hardness as CaCO ₃ , ppm	Nil
O ₂ , ppm	<0.005
Silica as SiO ₂ , ppm	< 0.02
pH (at 25 deg. C)	8.5-9.5
Conductivity, μS/cm (at 25 ⁰ C before pH adjustment with NH ₃)	< 0.3
Oil, ppm	Nil
Fe +Cu mg/lt.	<0.01
Residual Hydrazine (as N ₂ H ₄) Mg/l	<0.05
Oxygen consumed in 4 hours, mg/l	Nil
2.10 Boiler Blow Down (Boiler CBD)	
pH	9.0-10.0
Silica as SiO ₂ , ppm	< 0.5
Conductivity, μS/cm	< 50
Phosphate, ppm	2-5
2.11 Service Water	
Colour	< 5.0
Smell	Agreeable
pH	7.0-8.5
Taste & Odour	Unobjectionable
TDS, mg/l	< 150
Turbidity, NTU	< 1.0
Total Hardness, mg/l	< 85
Chloride (as Cl), mg/l	< 15
Sulphate (as SO ₄), mg/l	< 60
Total Iron (Fe), mg/l	< 0.01
Dissolved Silica, mg/l	< 4
Supply Pressure, kg/cm ² g (Min/ Nor/ Max)	4.0/6.0/8.0
Supply Temperature, deg C	Ambient
Mechanical Design Pressure, kg/cm ² g	10.5
Mechanical Design Temperature, deg C	65
2.12 Process Water (after treatment) , BOO Operator to Fill	
pH	
Chlorides, mg/l	
Sulphates, mg/l	
Silica, mg/l	
Iron, mg/l	



**RAW MATERIAL, PRODUCT AND UTILITY SPECIFICATIONS
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	Manganese, mg/l	
	Total Suspended Solids, mg/l	
	Total Dissolved Solids, mg/l	
	Oil & Grease, mg/l	
	Ammonia, mg/l	
	Alkanity, mg/l as CaCO ₃	
	Calcium Hardness, mg/l as CaCO ₃	
	Total Hardness, mg/l as CaCO ₃	
	Supply Pressure, kg/cm ² g (Min/ Nor/ Max)	
	Supply Temperature, deg C	
	Mechanical Design Pressure, kg/cm ² g	
	Mechanical Design Temperature, deg C	
2.13	Drinking Water	
	Colour	< 5.0
	Smell	Agreeable
	pH	7.0-7.5
	Taste & Odour	Unobjectionable
	TDS, mg/l	< 150
	Turbidity, NTU	< 1.0
	Total Hardness, mg/l	< 85
	Chloride (as Cl), mg/l	< 15
	Sulphate (as SO ₄), mg/l	< 60
	Total Iron (Fe), mg/l	< 0.01
	Dissolved Silica, mg/l	< 4
	Supply Pressure, kg/cm ² g (Min/ Nor/ Max)	4/ 5.5/ 6.0
	Supply Temperature, deg C	Ambient
	Mechanical Design Pressure, kg/cm ² g	10.0
	Mechanical Design Temperature, deg C	65
	Note: Drinking water of quality conforming to IS: 10500-1991 shall be provided by the Owner to Boo Operator at the Battery Limit.	
2.14	Plant Air	
	Moisture	Saturated
	Oil Content	Nil
	Supply Pressure, kg/cm ² g (Min/ Nor/ Max)	4.0/7.0/8.0
	Supply Temperature, deg C (Min/ Nor/ Max)	40/40/50
	Mechanical Design Pressure, kg/cm ² g	10.5
	Mechanical Design Temperature, deg C	65
2.15	Fire Water	

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	Pressure kg/cm ² g	Min. 7 at farthest point (As per NFPA/ TAC)
	Temp. deg C	Ambient
2.16	LDO/ FO *	
	Quality	IS-15770 latest revision for LDO IS-1593 latest revision for FO
	Pressure kg/cm ² g	Atm.
	Temp. deg C	Ambient
	During start-up/ Shutdown, LDO/ FO shall be used. During normal operation, Fuel gas generated within Boo area shall be used.	
2.17	FLUXANT	
	Purity in terms of CaCO ₃	To be filled by BOO Operator
	Appearance (Solid Lumps)	To be filled by BOO Operator
	Fluxant (Lime) procurement and transportation will be in the scope of BOO Operator. Fluxant (Lime) handling, storage, conveying etc. shall be in the scope of BOO Operator's scope.	

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SECTION – 1.6

PROCESS DESIGN GUIDELINES

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA



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1.0 INTRODUCTION:

	PROCESS DESIGN GUIDELINES COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P- II/ SEC-1.6	0	
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The purpose of this document is to ensure consistency of approach to design of equipment across the Dankuni Coal Complex, CIL. The requirements given below are for the purpose of general guide line for BOO OPERATOR. However BOO OPERATOR may follow process design guide lines as suggested by the process licensor. BOO OPERATOR shall indicate in his bid the codes and standards which shall be followed for design of Coal Gasification based Methanol plant.

2.0 GENERAL INFORMATION:



2.1 Equipment and machinery shall be provided so that the PLANTS can operate for minimum two years without major overhaul or inspection. All design shall conform to the latest edition of the applicable sections of ASME, ASTM, IEEE, NFC, TEMA, AISI, NEMA, AISC, ACI, OSHA, UBE and other governing codes or standard practices. Any other equivalent and acceptable Code of Standard practice may be adopted with the approval of the LICENSEE. In addition, the following state/local Codes/laws shall supplement:

a)	Pressure Vessels/ Formed ends	ASME, Section VIII, DIV.I / Indian Standard IS 4049.
b)	Boilers	Indian Boiler Regulations Act
c)	Buildings & Structural	Relevant Indian Standard (BIS)
d)	Electricity	Indian Electricity Rules.
e)	Sanitary	Relevant Indian Standard (BIS)
f)	Safety	a) Manual of Chief Inspector of Explosives, Govt. of India. b) Oil Industry Safety Directorate (OISD) norms
g)	Water Pollution	Relevant Indian Standard (BIS)

2.2 System of Measurements:

The system of measurement shall be Metric as follows:

Parameter	Preferred Units	Alternative Units
Temperature	°C	
Pressure - absolute	kg/cm ² abs	
Pressure - gauge	kg/cm ² g	
Flow (liquid)	m ³ /hr	kg/hr
Flow (gas)	Nm ³ /hr	kg/hr
Flow (steam)	kg/hr	
Length, Level	mm	m
Time	hr	sec, min
Heat	kcal	
Power	kW	
Fouling resistance	m ² hr °C / kcal	
Pipe size / diameter	mm (NB)	
Mass	kg	
Liquid relative density	sp gr T°C/15.6°C	
Liquid density	kg/m ³	

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Vapor flowing density	kg/m ³	
Furnace draft	mm of WC	
Storage tank pressure	mm of WC	
Vacuum	mm of Hg, mm WC	
Standard vapor	Nm ³ /hr at 0°C & 1.033 kg/cm ² a	
Standard liquid	Sm ³ /hr at 15.6°C	
Thermal conductivity	kcal/hr-m-°C	
Heat Transfer coefficient	kcal/hr-m ² -°C	
Enthalpy, Entropy	kcal/kg	
Heat rate	10 ⁶ kcal/hr or MM kcal/hr	
Viscosity	cP	
Kinematic Viscosity	cSt	
Sound Pressure	dB(A)	
Sound Power	dB(A)	

3.0 EQUIPMENT DESIGN INFORMATION:

3.1 Columns and Vessels:

Preferred diameters of columns, vessels and reactors shall be as.

a) Corrosion allowance

SS	Min.0.75 mm
CS/LAS	Min. 3.0 mm
Cladding thickness	Min. 3.0 mm

b) Man holes in Columns and Vessels

ID 900 mm and below: Flanged top cover if access required.
ID above 900 mm: Preferred 24", Minimum 20"

Columns: Man holes are to be provided above the top tray and below the bottom tray. The spacing of man holes in tray columns shall be every 6 m (approx). The minimum number of manholes for columns is three.



Vessels: Minimum number of manholes is one. For vessels more than 6 m in length the minimum number is two. In case of small vessels, hand holes of 150 mm (6") are to be provided.

c) Design pressure

i) Factors like pump shut-off conditions, pressure drops in recycle loop etc. should be considered for fixing design pressure. Pump shut-off shall be calculated at 1.25 x rated head + max. Suction pressure.



ii) When operating pressure is less than or equal to 100 kg/cm², design pressure shall be equal to normal operating pressure plus 10% (min. 2.0 kg/cm²). When operating pressure is more than 100 kg/cm², design pressure shall be equal to normal operating pressure plus 5% (min 10 kg/cm²).

iii) All steam handling / condensate vessels shall be designed for full vacuum conditions also.

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- iv) All vessels/ columns subject to internal pressure should be designed to withstand a minimum external pressure of 0.175 kg/cm² abs.
 - v) Minimum design pressure for equipment connected with flare header should be 3.5 kg/cm² g.
 - vi) Special consideration should be given (for vacuum design) to the design of vessel normally subject to internal pressure and connected to compressor suction or ejectors.
- d) Design temperature
- i) Design temperature for unfired pressure vessels and interconnecting piping will in general be equal to maximum anticipated operating temperature plus 30°C if vessel operates between zero to 400°C and 28°C if vessel operates above 400°C. If it operates below 0°C temperature, LICENSOR should follow his own philosophy.
 - ii) Conditions like steam-out (for handing out vessel to maintenance) will be considered while specifying design temperature.
 - iii) For vessels operating at ambient temperature, 65°C will be used for mechanical design.
- Note:** When different metal temperature can be predicted to occur for different zones of a vessel during operation then different temperature should be indicated on the sketch and different temperature should be taken into account for designing the vessel.
- e) The column internals can be trays or packing. Preferred type of trays shall be a valve tray (stainless steel).
- f) Hydraulic Residence time: Residence time is defined between low liquid level and high liquid level.

Service	Residence time, minutes
Feed Surge Drum	
Drum diameter: < 1.2 m	30
Drum diameter: 1.2 to 1.8 m incl.	20
Drum diameter: > 1.8 m	15
Column Feed	15 minutes on flow control or 10 min on cascade level/flow control
Re-boiling by heater	-Calculated on net bottom product: 15 minutes on flow control or 8 min on cascade level/flow control for further processing or 2 min with discharge to storage. -Calculated on total feed heater: 2 minutes. Between LLL & TL (with LSLI installed at min. distance from LLL): 8min on the equivalent flow rate of the vapor generated in the fired heater.

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Reflux to Tower	5
Product to Storage	5
Product feeding another unit	15 minutes on flow control or 10 min on cascade level/flow control
Flow to Heat Exchanger	2
Flow to Sewer or Drain	1

In the case of pumps ensuring several services such as reflux and liquid distillate to storage, the residence time of the corresponding vessel will be whichever is greater from the above list.

In case hold-up must be provided for both product and reflux, the larger volume is used, not the sum of the two volumes. When the discharge rate is unimportant, a nominal hold-up time of approximately 2 minutes is provided.

The normal operating liquid level should be taken as the midpoint between the high and low levels. Level control should span between the high and low levels. Where high and low level trips are required, these should be located at a reasonable elevation above and below the high and low levels respectively, to allow operator intervention before a trip occurs.

Low liquid level shall be at least 200 mm above the bottom (for horizontal vessels) or bottom tangent line (for vertical vessels).

For water settling the above applies but this may need to be increased. Where there may be solids in the drum, which are not to be drawn off, the liquid outlet may be raised and the low liquid level shall be increased accordingly.

For horizontal vessels, the highest liquid level shall be at least either 300 mm or 20% of the drum diameter below the top, whichever is the greater.



Note: If a crinkled wire mesh pad is present then highest liquid level shall be at least 300 mm below the bottom of the pad.

For vertical vessels, if vapor flow is present the highest liquid level shall be at least 300mm below the bottom of the inlet arrangement. If little or no vapor is present, the highest liquid level shall be at least 300 mm or 15% of the drum diameter below the top tangent line, whichever is the greater. The minimum time between a HHLL alarm and trip and between a LLLL alarm and trip shall be no less than 2 minutes.

g) Tower Bottoms Surge Capacity & Hold-up Volume:

The liquid residence time (from the low to high levels) for the design of the bottom section of a column is as follows:

- i. Bottoms as feed to a subsequent tower on level control are five (5) minutes. In general, level control will frequently prove satisfactory to the second of a series of towers.
- ii. Bottoms as feed to a subsequent tower on flow control is ten (10) to twenty (20) minutes, when the column is acting as a feed surge drum to another unit. This surge capacity may be obtained by swaging to a larger diameter for the holdup section of the column, in some cases.
- iii. Bottoms to a heat exchanger and/or tankage are two (2) minutes. This may be reduced in the case of a crude or vacuum tower in order to prevent coking.

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- iv. Feed to a fired coil re-boiler is the sum of five (5) minutes on the vaporized portion and two (2) minutes on the bottoms product. It is normally desirable that the five (5) minutes on the vaporized portion be employed to establish the normal low level, with
- v. the subsequent two (2) minutes on bottoms product used to establish the high liquid level (normally 300 mm is the minimum allowed distance between these levels).
- vi. For vacuum towers, a space corresponding to 30 seconds surge on total vacuum bottoms plus quench rate is set between low and high liquid level at tower bottoms.

h) Knock-out Surge Capacity and Hold-up Volume:

For normal accumulation the following liquid hold up applies:

i) At low normal accumulation rate:

Liquid draw-off is usually manually controlled. Enough volume should be provided to ensure the frequency of emptying is less than once per shift (i.e. eight (8) hours) or preferably twenty four (24) hours. Generally a nominal height above the lower tangent line (say 200 mm) will be adequate.

ii) At higher normal accumulation rate:

Liquid draw-off is usually under level control. The distance between high and low level is usually made to suit a standard controller range, say 350 mm, (corresponding to controller connections and generally providing hold up time far in excess of the normal requirement of approximately two (2) minutes).

For a spill the following liquid hold up applies:

i) Frequently capacity is required for "spill from preceding unit". Provide a volume equal to the entire production of the unit for ten (10) minutes between the 'alarm' level (see Note * below) and a point 300 mm above the normal high level.



Sometimes spill requirements govern the drum design. That is, an L/D ratio of approximately 3:1 results in a large drum diameter relative to the vapor load. Use of a critical wire mesh screen would then be uneconomic.

(Note: * level alarm provided if level rises 300 mm above 'normal' high level)

i) Minimum Auxiliary Nozzle Size:

The following list is a guide to the minimum auxiliary nozzle sizes to be used for process design sizing of nozzles (minimum mechanical nozzle size of 50 mm (2") to be specified during vessel design).

Vessel Volume, m ³	Vent	Drain	Pump out	Steam out	Blow down
1.5	1"	1"	1"	1"	2"
1.5 – 5.6	1"	1½ "	1½ "	1"	3"
5.6 – 17	2"	2"	2"	1"	3"

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17 – 70	2"	3"	3"	2"	4"
70 and over	2"	3"	3"	3"	4"



3.2 Fired Heaters

Fired heaters shall be designed for maximum efficiency. Air pre-heating is preferred to steam generation for heat recovery to improve furnace efficiency. Preferred order of levels for steam generation, if required to be included for energy optimization, would be HP/MP/LP. Heaters shall be provided for gas/ fuel oil firing. Each burner shall have a pilot gas burner. Atomizing steam shall be MP steam. Soot blowers shall be pneumatic, locally operated, retractable with auto-manual sequential control. Steam air de-coking facility shall be preferred if necessary.

3.3 Heat Exchangers/ Air Coolers/ Condensers/ Re-boilers:

The following general guidelines will be followed:

- 3.3.1 Air-cooling shall be maximized for which the cut-off temperature of process streams shall be 55 deg C. However, when further trim-cooling by water is necessary, the cut-off temperature of process stream shall be 65 deg C. Dry bulb temperatures 35 deg C to be considered for Cooler sizing. However, to avoid small trim cooler or air cooler these guide lines can be relaxed.
- 3.3.2 Preferred straight tube length is 6000 mm.
- 3.3.3 Preferred size for Carbon Steel and low alloy (up to and including 5 Cr ½ Mo) tubes is 20 x 2 mm and 25 x 2.5 mm respectively.
- 3.3.4 Preferred size for brass and admiralty tubes is 20 x2 & 25 x2.5 mm respectively.
- 3.3.5 Preferred size for high alloy (above 5 Cr 1/2 Mo and Austenitic) tube is 20 & 25 x t to suit design.
- 3.3.6 Preferred tube pitch is square pitch in fouling services. Maximum allowable bundle weight is 15 MT. Maximum allowable bundle diameter 1400mm.
- 3.3.7 For Shell and Tube Heat Exchangers:
- a) Design fouling factor: Licensor will use following suggested fouling factors towards sizing of heat exchangers in the plant. Suggested fouling factor in the Process side is 0.0003 (m² .hr °C/kcal) and in the Cooling water side is 0.0004 (m² .hr °C/kcal).
 - b) Corrosion allowance: Unless otherwise specified corrosion allowance for all exchangers should be as per TEMA standard.
 - c) Design Pressure:
 - i) Maximum anticipated operating pressure plus 10 % or 2 kg/cm², whichever is greater. The minimum design pressure is 3.5 kg/cm²g.
 - ii) Exchangers that are subject to pump shut off, in general, shall have design pressure equal to maximum shut off pressure.
 - iii) In case exchanger is operating under vacuum or in steam service, design should be for full vacuum.

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- iv) The sheets and tubes of feed/ effluent exchanger in high pressure service need not be designed for full design pressure of the shell and / or channel provided these components can never experience these conditions. They should be designed for maximum differential pressure expected. Start-up, shutdown & emergency depressurization condition should be considered. In addition to above criteria design pressure of an exchanger should reflect the location and set pressure of the safety relieving valve protecting it.

d) Design Temperature:

- i) Exchanger operating between zero to 400°C shall be designed for the maximum anticipated operating temperature plus 28°C but not less than 65°C.
- ii) In case of possible loss of loss of cooling media, the tubes, tube sheets and floating head may be subjected to full inlet temperature. These components should be designed for maximum anticipated temperature of hot medium.
- iii) The exchangers operating at zero deg C and below should be designed for minimum anticipated temperature.

3.3.8 Fluid Allocation:

To allocate fluids to shell or tube side of an exchanger, the following general principles of fluid allocation shall apply: a) cooling water on tube side b) high pressure fluid on tube side c) most corrosive fluid on tube side d) higher fouling fluid on tube side e) most viscous fluid on tube side f) large volume of condensing vapors on shell side g) single phase fluids both sides put smaller flow on shell side

The above principles may conflict in some instances and alternative designs shall be investigated. In these cases the most economical design shall be selected.

3.4 Pumps:



- a) Spare Philosophy: 100% spare for continuous service and critical intermittent service.
- b) Drive of pumps: Electric Motor, unless otherwise for process/ safety reasons.
- c) The available NPSH shall exceed the required NPSH by at least 0.6 m up to design (rated) capacity for boiling liquids, dissolved gases, foaming liquids and other fluids.

For Boiler Feed Water Pumps the available NPSH shall exceed the required NPSH by a minimum 2.0 m margin up to design capacity at the initial calculation stage. When accurate pump suction layouts are known this margin may be reduced to 1.5 m following review of the calculation.

Process engineers shall identify on the process specification turndown flows below 50% of the design capacity, when such flows are possible during long-term operating conditions covered by guarantees of plant performance.

The reference levels for setting NPSHA shall be the bottom tangent line for vertical vessels, the bottom of the vessel for horizontal vessels, the low-low level for tanks, and the pump impeller centre line for pumps.

The following elevations for pump impeller centerline shall be assumed if no pump vendor details are available:

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Pump Capacity, m ³ /h	Centre Line Elevation, m
Up to 45	0.76
45 - 225	0.91
225 - 2270	1.07
2270 - 4540	1.37



3.5 Line Sizing:

3.5.1 Liquid Flow:

The guidelines shown in the following table should be used to size process piping for liquids. The guidelines cover most normal situations for systems within unit battery limits, but they may not be applicable for all cases. For critical services and long headers, the total pressure drop in the system must be checked to ensure the system meets the design pressure balance, whether or not individual process lines meet the pressure drop and velocity criteria given here. This standard may not apply to critical services, such as slurry lines or high pressure piping, for which reference should be made to additional standards.

SIZING LIQUID LINES	'Recommended' High Limits	
	ΔP per 100 m, kg/cm ²	Velocity (4, 5) m/sec
Pump suction lines (1)		
- bubble point liquids	0.10	1.8
- subcooled liquids (< DN 200) [< 8"]	0.45	2.4
- subcooled liquids (\geq DN 200) [\geq 8"]	0.45	3.7
Pump discharge lines		
- CS	0.90	6.1
- alloy / SS	0.90	7.6
Reboilers		
- trap out lines (3)	0.07	1.5
- return lines	0.07	-
Liquid transfer lines (2)	0.35	3.7
Cooling water lines	0.35	3.7
Steam condensate lines (liquid)	-	0.6
Notes (1) Pump suction line diameters should normally not be more than two standard line sizes larger than the pump suction nozzle. (2) Or as required by system pressure balance. (3) If the liquid velocity is too high, swaged up orifice meter runs may be required, hence it is recommended to restrict velocities in lines containing orifice meters within the following upper limits: - Line sizes \leq 300 mm (12") : 3.4 m/s max. - Lines sizes \geq 350 mm (14"): 3.1 m/s max.		

3.5.2 Pump Discharge Lines:

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Line sizing is a trade-off between piping installation costs and operating costs. Typical values for allowable pressure drops in pump discharge lines are given below for both carbon steel and alloy piping.

Pump Discharge Line Typical Pressure Drops:

Flow rate, m ³ /hr	Carbon Steel Piping ΔP , kg/cm ² per 100 m	Alloy Piping ΔP , kg/cm ² per 100 m
0 - 60	0.6 – 2.0	1.4 – 3.5
60 - 160	0.3 – 1.6	0.9 – 2.5
160 +	0.2 – 0.9	0.5 – 1.6



3.5.3 Vapour Flow:

The guidelines shown in the following table should be used to size vapor lines. The guidelines cover most normal situations for systems within unit battery limits, but they may not be applicable for all cases. For critical services and long headers, the total pressure drop in the system must be checked to ensure the system meets the design pressure balance, whether or not individual process lines meet the pressure drop and velocity criteria given here. For long vapor lines, such as flare headers or vacuum transfer lines, when the $\Delta P > 10\% P$, the compressible flow calculation procedure should be adopted.

SIZING VAPOUR LINES	'Recommended' High Limits	
	ΔP per 100 m kg/cm ²	Velocity, m/s
Operating Pressure Range		
HYDROCARBON LINES (< 100 m in length)		
Vacuum: 0.07 kg/cm ² a or less	0.014	120 / $\rho^{0.5}$
Vacuum: ~ 0.50 kg/cm ² a	0.035	120 / $\rho^{0.5}$
0.0 – 3.5 kg/cm ² g	0.12	120 / $\rho^{0.5}$
3.5 – 10.5 kg/cm ² g	0.35	120 / $\rho^{0.5}$
10.5 – 35 kg/cm ² g -	0.69	120 / $\rho^{0.5}$
> 35 kg/cm ² g	1.15	120 / $\rho^{0.5}$
STEAM LINES (< 100 m in length)		
Vacuum: 0.07 kg/cm ² a or less	0.014	-
Vacuum: ~ 0.50 kg/cm ² a	0.046	-
0.0 – 3.5 kg/cm ² g	0.12	-
3.5 – 10.5 kg/cm ² g	0.35	-
10.5 – 35 kg/cm ² g -	0.69	-
> 35 kg/cm ² g	1.15	-

4.0 EQUIPMENT DESIGN MARGIN:

The following values shall be incorporated into equipment design to allow for increased capacities.

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4.1 Columns:

Columns shall generally be sized according to vapor/liquid loads specified by the material balance. Over design on vapor and/or liquid loads must be agreed on a case to case basis, depending on the service and on whether foaming etc. may occur. The factors shall be specified on the equipment data sheets.

The following design criteria shall apply.

Trayed columns:

Columns with a diameter under 900 mm shall be designed to a maximum 70% of flooding rate

All other columns shall be designed to a maximum 80% of flooding rate

Packed columns:

Packed sections shall be designed to a maximum of 70% of flooding rate and shall be within the maximum pressure drop specified for the packing.

4.2 Pumps:

Unless otherwise stated, the sizing of pumps shall be in accordance with the material balance and the following overcapacity rates on flow rate:

<u>Centrifugal Pumps</u>	<u>Overcapacity, %</u>
-Reflux & pumparound pumps	20
-Offsites product pumps	Zero
-All other pumps	10
-Intermittent services	Zero
 <u>Reciprocating Pumps</u>	
All	10

4.3 Heat Exchangers:

Unless otherwise stated, heat exchangers shall be sized according to the heat and material balance and the following over capacity rates:



- 10% margin on flow, except for pump around services where a flow margin of 20% shall be used
- 10% margin on duty
- 15% margin on re-boilers and condensers (duty and flow)

5.0 EQUIPMENT SPARING:

5.1 General:

Installation of standby spare equipment shall be included where justified for safety, reliability or economic reasons. All refinery units are scheduled for turnaround once every five years for planned maintenance. Running equipment requiring more frequent turnarounds shall justify a spare.

Whilst aiming to minimize standby equipment care should however be taken to ensure that unit operations are not rendered vulnerable to failure of relatively inexpensive equipment (e.g. lube oil and seal oil pumps for large turbo-compressor units).

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5.2 Heat Exchangers:

Heat exchangers with a high fouling potential must always be arranged in parallel trains, such that one train can be taken out of service for cleaning while the train in operation meets the plants minimum capacity.

5.3 Pumps:

All pumps with an immediate influence on the process must have a spare. However, consideration shall be given to the use of common installed stand-by pumps performing two duties.

Sparing of pumps with a delayed influence on the process (e.g. inhibitor feeding pumps) will be evaluated on an individual basis.

In general, both the main pump and the spare are to be motor driven. However, consideration is to be given to steam turbine drive for main and/or spare pumps where significant relief load reduction can be achieved.

Consideration is also to be given to having steam turbine drives and motor drives in critical services, such as BFW. For critical services such as firewater, the use of diesel drives on pumps shall be considered.

5.4 Compressors, Fans and Blowers:

Sparing of compressors will be as follows:-

- Centrifugal compressors shall have a spare rotor in the warehouse.
- Reciprocating compressors shall have a 100% spare

For fired heaters fans:

- ID fans shall have a 100% spare
- FD fans shall have a 100% spare

6.0 CONTROL VALVES:

Control valves shall be sized for a normal flow at no more than 70 % of the capacity of the valve, with no less than 25 % of the total system friction drop or 10 % of the operating pressure to 70 kg/cm², whichever is greater, allotted to the valve. Above 70 kg/cm² a lower percentage of the operating pressure may be used for valve differential pressure depending on process and control considerations for non flashing services.



(Note that a control valve having a pressure drop of 33 % of the total frictional loss, excluding the valve, is approximately equivalent to a valve with a pressure drop of 25 % of the total system friction drop)

In all cases the minimum pressure drop allowed for a control valve is 0.7 kg/cm² at design flow-rate.

Exceptional cases (e.g. gravity flow) where lower pressure drops are required should be evaluated on a case by case basis.

In summary:

- i) At normal flow rate,
CV DP > 25% of Total Frictional Pressure Drop or,
CV DP > 33% of Frictional Pressure Drop, excluding CV DP.
- ii) At normal flow rate,

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CV DP > 10% of Discharge Vessel Pressure.

- iii) At design flow rate,
CVDP > 0.7 kg/cm²

Control valves in continuous service shall generally be provided with isolation and bypass valves. Hand-wheels shall be provided wherever no bypass valves are envisaged. Bleeds shall be provided on the upstream side (or both upstream and downstream side) of the valve as appropriate.

7.0 PLANT RELIABILITY:

In order to install a high degree of confidence and reliability of the offered plant, the following shall be taken care of by BOO OPERATOR:

- a) Providing adequate redundancy and standby requirements both for equipment and control systems based on their experience of operating similar BOO plants.
- b) Maintaining adequate inventory of spare parts – BOO OPERATOR shall maintain adequate inventory for the spare parts required for routine maintenance.
- c) 2 out of 3 voting logic to be considered for major plant trip logic functions.
- d) Providing catalyst volumes in the reactors with minimum catalyst life of 3 years, standby reactors to be considered wherever catalyst life is less than 3 years.
- e) Adsorbents for PSA to have minimum life time of 3 years.
- f) Provision of online changing of absorbents in desulphurisation section.



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PART II: TECHNICAL

SECTION – 1.7



ENGINEERING SPECIFICATIONS FOR PRESSURE VESSEL (STATIC EQUIPMENTS)

**PROJECT: COAL TO METHANOL (C2M) PROJECT
THROUGH COAL GASIFICATION ROUTE AT
DANKUNI COAL COMPLEX WEST BENGAL,
INDIA ON BUILD-OWN-OPERATE (BOO)
BASIS**

	ENGINEERING SPECIFICATIONS -STATIC EQUIPMENTS SUPPLY OF COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN- OPERATE (BOO) BASIS	PC176/E/4001/ P-II/ SEC-1.7	0	
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1.0 REFERENCED PUBLICATIONS

- a) The following codes and standards in their latest edition including latest addenda as on the date of first issue of this design basis shall be followed unless otherwise specified in the requisition for the design, fabrication, inspection and testing of Vessels, Columns, Reactors, Spheres, Storage Tanks, Steel Silos, Bins, Hoppers, Steel Flare/Vents Stacks & heat exchangers:

ASME SEC. VIII DIV.1	Rules for construction of Unfired Pressure Vessels
ASME SEC. VIII DIV.2	For Pressure vessels and heat exchangers (Selectively for high pressure/high thickness)
ASME SEC. VIII DIV.2/PD 5500	For Storage Spheres/Bullets
ASME SEC.1	Rules for construction of power boilers,
IBR	Indian Boiler Regulation Act 1950, Latest Edition.
ASME SEC. II A&B	For material specification
ASME SEC II PART C	Specification for welding rod, electrode & filler metal
ASME SEC II PART D	Properties
ASME SEC. IX	For welding
ASME SEC V	Non destructive examination
ASTM/IS	For material specification
API 650/IS: 803	For Welded Steel Tanks for Oil Storage
API 620	For Design & Construction of Large, Welded, Low- pressure Storage Tank
API 625	Tank Systems For Refrigerated Liquefied Gas Storage
API 661	For Air Cooled Exchanger
IS 800	For Air Cooled Exchanger Structural Design

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API 2000 Venting Atmospheric & Low Pressure Storage Tanks.

IS: 875/SITE DATA For wind load consideration

IS: 1893/SITE DATA For Seismic design consideration (IS: 1893 Part –IV Response Spectrum Method)

ASME B 16.5 For Pipe flanges & Flanged fittings
ASME B 16.47 For Large diameter Steel flanges

ASME B 16.20 For gaskets

ASME B 96.1 Welded Aluminum Alloy Storage Tanks

EJMA Standard of Expansion joint Manufacturing Association

TEMA Class R For shell and tube Exchanger

OISD-STD 150 For Mounded Vessel

API 941 Steels for Hydrogen Service at Elevated Temperature & Pressure

b) STATUTORY PROVISIONS:

National laws and statutory provisions such as Indian Boiler Regulation with any local by-laws for the state shall be complied with. Static and Mobile Pressure Vessel (SMPV) rules as applicable shall also be complied with.


c) PUBLICATIONS

NACE MR 0103 Materials Resistant to Sulfide Stress Cracking in Corrosive Petroleum Refining Environments.

NACE MR 0175 / ISO 15156 Petroleum and natural gas industries - Materials for use in H₂S containing environments in oil and gas production.

NACE RP 0296 Guidelines for Detection, Repair and Mitigation of Cracking of Existing Petroleum Refinery Pressure Vessels in Wet H₂S Environment.

NACE TM 0284 Evaluation of Pipeline and Pressure Vessel Steel for Resistance to Hydrogen Induced Cracking.

ENGINEERING SPECIFICATIONS -STATIC EQUIPMENTS SUPPLY OF COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN- OPERATE (BOO) BASIS	PC176/E/4001/ P-II/ SEC-1.7	0	
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NACE TM 0177

Laboratory Testing of Metals for Resistance to Sulphide Stress Cracking in Hydrogen Sulphide Environment.

WRC Bulletin # 107

Local Stresses in Spherical & Cylindrical Shells due to External Loadings.

WRC Bulletin # 297

Local Stresses in Cylindrical Shells due to External Loadings on Nozzles.

2.0 DESIGN PHILOSOPHY / GENERAL CRITERIA

Equipment shall be designed in compliance with the latest design code requirements and applicable standards/ specifications. All design calculations shall be performed considering all applicable loads for erection, operating and hydro test conditions.

2.1 MINIMUM SHELL/HEAD THICKNESS

Vessel pressure components and supports shall have minimum thicknesses after forming not less than the requirements of the Code and this standard. The minimum nominal thickness before forming of carbon and alloy steel vessels shells, heads and support skirts shall not be less than the larger of the following:

- 1 $\frac{\text{Inside diameter in mm} + 2540}{1000} + \text{C.A. (mm)}$
- 2 4.5MM + C.A
3. 10mm + clad thickness for clad vessels.


Nozzle necks shall not be less than ASME VIII Div. 1 Code minimum thickness (Para UG-45).

Minimum thickness of vessel skirts shall be 6 mm.

Internal non-pressure piping and fittings in vessels with up to 3mm C.A. shall have the following minimum nominal wall thickness unless otherwise shown on the data sheet.

Carbon Steel

Up to 100 mm NB	Sch. 80
150 mm NB to 250 mm NB	Sch. 40 (STD Wall)
Over 250 mm NB	STD Wall
Alloy Steel or All sizes	STD Wall
Non-Ferrous.	

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For higher C.A., thicknesses shall be suitably increased.

- 4) For shell & tube heat exchangers, minimum thickness shall be as per TEMA & Tube sheet as per UHX of ASME SECTION VIII Div.1
- 5) For Air Cooled heat exchangers, minimum thickness shall be as per API 661, However minimum tube sheet thickness shall be 22mm (excluding corrosion allowance)

2.2 TEST PRESSURE

- a) Equipment shall be hydrostatically tested in the fabricator's shop as per design code.
- b) Equipment open to atmosphere shall be tested by filling with water to the top.
- c) Unless otherwise specified in applicable design code allowable stress during hydro test in tension shall not exceed 90% of yield point.
- d) Storage tanks shall be tested as per applicable code.

2.3 CORROSION ALLOWANCE:


Unless otherwise specified elsewhere, minimum corrosion allowance shall be considered as follows:

- Carbon Steel equipment	:	3.0 mm *
- Low alloy steel equipment	:	1.5 mm* (3 mm for shell & tube exchangers)
- Stainless steel equipment	:	NIL
- Clad equipment	:	NIL (3 mm cladding minimum)
- Lined equipment	:	3.0 mm (plus lining)
- CS Storage Tank bottom most shell course and bottom plate	:	3.0 mm
- CS Storage Tank shell (other courses)	:	1.5 mm
- Storage tank Fixed roof/ Floating Roof	:	NIL
- CS Buried Vessels (External)	:	1.5 mm
- CS Spheres	:	1.5 mm

* Except for tubes

2.4 SUPPORTS:

- 2.4.1 All columns with diameter 1000 mm and more shall be self-supporting.

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- 2.4.2 All columns with diameter less than 1000 mm shall be supported by superimposed structure around the column covering the entire height. Guy wires are not permitted to be used for supporting any equipment.
- 2.4.3 In specific cases, columns having diameter less than 1000 mm and total L/D ratio not exceeding 10 may be self-supported.
- 2.4.4 Storage spheres shall be supported on pipe legs with tie rod bracing and turnbuckles.
- 2.4.5 Buried vessels shall be suitably anchored to prevent the uplift due to under ground water. Anchor bolts shall have corrosion allowance of 6 mm on diameter. Buried vessels shall be rested on concrete saddles with anchoring bracket at the centerline of the vessel.
- 2.4.6 All skirt supported columns/equipment with height 20 m and above (irrespective of weight) and weight 50 MT and above (irrespective of height) are to be provided with tailing lug.

2.5 MANHOLES:

Vessels and columns with diameter greater than 900 mm and up to 1500 mm shall be provided with 500 NB manholes. However, if required, vessels and columns with diameter 1500 mm and above may be provided with 600 NB manholes.

2.6 FLANGES:


- 2.6.1 Nozzle flanges up to 600 NB shall be as per ASME B16.5 and above 600 NB shall be as per ASME B 16.47 (SERIES 'B') except that for high pressure heat exchanger.
- 2.6.2 Unless otherwise specified, W.N. Flanges shall be used for all classes.
- 2.6.3 Unless otherwise specified, all girth flanges and intermediate body flanges shall be of weld neck type only.
- 2.6.4 Flange rating shall be established based on design pressure, design temperature and considering all external loads (moments and axial force).

2.7 PIPE DAVIT:

- i) Vertical Vessel/Column having safety valve size 80 NB and above and or having internals, shall be provided with pipe davit.
- ii) Exchangers shall be provided with davits for removal of flat channel cover and shell covers only.

2.8 IMPORTANT CONSIDERATIONS:

- Vessels and columns shall be designed considering maximum operating liquid head in addition to design pressure.

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- All columns and vessels shall be capable of withstanding water full condition during system testing.
- In addition, all vertical vessels, columns and horizontal vessels shall be designed so as to permit site testing of the equipment with water at the test pressure on the top of the equipment considering 33% of design wind load. The design shall be based on fully corroded condition.
- Vessels and columns shall be tested at shop hydrostatically at pressure calculated as per applicable code in new and cold condition.
- Design of components not covered in IBR (Indian Boiler Regulations) shall be in accordance with ASME SEC VIII DIV I.
- All nozzle necks, all nozzle flanges and blind flanges shall be of weld deposit construction for clad equipment. Loose liners are not permitted.
- All vertical equipment shall be provided with two lifting lugs. Lifting lugs shall be designed with impact factor of two.


2.9 SILENT REQUIREMENTS OF STATIC EQUIPMENTS

2.9.1 HEAT EXCHANGERS:

1. Tube Sheet type for Floating head and U Tube heat exchanger:

	Non-extended for floating head and U tube exchangers. Extended for Stab in bundles only if B' type stationary head of U tube Exchangers.
--	---

2. Testing accessories for shell and tube Heat Exchanger:
 - a. Testing rings shall be provided on all floating 'S' & 'T' head type exchangers.
 - b. Dummy shell shall be provided for fixing test ring for exchangers such as kettle type or floating head without shell covers (TEMA 'AHT' or 'AKT') or stab in bundle where shell design pressure is higher than tube side pressure.
 - c. Test flanges shall be provided

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- i) For exchangers with removable bundle and bonnet type channel.
- ii) For exchanger with removable bundle and channel with flat cover if tube side pressure is greater than shell side pressure.
- d. Minimum number of test rings/ test flanges/ dummy shells shall be at least one per set of three bundles.
- e. For shell side interconnected and stacked exchangers the minimum number of test rings shall be equal to the number of exchangers in one stack.
- f. For 'U' tube & removable bundle exchanger, number of test flanges shall be equal to number of exchangers in one stack.

2.9.2 Tall Columns

Mechanical design of self-supporting tall column and its anchorage block shall be carried out considering combination of various loads as below:

2.9.2.1 Loadings


The loadings to be considered in designing a self-supporting tall column/tower shall include:

- (i) Internal and or external design pressure specified on process data sheets.
- (ii) Self weight of column inclusive of piping, platforms, ladders, manholes, nozzles, trays, welded and removable attachments, insulation and operating liquid etc.
- (iii) Other loadings as specified in UG-22 of ASME Code Sec. VIII Div.1, wherever applicable.

2.9.2.2 Loading Condition

Analysis shall be carried out for following conditions:

- (i) Erection Condition Column (uncorroded) erected on foundation, without insulation, platforms, trays etc. but with welded attachments plus full wind on column.

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- (ii) Operating Condition Column (in corroded condition) under design pressure, including welded items, trays, removable internals, piping, platforms, ladder, reboiler mounted on column, insulation and operating liquid etc. plus full wind on insulated column with all other projections open to wind, or earthquake forces.
- (iii) Test Condition: Column (in corroded condition) under test pressure, filled with water plus 33% of specified wind load on uninsulated column including all attachments shall be considered.
- (iv) Earthquake And Wind Shall Be Considered Not Acting Concurrently.

2.9.2.3 Deflection of Column

Maximum allowable deflection at top of column shall be equal to height of the column divided by 200 up to a maximum of 300 mm.

- (i) If the deflection of column exceeds the above allowable limit, the thickness of skirt shall be increased as first trial up to a maximum value equal to the column thickness and this exercise shall be stopped if the deflection falls within allowable limit.
- (ii) If the above step is inadequate, skirt shall be gradually flared to reduce the deflection. Flaring of skirt shall be stopped if the deflection falls within limits or half angle of cone reaches maximum limit of 9.
- (iii) If the above two steps prove inadequate in limiting the deflection within allowable limits, the thickness of shell courses shall be increased one by one starting from bottom course above skirt and proceeding upwards till the deflection falls within allowable limits.

2.9.2.4 Stress Limits


The stresses due to pressure, weight, wind/seismic loads shall be combined using maximum principal stress theory for ASME Section VIII Div. I.

2.9.2.5 Skirt Support Base

Base supporting including base plate, anchor chairs, compression ring, foundation bolting etc. shall be designed based on over-turning moment (greater of seismic or wind). A minimum number of 8 foundation bolts shall be provided. Nos. of foundation bolts shall be in multiple of four.

2.9.2.7 Dynamic Analysis of Column/Tower

Dynamic analysis of each column shall be carried out for stability under transverse wind induced vibrations as per standard design practice.

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2.9.3 TOWERS

- a) The design shall be done based on Process Licensor's Specifications.
- b) Material selection shall strictly be as per Licensor's Specification.
- c) Minimum thickness as per Licensor's Specification shall be adhered to.
- e) FEM Analysis shall be done for all shell to head junction Y shaped skirt, welded/weld overlaid support rings and any other stressed point.
- f) All internals shall have minimum thickness as given in Process Licensor's Specification and shall be designed for loads defined by Process Licensor.

2.9.4 DOUBLE WALLED STORAGE TANKS

2.9.4.1 Type of Containment shall be selected from the following

- a) Single Containment
- b) Double Containment (with or without outside-pressured concrete wall)

2.9.4.2. Metallurgy of inner and outer tanks shall be selected on the basis of containment and service requirement.


2.9.4.3. Type of foundation shall be selected from the following:

- a) Elevated pier type
- b) Electrically heated type.

3.0 INSPECTION & TESTING:

The following tests/procedures are mandatory to be witnessed / reviewed by Owner/ it's authorized inspection agency.

- i) Drawings & design calculations for critical equipments, other for reference.
- ii) Welding procedure specifications approval.
- iii) Heat treatment procedure approval (if applicable).
- iv) Hydraulic test
- v) NDT tests reports e.g. RT, UT, MP / PT & hardness etc. including Leak test, Ferrite check, Iron contaminated test, Inter-granular corrosion test etc.
- vi) Material test certificates & Positive material identifications
- Vii) PWHT charts
- Viii) Production test coupons
- ix) WPS & PQR

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- x) UT for Lack of bond in clad material.
- xi) Mock-up test for tube to tube sheet joint.
- xii) In-process inspection of tray / internal parts- Visual dimension, Shearing, Punching & Bending.
- xiii) Vacuum test for Tank bottom plates.
- xiv) For Air cooled H.E, Inspection of tube sheet / plug sheet after machining & pullout test on fin tubes.

- 3.1 The equipment shall be considered acceptable for dispatch only after final certification for acceptance is issued by concerned inspector.
- 3.2 Formed heads cold formed or hot formed below normalizing temperature shall be subsequently normalized and weld seams if any shall be fully radio graphed after forming.
- 3.3 All nozzle reinforcing pads wherever applicable shall be tested pneumatically at 1.25 Kg/cm²g pressure with soap solution on attachment welds. Vent holes shall be plugged with non-hardening mastic to prevent ingress of water.
- 3.3 All completed equipment shall be tested hydraulically as per the requirements of codes, standards & specifications in presence of the inspecting authority. Pneumatic test of completed equipment shall be carried out only when specially mentioned in the specification sheets. Duration of test shall be as per applicable codes & standards. Test medium/water shall be tested for the chlorine contents before filling the equipment.
- 3.4 The temperature of test water shall comply with requirement of Fabrication code.
- 3.5 Unless otherwise stated gaskets used during testing shall be same as specified for operating conditions. After testing, gaskets used during testing shall be replaced by new gaskets.

4.0 NDT REQUIREMENTS:


The following NDT requirements are mandatory in addition to codes, standards & specification requirements.

A) UT examination:

- i) All butt - as supplement to radiography (where radiography is not possible)
- ii) FPW of nozzle attachments as supplement to radiography
- iii) All forgings
- iv) All butt welds after hydro test

B) MP / PT Examination:

- i) All edges of plates and opening in shell of CS and LAS/SS.
- ii) Root and final layer of all butt welds.

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- iii) All weld surfaces after PWHT.
- iv) All forgings after machining.
- v) All fillet & butt weld after hydro testing.
- vi) Knuckle surface of dished ends / toriconical sections, pipe bends and expansions bellow.
- vii) All attachment welds.

C) Radiography:

- i) All weld seams of formed head, if made in more than one segment shall be full radiography after forming and heat treatment if any.
- ii) When spot radiography is specified, all T joints & minimum 10% of total weld length excluding T joints shall be radiographed.
- iii) All nozzles fabricated from plates shall be 100% radiographed.
- iv) All butt welds irrespective of thickness (100% radiographed) before PWHT and hydro test.

5.0 DOCUMENTS, DATA & DRAWINGS:

5.1 GENERAL

BOO OPERATOR shall develop detailed mechanical design & fabrication drawings pertaining to each type of Static Equipment as applicable.

BOO OPERATOR shall be responsible for the review & approval of all such design and fabrication drawings submitted by the Equipment manufacturer. Owner's/PMC's review/approval shall be limited to the mechanical design and vendor fabrication drawings for critical items. A list of such critical items shall be furnished by BOO OPERATOR along with bid.


5.2 DRAWINGS AND DOCUMENTS REQUIRED ALONG WITH BID

The Contractor shall furnish the following along with the bid:

- (a) Technical Compliance Pro-forma, duly completed.
- (b) List of deviations if any, to the applicable specifications.
- (c) List of Critical items.

6.0 SPARE PARTS

- a) **MANDATORY SPARES** : Guidelines for Mandatory spare requirement for all type of equipment shall be as per Section-10 of ITB. However BOO Operator may have their own Philosophy for procurement of mandatory spares & 2 years spares with in the

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contractual period. BOO OPERATOR must procure insurance spares as per CIL norms and they should be preserved & handed over to CIL on completion of the contractual period. The norms for CIL insurance spares shall be as per Section Section-10 of ITB.

- b) **SPARE PARTS FOR TWO YEARS NORMAL OPERATION:-**Two years operating spare shall be as per BOO OPERATOR philosophy. While handing over plant after completion of the contractual period, BOO OPERATOR must hand over spares for 2 years operation & maintenance. Guidelines for this is reflected in the document Section-10 requirements for spare parts.

ANNEXURE-I

Material selection


The following table gives general guidelines for material selection for various pressure parts/ non placements parts of the equipment based on design temperature wherever material of construction is not specified by the process licensor. Use of alternate equivalent material is

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permitted with prior approval from CIL / PMC.

DESIGN TEMP. °C	PRESSURE PARTS					NON PRESSURE PARTS			
	PLATE	PIPE (SEE NOTE 8)	TUBES, SPACERS (SEE NOTE-11)	FORGING (SEE NOTE 12)	BOLTS/ STUDS/ NUTS EXTERNAL (SEE NOTE 13)	STRUCTURAL ATTACHMENT WELDED TO PRESSURE PARTS, BAFFELS, SUPPORTS, TIE RODS, SEALING, SLIDING STRIPS ETC.	INTERNAL PIPES	STUDS BOLTS NUTS INTERNAL	TIE RODS
CRYOGENIC									
FROM-254 UPTO-196	SA 240 GR.304L,304, 316,316L, 347 (IMPACT TESTED)	SA 312 TYPE 304 304L,316, 316L,347	SA 213 TYPE 304 304L,316, 316L,347	SA 182 GR.F 304,304L,316 347,316L	SA 320 GR.B8,8C,8T STRAIN HARDENED	SAME AS PRESSURE PARTS			SS GRADE SAME AS TUBES
ABOVE-196 UPTO -80	SA 240 GR.304L,304, 316,316L, 321,347 SA 353/553 GRA	SA 312 TYPE 304 304L,316, 316L,321, 347 SA 333 GR.8	SA 213 TYPE 304 304L,316, 316L,321, 347 SA 334 GR.8	SA 182 GR.F 304,F304L, F316L,316 321,347, SA 522	SA 194 GR.S, 8C,8T				
LOW TEMPERATURE									
ABOVE -80 UPTO -60	SA 203 GR.E IMPACT TESTED (SEE NOTE-1)	SA 333 GR.3	SA 334 GR.3	SA 350 GR.LF3	SA 320 L7 SA 194 GR.4 OR GR.7	SA 203 GR.E	SA 333 GR.3	SA 193GR.B8 SA 194 GR.8	CS KILLED
ABOVE -60 UPTO -45	SA 537 CL.1 IMPACT TESTED (SEE NOTE-1)	SA 333 GR.3	SA 334 GR.3	SA 350 GR.LF3	SA 320 L7 SA 194 GR.4 OR GR.7	SA 537 CL.I	SA 333 GR.3	SA 193GR.B8 SA 194 GR.8	CS KILLED
ABOVE -45 UPTO -29	SA 516 (ALL GRADES) IMPACT TESTED (SEE NOTE-2)	SA 333 GR.6 OR GR.1	SA 334 GR.6 OR GR.1	SA 350 GR.LF2	SA 320 GR.L7 SA 194 GR.4 OR GR.7	SA-516 (IN ALL GRADES)	SA 333 GR.6	SA 193GR.B8 SA 194 GR.8	CS KILLED
ABOVE -29 UPTO 0	SA 516 (ALL GRADES) (SEE NOTE-3)	SA 106 GR.B (SEE NOTE 3)	SA 334 GR.6 OR 1 (SEE NOTE 3)	SA 105/ SA 266 (SEE NOTE 3)	SA-193 GR.B7 SA-194 GR.2H	SA-516 (IN ALL GRADES)	SA 106 GR.B	SA-193GR.B8 SA-194 GR.8	CS KILLED
INTERMEDIATE TEMPERATURE									
ABOVE 0 UPTO 343	SA 516 (ALL GRADES) SA 240 TYPE 304L,316, 321 (SEE NOTE 4)	SA 106 GR.B SA-312 TP 304L, 316L, 321 SA-376 TP 321	SA 179 SA-213 TP 304L, 316L, 321	SA-105 SA-266 SA 182 F 304L,316L, 321	SA-193 B7 SA-194 GR.2H SA-193 B7 SA-194 GR.2H	IS-2062 (PLATES) SAME AS PRESSURE PARTS	SA 106 GR.B SA 106 GR.B	SA-193 GR.B8 SA-194 GR.4 SA-193GR.B8 SA-194 GR.8	IS- 2062 (WELDABLE QUALITY) SAME GRADE AS PRESSURE PARTS
ABOVE 343 UPTO 427	SA-204 GR.B SA 387 GR.11 CL.1,CL.2 SA 240 TYPE 304L,316L, 321(SEE NOTE 4)	SA 335 GR.P1 SA 335 GR.P11 SA 312 TYPE 304L, 316L, 321, SA 376 TYPE 321	SA 209 GR.T1 SA 213 GR.T11 SA 213 TYPE 304L, 316L, 321	SA 182 GR.F1 SA 182 GR.F11 SA 182 F 304L, 316L, 321	SA 193 GR.B7 SA 194 GR.4 SA 193 GR.B7 SA 194 GR.4 SA 193 GR.B7 SA 194 GR.4	SAME AS PRESSURE PARTS SAME AS PRESSURE PARTS SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS SAME AS PRESSURE PARTS SAME AS PRESSURE PARTS	SA-193 GR.B8 SA 194 GR.8 SA-193GR.B8 SA 194 GR.8 SA-193GR.B8 SA 194 GR.8	C-1/2 Mo (COMML. QLT) 1/4 Cr.1/2 Mo (COMML. QLT) SA 479 Gr-304L, 316L, 321
ELEVATED TEMPERATURE									
ABOVE 427 UPTO 538	SA 387 GR.11 CL.1,CL.2 SA 387 GR.12 CL.1,CL.2	SA 335 P11 SA 335 P12	SA 213 T11 SA 213 T12	SA 182 GR.F11 SA 182 GR.F12	SA 193 GR.B16 SA 194 GR.4	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SA-193 GR.B8 SA 194 GR.8	1/4Cr-1/2Mo (COMML. QLT)
ABOVE 427 UPTO 500	SA 240 TYPE 304,316,321 (SEE NOTE 4)	SA 312/ SA 376 TYPE 304,316, 321	SA 213 TP 304,316, 321	SA 182F 304, 316, 321	SA 193 GR.B16 SA 194 GR.4	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SA-193 GR.B8 SA 194 GR.8	SA 479 Gr. 304L,316L, 321
ABOVE 538 UPTO 593	SA 387 GR.22 CL.1,CL.2 SA 387 GR.21 CL.1,CL.2	SA 335 P22	SA 213 T22	SA 182 GR.F22 SA 336 GR.F22	SA 193 GR.B5 SA 194 GR.3	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	2/4 Cr.1 Mo (COMML. QLT)
ABOVE 500 UPTO 815	SA 240 GR.304H, 316H, 321H	SA 312/ SA 376 TYPE 304H, 316H, 321H	SA 213 TYPE 304H, 316H, 321H	SA 182 GRADES 304H, 316H,321H	SA 193 GR.B8 SA 194 GR.8 (STRAIN HARDENED)	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SAME AS PRESSURE PARTS	SA 479 Gr. 304H, 316 H, 321 H.

- Plates are purchased to the requirement of the standard ASME SA-20, which requires testing of individual plates for low temperature service. Carbon steel material is ordered to meet the impact requirements of supplement S5, of standard ASME SA 20; typical material specification is as follows. SA 516 Gr.60. Normalised, to meet impact requirements per supplement S5 of SA 20 at minus 50°F.

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2. All permanent attachments welded directly to 9% nickel steel should be of the same material or of an austenitic stainless steel type, which cannot be hardened by heat treatment.
3. Check for impact testing requirement as per UCS-66, for coincident temperature and part thickness.
4. Selection of stainless steel material shall be based on process recommendation / process licensor.
5. This table is not applicable for atmospheric/low pressure storage tanks. Materials shall be selected as per API 650/API 620 as applicable.
6. Materials for caustic service, sour service or sour service + HIC shall be selected based on specific recommendation of process licensor.
7. Material for pressure vessels designed according to ASME Section VIII Division 2 shall be given special consideration as per code.
8. All pipes shall be of seamless construction.
9. Non-ferrous material and super alloys are not covered above and shall be selected based on specific recommendation.
10. Material for vessel / column skirt shall be the same material as of vessel /column shell for the upper part with a minimum of 1000mm.
11. All tubes shall be of seamless construction.
12. SA 336 shall be used for Heat Exchanger non-standard SS/LAS forgings.
13. Internal bolting shall be selected on the basis of shell side material solid or clad as follows:

SHELL MATERIAL

Carbon steel & upto 1% Cr
5% Chrome
13% Chrome
Stainless Steel A 193 Gr* A 194 Gr*

STUD


ASTM A 193 Gr B-7M
A 193 Gr B5
A 193 Gr B6X

NUTS

ASTM A-194 Gr 2HM
A 194 Gr 3
A 194 Gr 6

For low temperatures, min. quality of bolting material shall be as specified for external bolting and shall be improved if shell side materials are better.

* Compatible / same grade of SS

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ANNEXURE –II

GENERAL POINTS FOR HYDROGEN SERVICE.

- 1) Hydrogen Service
 - a) Hydrogen partial pressure exceeding 50 psia (3.5 kg/cm²(a)).
 - b) More than 90 percent hydrogen at any pressure level.

- 2) Severe Cyclic Service

Cyclic Service as defined in ASME B31.3, Section 300.2. Cyclic service may be mechanical, thermal, or a combination of both.

- 3) The hydrogen partial pressure (design) does not exceed 50 psia {3.5 kg/cm²(a)}.

- 4) Details


Either an integrally reinforced nozzle or balanced integral reinforcement in both the nozzle neck and vessel is required for hydrogen service and is preferred for all services. Built-up construction using pipe or rolled plate with a flange and reinforcing pad is permissible for non-hydrogen service. Gussets are not permitted.

- 5) A) Plates and forgings over 2 inches (50mm) thick or used for pressure containment in Hydrogen service shall be Ultrasonically examined with 100% scanning in accordance with the following:
 - (i) Plates shall be examined before forming in accordance with ASME SA-435 including supplementary requirements S1.
 - (ii) Forgings shall be examined in accordance with ASME SA-388 and ASME Section VIII, Division 2, AM-203.2.

B) Examined by either liquid penetrant (PT) or magnetic particle (MT) in accordance with the following:

 - (i) The entire surface of all forgings after finish machining.
 - (ii) Formed plate surfaces to be welded, i.e., the weld level area, and a minimum of 2 inches (50 mm) of the neighbouring surfaces.
 - (iii) Formed plate surfaces where weld overlay will be applied.

- 6) Internal support rings shall be continuously welded to the shell on the top and intermittently welded on the bottom. Internal lugs and brackets shall be continuously

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welded on the top and sides only. In hydrogen service all internal and external welds shall be full penetration, free of undercuts, through the support side of the joint.

- 7) In hydrogen services, all fillet welds (internal and external) to pressure containing components shall be ground to a smooth and generous concave contour.
- 8) Covered welding electrodes (i.e. shielded metal arc welding – SMAW) shall be of the low hydrogen coating type and shall be in accordance with ASME Section II, Part C, SFA-5.5. Rod ovens, and other means as necessary, shall be used to ensure that the rods remain dry.
- 9) In hydrogen service, nozzles with tubular liners welded on both ends shall be vented with a 1/8 inch NPS hole, drilled from the outside to the OD of the liner. The vent hole shall be tapped for future plugging with a material adequate for the operating temperature but incapable of retaining the operating pressure.
- 10) When austenitic stainless steel weld deposit overlay is used in an elevated operating temperature {over 700°F (370°C)} hydrogen service the fabricator shall demonstrate that their procedures and materials provide immunity to lining disbanding. Testing shall be representative of the actual operating conditions (e.g. hydrogen partial pressure, materials and material thicknesses, temperatures, and heating/cooling rates).
- 11) In addition to the requirements of ,when the hydrogen partial pressure exceeds 50 psia {3.5 kg/cm²(a)}, the design temperature exceeds 600°F (315°C), and an austenitic stainless steel weld deposit overlay is used, the overlay shall be 100 percent ultrasonically examined for lack of bond. The examination shall occur after the final post weld heat treatment and shall be from the outside. Examination shall be in accordance with ASME Section II, Part A, the SA-578. The acceptance level shall be S7. Indications of a lack of bond shall be recorded and re-examined from the inside. Indications of an unbonded area that exceed the acceptance criteria shall be repaired by weld deposit overlay and re-examined.
- 12) When the hydrogen partial pressure exceeds 50 psia {3.5 kg/cm²(a)}, the design temperature exceeds 600°F (315°C), and an austenitic stainless steel cladding is used, clad surfaces shall be 100 percent ultrasonically examined for lack of bond. The examination shall occur from the outside after forming and before the final post weld heat treatment. The ultrasonic examination shall be in accordance with ASME Section II, part A, SA-578. The acceptance level shall be S7. Suspected unbonded areas shall be recorded and re-examined from the inside surface. Indications of unbonded areas that can not be encompassed within a 3-inch (75 mm) diameter circle shall be recorded, repaired by weld deposit and re-examined. All unbonded areas within 2 inches (50mm) of where attachments will be welded directly to the cladding shall also be repaired and re-examined. In addition, the lining shall be spot ultrasonically examined in accordance after final post weld heat treatment. The acceptance level shall be S6. Repaired areas and weld deposit overlay at weld seams shall be 100% liquid penetrant (PT) examined in accordance with ASTM E 165. At attachments, the final PT shall be performed after final post weld heat treatment and pressure test.

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PART-II, TECHNICAL



SECTION – 1.8

ENGINEERING SPECIFICATION – ROTATING EQUIPMENTS

**PROJECT: COAL TO METHANOL (C2M) PROJECT
 THROUGH COAL GASIFICATION ROUTE
 AT DANKUNI COAL COMPLEX WEST
 BENGAL, INDIA ON BUILD-OWN-
 OPERATE (BOO) BASIS**



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0	24.09.2020	24.09.2020	ISSUED FOR TENDER	YKG	RRK	RRK
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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1.0 REFERENCED PUBLICATIONS

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The following codes are referred and applicable for the equipment as enlisted.

Table 1: Applicable/Referred Codes and Standards



Sno.	Description	Standards / Codes	Remarks
1	PUMPS:		
1.1	Centrifugal Pumps (Special Purpose Process Service)	API Std. 610 (Latest edition.)	(1)
1.2	Centrifugal Pumps (General Purpose Process Service)		(2)
1.3	Centrifugal Pumps (General Water Service)		(3)
1.4	Centrifugal Pumps (Slurry & Liquor Service)		
1.5	Positive Displacement Pumps (Reciprocating)	API Std. 674 (latest edition.)	
1.6	Positive Displacement Pumps (Controlled Volume)	API Std. 675 (latest edition)	
1.7	Positive Displacement Pumps (Rotary)	API Std. 676 (latest edition)	
1.8	Liquid Ring Vacuum Pumps	API Std. 681 (latest edition)	
1.9	Seal-less Pumps	API Std. 685 (latest edition)	
2	COMPRESSORS / FANS & BLOWERS		
2.1	Centrifugal Compressors	API Std. 617 (latest edition)	
2.2	Axial Compressors	API Std. 617 (latest edition)	
2.3	Expander-Compressors	API Std. 617 (latest edition)	
2.4	Centrifugal Fans		
2.5	Induced Draft / Forced Draft Fans	API 673 (latest edition)	
2.6	Packaged Integrally Geared Centrifugal Air Compressors	API Std. 672 (latest edition)	
2.7	Reciprocating Compressors (Utility & Instrument Air Service)		
2.8	Reciprocating Compressors (Process Service)	API Std. 618 (latest edition)	
2.9	Positive Displacement Compressors (Rotary)	API Std. 619 (latest edition)	

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2.10	Roots Blowers		
3	MECHANICAL DRIVERS / GEAR BOXES		
3.1	Diesel Engines		
3.2	Gas Turbines	API Std. 616 (latest edition)	
3.3	Steam Turbines (General Purpose)	API Std. 611 (latest edition)	(4)
3.4	Steam Turbines (Special Purpose)	API Std. 612 (latest edition)	(5)
3.5	Special Purpose Gear Box	API Std. 613 (latest edition)	(6)
3.6	General Purpose Gear Box	API Std. 677 (latest edition)	(7)
3.7	Special Purpose Coupling	API Std. 671 (latest edition)	(8)
4	AUXILIARIES		
4.1	Lubrication, shaft sealing and control-oil systems and auxiliaries	API Std. 614 (latest edition)	
4.2	Shaft sealing for centrifugal & rotary pumps	API Std. 682 (latest edition)	
4.3	Vibration, Axial Position & Bearing Temp. Monitoring Systems	API Std. 670 (latest edition)	
5	MISCELLANEOUS	(For reference)	
5.1	Steam Turbines	PTC 6	
5.2	Centrifugal compressor, Turbines and Exhausters	PTC 10	
5.3	Large Industrial Fans	PTC 11	
5.4	Gas Turbines	PTC 22	
5.5	Gear units	ANSI/AGMA	
5.6	Bearings	ABMA	
5.7	Laboratory Methods of Testing Fans for Rating Purposes	AMCA	
5.8	Mechanical Vibrations - Balancing quality requirements of rotating rigid rotors	ISO 1940 and Respective API standard	

Remarks:

- (1) **Centrifugal pumps for special purpose process service** are classified as pumps which are meant for process service (both for on-site & offsite) but excluding the



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pumps covered either under general- purpose process service or general water service.

- (2) **Centrifugal pumps for general purpose process service** are classified as pumps for applications where maximum pressure by all considerations does not exceed 16.0 kg/cm² g, pumping temperature remains within -29°C to 205°C, Specific gravity is not less than 0.7 at the specified operating conditions or when dual pressurized / unpressurised mechanical seals are not required/specified. Typical areas of application are non-process services & utility services such as De-mineralised Water (DMW) plants, Raw Water Treatment Plants (RWTP), Effluent Treatment Plants (ETP), Blow down services etc.
- (3) **Centrifugal pumps for general water service** are classified as pumps for applications such as Large Capacity Cooling Water Pumps, Auxiliary Cooling Water Pumps & other centrifugal pumps handling clean & cold water.
- (4) **General-purpose steam turbines** (conforming to API Std. 611) shall be used where driven equipment is usually spared, or is in non-critical service and where the steam supply conditions will not exceed 48 bar,g inlet pressure or 400°C inlet temperature or both and where speed will not exceed 6000 rpm. General-purpose steam turbines may also be used, subject to market availability, for cases where the steam supply conditions will not exceed 60 bar,g inlet pressure and 475°C inlet temperature and where speed will not exceed 6000 rpm and where turbine rating will not exceed 1500 kW and where driven equipment is usually spared, or is in non-critical service.
- (5) **Special-purpose steam turbines** (conforming to API Std. 612) shall be used where driven equipment is not spared and/or is in critical service.
- (6) **General-purpose gear units** (conforming to API Std. 677) shall be used in equipment trains that are usually spared, or are in non-critical service and up-to a maximum driver rating of 750 kW. All ID fan trains are to be considered as meant for non-critical service.
- (7) **Special-purpose gear units** (conforming to API Std. 613) shall be used in equipment trains that are usually not spared, or are in critical service.
- (8) **Special-purpose couplings** (conforming to API Std. 671) shall be used in equipment trains, as specified in the Engineering specification.

2.0 DESIGN PHILOSOPHY

2.1 SCOPE

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This Specification covers the design criteria for the purpose of carrying out Engineering for Procurement of various rotating equipment required including requirements with regard to spare parts & special tools. This Engineering specification shall be applied for supply of COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA.

Electrical items, Instrumentation & Controls, Piping, Pressure Vessels, Mechanical Equipment, Heat exchangers etc. associated with rotating equipment shall comply with the design requirements as given in the respective specifications forming part of the bid package / inquiry.

All technical specification used by PDIL/ BOO OPERATOR if in conflict with licensor's specification, Licensor's specification shall override.

2.2 EQUIPMENT QUALIFICATION CRITERIA (EQC)

All Rotating Equipment shall be field proven and shall have well experience record. The vendor for the complete unit shall be an established manufacturer of Rotating equipment and he shall also be the manufacturer of the proposed Rotating equipment having adequate engineering, manufacturing & testing facilities for the same.

The vendor shall have engineered, packaged, tested and supplied similar packages in terms of type of Rotating equipment, driver, sealing system, inlet volumetric capacity & driver rating (kW) from the proposed plant.

The vendor besides satisfying the above requirements shall also be the packager of the complete system proposed and shall have the single point responsibility for the entire package.

The equipment model offered shall be from regular manufacturing range of the manufacturer and shall meet the following minimum service and manufacturing experience requirements.



2.3 ASSOCIATED ACCESSORIES AND AUXILIARY SYSTEMS

2.3.1 BOO OPERATOR shall furnish all rotating equipment, drivers, auxiliary systems, instrumentation and control systems, all necessary electrical and safety devices as applicable or required for safe and reliable operation of the unit.

BOO OPERATOR in his scope of supply and work shall also include the hardware required over and above what is specified, for safe and satisfactory operation of the equipment package.

2.3.2 Motors, electrical/instrument components and electrical/instrument installations shall be suitable for the area classification specified by the BOO OPERATOR and shall meet the requirements as defined in the electrical/instrument specification attached with the relevant sections of the bid package /order.

2.4 SEALING SYSTEM SELECTION CRITERIA

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2.4.1 Centrifugal Pumps

2.4.1.1 All Pumps shall be provided with mechanical seals (except, clean cold water service)

2.4.2 Centrifugal Compressors

2.4.2.1 Centrifugal Compressors (for gas service) shall be provided with Dry Gas Seals except for services (like Air, N₂ etc.) where normally labyrinths shall be used for sealing.

2.4.2.2 Dry gas seal and sealing skid comprising of dry gas seal filters, valves and instrumentation etc. shall be procured from Dry Gas seal supplier only. Seal gas/reference gas filters shall have stand by unit for cleaning/replacement during operation of compressor. Dry gas seal shall be bi-directional type and interchangeable between drive and non-drive end.

2.5 COUPLINGS & COUPLING GUARDS

2.5.1 Unless otherwise specified, Couplings shall be of metallic, non-lubricated, flexible element type (i.e. either diaphragm or discs) with spacer, for all equipment. All coupling models shall be selected for a minimum service factor of 1.5.

2.5.2 Couplings for the following equipment shall conform to API Standard 671:

- Centrifugal compressors (API Std. 617)
- Special purpose Steam Turbines (API Std. 612)
- Gas Turbines (API Std. 616)
- Rotary Screw Compressors (API Std. 619)
- Multi-stage (greater than two stages) centrifugal pumps with driver rating greater than 160 kW.

2.5.3 Couplings as per manufacturer's standard may be supplied for the following equipment:



- Reciprocating Compressors
- Packaged Integrally Geared Centrifugal Air Compressors
- Packaged Rotary Compressors (Screw type for Plant & Instrument Air Service)

2.5.4 Removable coupling guard shall be provided which shall be fabricated from non-sparking material, and shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs. Centrifugal compressors and Gas Turbines coupling guards may have vendor standard features.

2.6 ALLOWABLE NOISE LEVEL

2.6.1 Equipment noise level (Driver + Driven equipment train + auxiliaries) shall not exceed 85 dBA when measured at One-meter distance from the equipment skid in any direction.

This requirement is not applicable for equipment for infrequent operation such as diesel

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engine driven fire water pump package.

- 2.6.2 Acoustic hoods shall not be used for any equipment excepting for DG sets (rating up-to 1000 kVA), gas turbines, rotary compressors & roots blowers.

2.7 EQUIPMENT STORAGE

All rotating equipment shall be packed for an outside storage period of at least 12 months.

2.8 INSTALLATION CRITERIA

2.8.1 Pumps

All pumps shall be suitable for outdoor installation. No equipment shelter is envisaged.

2.8.2 Compressors

- 2.8.2.1 All compressors shall be located under-roof with side walls partially open and shall be suitable for outdoor installation.

- 2.8.2.2 Centrifugal compressors driven by steam turbine/electric motor:

All centrifugal compressors driven by steam turbine/electric motor shall be installed on Mezzanine floor with adequate working platform all around and drop out facility for maintenance. Other associated auxiliaries such as lube oil system, surface condenser, Condensate water pumps etc. shall be located on ground floor (i.e. on finished floor level). Alternative arrangement shall be subject to PMC/CIL approval.



- 2.8.2.3 Reciprocating multi-stage/multi-cylinder compressors:

Reciprocating compressors shall be so located that no trenches are required for volume/pulsation bottles. Large reciprocating multi-stage/multi-cylinder compressors can be installed on Mezzanine floor with its interstage piping/auxiliary equipment located on the ground floor. Skid mounted reciprocating compressors shall be located on finished floor level.

2.9 MAINTENANCE FACILITIES

2.9.1 General

Equipment layout shall incorporate adequate maintenance platforms, support

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structures, hand rails, operational access, material handling facilities for inspection and maintenance of equipment.

2.9.2 Compressors

2.9.2.1 Centrifugal Compressors

Adequately sized EOT crane with inching facility with 2 speeds (micro & macro) shall be provided for maintenance of the centrifugal compressor. Electric motor driver if applicable shall be considered as a single component for maintenance.

2.9.2.2 Plant & Instrument Air Compressors

Adequately sized EOT crane with inching facility shall be provided for maintenance of the Compressor and its electric motor driver. Electric Motor Drivers shall be considered as a single component for maintenance.

2.9.2.3 Reciprocating Compressors

Adequately sized EOT crane with inching facility shall be provided for maintenance of the compressor and its driver. Electric motor driver shall be considered as a single component for maintenance except for the single bearing motors where the Motor Rotor and stator shall be considered as individual components.

2.10 HEAT EXCHANGERS

2.10.1 Lube Oil Coolers

2.10.1.1 Unless otherwise specified, Oil coolers shall be water-cooled shell and tube type with removable bundle as per TEMA 'C'.

2.10.1.2 In case of oil coolers, the oil-side operating pressure shall be higher than waterside operating pressure except for cases where this is not feasible.



2.10.1.3 The material of construction shall be suitable for specified service. The tube material of construction shall be admiralty brass on tube side

2.11 SAFETY

2.11.1 Equipment design and engineering shall incorporate adequate safety features (as per applicable specifications of respective equipment as well as Health, Safety and Environment Codes & Standards applicable for the subject project) to provide protection to operating personnel, equipment and environment.

2.11.2 Thermal relief valves shall be provided for components that may be blocked in by isolation valves (including any cooling water return circuit piping of a cooler or a jacket).

2.11.3 All electrical components & installations, instruments shall be suitable for the electrical area classification and grouping in which the equipment is installed.

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3.0 SPECIAL REQUIREMENTS

All inspection/ testing/measurement/record shall be done as per respective API/ASME&PTC.

3.1 CENTRIFUGAL COMPRESSORS

3.1.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.1.2 Inspection and Testing

The following tests may be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic test.
- Helium Pressure test (For casing of compressors handling gas containing 30% mole or higher of H₂).
- Impeller overspeed test.
- Mechanical run test (For main and spare rotor)

During the test apart from other API requirements, the following data shall be recorded

- Vibration data in polar form and Tape recording of Vibration data.
- Gas leak test (After post test inspection).
- Post test inspection after mechanical run test.
- Performance test as per PTC-10.
- Sound level test (during mechanical run test) Complete unit test (including all Auxiliaries)
- Dry gas seal test.
- Full load, Full pressure, Full speed test, if specified.

3.2 RECIPROCATING COMPRESSORS



3.2.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.2.2 INSPECTION AND TESTING

3.2.2.1 Material certificate for Chemical and Physical properties of the following components shall be provided: Cylinder liner, Piston, Piston rod, Crankshaft, Connecting rod, Cross head, Crankcase, Valves, Heat exchangers, Pressure vessels, Bolts (Connecting rod and Main Bearing).

3.2.2.2 a. Ultrasonic testing of the following -Crank shaft, connecting rod, Piston rod,

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Pressure vessels.

- b. Magnaflux testing/D.P. Testing of the following - Cross Head, Connecting rod, Piston rod, Pressure vessels.
- c. 100% X-ray examination for all the welded joints for Pipes, Vessels and Heat Exchangers handling process gas.
- d. Surface roughness and hardness check for the following - Cylinder bore/Liner bore, Piston rod in packing area, Crankshaft journal and Crank pin.

3.2.2.3 The following test may be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic test (for all pressure containing parts and auxiliaries)
- Leak proof test of Crankcase and Distance piece (24 hrs with Kerosene)
- Helium pressure test (as applicable).
- Checking of Cylinder clearance and rod run out.
- Mechanical run test (for 4 hours) with job auxiliaries.
- Stripping check and Internal inspection: Main Bearing Drive end side, Connecting rod Big End Bearing (atleast 1 no.), Piston assembly (1 no.), Cylinder bore effective surface (all cylinder).
- Vibration level check (for record during mechanical run test).
- Lube oil console, Cylinder cooling circuit console run test at Sub vendor works (as applicable)
- Functional test of control panel (By simulation at Sub Vendor works)

3.3 ROTARY TYPE POSITIVE DISPLACEMENT COMPRESSOR

3.3.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.3.2 Driver Sizing



The motor nameplate rating (with Service Factor =1) shall be at least 110% of the maximum power required for any of the specified operating conditions. Equipment driven by Induction Motors shall be rated at the actual motor speed for the rated load condition.

3.3.3. INSPECTION & TESTING

3.3.3.1 The following tests shall be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic Test
- Mechanical Run Test
- Mechanical Run Test for the spare rotor, if ordered along with the main equipment
- Performance Test
- Dismantle-Reassembly Inspection
- Sound level test

3.3.3.2 The vendor shall also furnish material certificates for major components.

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3.4 LIQUID RING VACUUM PUMPS/COMPRESSORS

3.4.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.4.2 DRIVER SIZING

The motor name plate rating (with service factor equal to one) shall be atleast 110% of the maximum power required (including gear and coupling losses) for any of the specified operating conditions.

Particular attention shall be given to starting conditions especially when the LRVP is required to start with the suction at the atmospheric pressure.

3.4.3 INSPECTION AND TESTING

3.4.3.1 The following tests shall be witnessed by BOO OPERATOR \authorized Inspecting agency:

- Hydrostatic Test
- Mechanical Run Test
- Gas Leak test under
- Performance Test
- Sound level Test

3.4.3.2 The vendor shall also furnish material certificates for major components.

3.5 DIAPHRAGM COMPRESSORS

3.5.1 EQUIPMENT QUALIFICATION CRITERIA



Equipment qualification criteria as per clause 2.2

3.5.2 Driver Sizing

For motor driven units, the maximum continuous rating (MCR), i.e. service equal to 1, shall be a minimum of 110% of the greatest power (including transmission losses) required under any of the specified compressor operating conditions or 5% higher than the power required at the relief valve setting pressure condition (including transmission losses) whichever is greater.

3.5.3 INSPECTION AND TESTING

The following tests shall be witnessed by BOO OPERATOR \authorized inspection agency:

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- Hydrostatic Test
- Mechanical Run Test (4 hrs)
- Helium Test if applicable
- Noise Level Test
- Functional test of control system and other auxiliaries as applicable.

3.6 **PACKAGED INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSOR.**

3.6.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.6.2 INSPECTION AND TESTING

The following test shall be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic Test (Pressure containing parts and auxiliaries).
- Combined Mechanical and Performance test (for main and spare rotor as applicable).
- Check Bearings and Seals after test.
- Functional tests of job lube oil system and job control panel at sub-vendor works.
- Noise level test.
- Guide Vane Test (if applicable)
- Gear contact pattern check.

3.7 **POSITIVE DISPLACEMENT (ROOTS TYPE) BLOWER**

3.7.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.7.2 INSPECTION AND TESTING

3.7.2.1 The following test shall be witnessed by BOO OPERATOR \authorized inspecting agency:



- Hydrostatic Test
- Performance test of the blower at manufacturer's works
- Mechanical run test of the blower at manufacturer's works -Noise level test

3.7.2.2 The vendor shall also furnish material certificates for major components.

3.8 **CENTRIFUGAL PUMPS**

3.8.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

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3.8.2 No centrifugal pump shall be selected where the difference of NPSH available and NPSH required is less than and equal to 1.

3.8.3 Inspection and Testing (For Each Pump)

3.8.3.1 Material Certificates for the following are required

- Casing, Impeller & shaft.

3.8.3.2 The material inspection requirement for pressure containing parts shall be as per the following inspection category:

Category A:

This category is applicable for carbon steel & cast iron for services with process design pressure upto 40 bar and design temperature from 0 to 150°C. Application area in this category shall be for non API pump for water service only.

Inspection requirement: As per vendor's standard Quality Assurance Plan.

Category B:

This category is applicable for services within the design pressure range of 0-70 bar and temperature range of -29°C to 300°C. Inspection requirement includes visual inspection and magnetic particle or liquid penetrant inspection of following components as a minimum:

- Nozzle weld
- Butt welds on pressure containing components
- Fillet welds on pressure containing components.
- Shaft



Liquid penetrant inspection shall be performed only when specified magnetic particle inspection is not feasible.

Category C:

This category is applicable for all hydrocarbon pumps and for services with process design pressure above 70 bar or process design temperature below -29°C and above 300°C. Inspection includes all the requirements of Category B together with radiographic or ultrasonic inspection of

- Nozzle weld
- Butt welds on pressure containing components. Ultrasonic inspection shall be carried out when radiography is not feasible.

3.8.3.3 Inspection shall also include dimensional check of pump, driver and auxiliaries (if any)

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duly mounted on the base plate, in accordance with certified general assembly drawing. This will include all main pump dimensions, base plate dimensions, location of foundation bolt holes, size/position/rating of flanges, coupling guard arrangement, verification of the required material certificates and their traceability to the respective components. In addition, following checks shall also be carried out:

- A measurement of the actual running clearances throughout the pump.
- A check of the hardness of wear rings.
- A check for good workmanship and finish throughout.

3.8.3.4 All tests, measurements & records shall be as per API 610 latest edition. The following tests shall be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic (For all pressure containing parts including auxiliaries)
- Performance
- NPSH (In case difference between NPSHA and NPSHR is less than or equal to 1.0m or when specified in the job specification)
- Dismantling inspection and reassembly after the running test, which shall include examination of mechanical seals, close clearance parts and measurement of running clearances. In case of multistage pumps having hydrodynamic bearings, the bearing shall be removed inspected and reassembled.
- Sound level test (During Performance Test).

3.9 FANS CENTRIFUGAL/F.D./I.D. FANS

3.9.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.9.2 Performance tolerance shall be as follows:

Capacity:	- 0%
Static Diff. Pressure:	-0%
Power:	+0%

3.9.3 INSPECTION AND TESTING



3.9.3.1 Material test certificate shall be furnished for casing, impeller, shaft & shaft sleeve.

3.9.3.2 Following NDTs are required: -DP/MT for impeller welds.

- Ultrasonic/DP for shaft.

3.9.3.3 Following tests shall be witnessed by the BOO OPERATOR \authorized inspecting agency:

- No-load running test for 4hrs.
- Vibration test at rated speed.

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- Performance test as per BS848/AMCA210/ASME PTC11
- Vibration test at minimum flow (turndown capacity)

3.10 **RECIPROCATING PUMPS**

3.10.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.10.2 Electric motor drivers shall have a rating as specified in API, however the motor rating shall be adequate to start the pump at the specified maximum suction pressure.

3.10.3 **INSPECTION AND TESTING**

The following tests shall be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic test.
- Performance test (including mechanical performance) for 4hours for pump along with job accessories.
- NPSH test when difference between NPSHA including allowances for acceleration head & NPSHR is less than 2m.
- Dismantling inspection of liquid end after performance test.

3.11 **POSITIVE DISPLACEMENT PUMP CONTROLLED VOLUME**

3.11.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

3.11.2 **INSPECTION AND TESTING**



Following test shall be witnessed by BOO OPERATOR \authorized inspecting agency:

- Hydrostatic Test.
- Performance Test.
- Linearity and Repeatability.
- Dismantling and Inspection after Test.
- Diaphragm Rupture Detection (as applicable).

3.12 **CRYOGENIC PUMPS**

3.12.1 EQUIPMENT QUALIFICATION CRITERIA

Equipment qualification criteria as per clause 2.2

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3.12.2 The following tests shall be witnessed by BOO OPERATOR \authorized Inspecting agency:

- Hydrostatic Test
- Mechanical Run Test
- Performance Test
- Sound level Test
- impact test

3.13 SPECIAL PURPOSE GEAR UNITS

3.13.1 In case of alternators gears shall be designed for short-circuit condition of the alternator.

3.13.2 Gears shall be of double helical or herringbone type.

3.13.3 INSPECTION AND TESTING

3.13.3.1 Following test shall be witnessed at lube oil system vendor's works by BOO OPERATOR \authorized inspecting agency:



- Hardness verification.
- Contact check
- Journal run-out test.
- Mechanical run test.

4.0 SPARES & SPECIAL TOOLS

4.1 **COMMISSIONING SPARE PARTS** Commissioning Spare Parts shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended spares shall be obtained along with the offer. Any commissioning spare consumed over and above the recommended commissioning spares, during commissioning shall be supplied free of cost by the equipment vendor.

4.2 **SPECIAL TOOLS/TACKLES** Special Tools/Tackles shall be procured along with the main equipment as per equipment manufacturer's recommendations. The list of such recommended special tools/tackles shall be obtained along with the offer.

4.3 **MANDATORY SPARES** Mandatory spares may be procured along with the main equipment. Spare rotors where supplied shall be boxed in a metal containers for vertical storage. Guidelines for Mandatory spare requirement for all type of equipment shall be as per SECTION 1.17, VOLUME II. However, BOO OPERATOR may have their own philosophy for procurement of mandatory & 2 year operation spare with in contractual period. BOO OPERATOR must procure insurance spares as per CIL's norms and they should be preserved & handed over to CIL on completion of the contractual period. The norms for CIL insurance spares shall be as per SECTION 1.17, VOLUME II.

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4.4 **SPARE PARTS FOR TWO YEARS NORMAL OPERATION** As per rotating equipment manufacturer's recommendations, a quotation for spare parts for two-years normal operation along with unit price shall be furnished with the proposal for customer to order the same separately. Customer shall indicate, in case these spares are required to be ordered along with the equipment or to be ordered separately. Two year operating spare shall be as per BOO OPERATOR philosophy. While handing over plant after completion of the contractual period BOO OPERATOR must hand over spares for 2 year operation & maintenance. Guidelines for this is reflected in the SECTION 1.17, VOLUME II requirements for spare parts.

5.0 DOCUMENTS, DATA & DRAWINGS

5.1 GENERAL

BOO OPERATOR shall develop detailed specifications for vendor data requirements pertaining to each type of Rotating Equipment as applicable.

BOO OPERATOR shall be responsible for the review & approval of all Vendor Data & Drawings submitted by the Equipment manufacturer. CIL/PMC's review/approval shall be limited to the vendor drawings and datasheets for critical items. A list of such critical items shall be furnished by BOO OPERATOR along with bid.

5.2 DRAWINGS AND DOCUMENTS REQUIRED ALONG WITH BID: BOO OPERATOR shall furnish the following along with the bid:

- (a) Technical Compliance Pro-forma duly completed.
- (b) List of deviations if any, to the applicable specifications.
- (c) List of critical items

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PART II: TECHNICAL

SECTION – 1.9

ENGINEERING SPECIFICATION – PIPING

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO) BASIS



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1.0 SCOPE

The scope of this document is pertaining to the design philosophy, norms and specific requirements which shall be adhered to by contractor or his associates and representatives during the course of the project in designing, procurement & construction of piping material.

2.0 APPLICABLE CODES & STANDARDS

Standard No.	Title
ASME/ANSI B16.5	Steel Pipe Flanges and Flanged Fittings
ASME/ANSI B16.9	Steel Butt-Welding Fittings
ASME/ANSI B16.10	Face to Face and End to End Dimensions of Valves
ASME/ANSI B16.11	Forged Fittings Socket Welded and Threaded -
ASME/ANSI B16.20	Metallic Gaskets for Pipe Flanges – Ring Joint, Spiral Wound, and Jacketed.
ASME/ANSI B16.21	Non-Metallic Flat Gaskets for Pipe Flanges
ASME/ANSI B16.25	Butt-Welding Ends
ASME/ANSI B16.34	Valves – Flanged, Threaded Welding End.
ASME/ANSI B16.47	Large Diameter Steel Flanges
ASME/ANSI B31.1	Power Piping
ASME/ANSI B31.3	Process Piping.
ASME/ANSI B31.5	Refrigeration Piping
ASME/ANSI B36.10M	Welded and Seamless Wrought Steel Pipe.
ASME/ANSI B36.19M	Stainless Steel Pipe
API 6D	Specification for Pipe Line Valves (Gate, Plug, Ball and Check Valves).
API 6FA	Fire Test for Valves.
API 501	Specifications for Metallic Gaskets for Refinery Piping.
API 594	Check Valves:, Wafer-Lug and double flanged type
API 598	Valve Inspections and Testing.
API 599	Steel Plug Valves Flanged and Butt-weld ends
API 600	Steel Gate Valves Flanged and Butt-welding ends, Bolted Bonnets API 602 Gate, Globe, and Check Valves for Sizes DN 100 (NPS 4) and Smaller for the Petroleum and Natural Gas Industries
API 603	Class 150 – Corrosion Resistant Flanged End gate valves.
API 604	Ductile Iron gate valves – flanged ends.
API 606	Compact C.S. Gate Valve extended body.
API 607	Fire Test for soft seated Ball Valve.
API-608	Metal Ball Valves, Flanged, Threaded & BW Ends.
API 609	Butterfly Valves, Lug type & Wafer type.
API 623	Steel Globe Valves—Flanged and Butt-welding Ends, Bolted Bonnets
IBR	Indian Boiler Regulations
AWWA C207-D	Large Dia. Steel Flanges (Ring Type).
EJMA	Expansion Joints Manufacture Association.
MSS SP 6	Standard Finishes for Contact Faces of Pipe Flanges and Connecting End Flanges of Valves and Fittings.
MSS SP 25	Standard Marking System for Valves, Fittings, Flanges & Unions

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MSS SP 43	Wrought Stainless Steel Butt-weld Fitting
MSS SP 45	By-pass and Drain Connection.
NACE MR0175-94	Sulphide Stress Cracking resistant Metallic Material
EN 10204	Metallic Products - Types of Inspection documents
ASTM D3035	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
NBC	National Building Code - 2016
NFPA	National Fire Protection Association.

3.0 GENERAL DESIGN

- 3.1 Threaded pipe nipples between headers and vent, drain and instrument isolation valves shall be Schedule 160 for CS and Schedule 80S for SS in the size range ½” to 2” NPS.
- 3.2 Piping 2” NPS and above shall be butt-welded, 1½” NPS and below shall be socket welded.
- 3.3 Minimum clearances shall be as indicated in Annexure.

4.0 DESIGN PHILOSOPHY

4.1 Equipment Layout shall be finalized based on the following data :

- a) Plot Plan of Proposed Plant
 - b) P&I Ds
 - c) Equipment Data Sheets
 - d) Wind Direction
 - e) Safety Distance as per statutory requirements.
- a) Economise piping.
 - b) Construction ,Operation , Maintenance, Crane approaches Requirement

4.2 Plant Layout & Design guidelines

The plant layout shall be based on ensuring adequate access, to allow construction, inspection, maintenance and operation to be performed in a safe and efficient manner, to permit ready access of Cranes for removal of Equipment for inspection and servicing.

Flushing connections shall be provided on all lines containing flammable or toxic material, slurries, and materials which solidify- when the line is dead. Sufficient Nitrogen purging points shall also be provided. Supply piping of fuel gas shall be arranged for equal flow distribution.



All utility and process piping shall be located above ground, and major lines shall be located in overhead pipe ways.

Piping to be sloped shall be indicated on the P&I D's.

4.3 Pipe-Rack/T-Post/Small Portals

In general, equipment layout shall be prepared considering straight pipe rack, however other shapes like L / T / U / H / Z etc can also be considered based on area available.

The width of the rack shall be 4M, 6M, 8M, 10M or 12M for single bay having four (4) tiers maximum. In general, the spacing between pipe rack portals (span) shall be taken as 8 M for main rack. However it can be decreased to 6 M depending on the size/number of the pumps to be housed below pipe rack. Intermediate Beams between two portals shall be provided to

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support smaller pipes $\leq 2"$. 20% extra space shall be provided on the pipe rack and portals on each tier for future expansion/modifications.

4.4 **Pumps**

Pump foundation height shall be 300 mm above H.P.P.

Gap between each pump foundation / and foundation of technical structure should be sufficient for easy removal of equipment after piping. All pumps not open to sky with motor rating ≥ 45 KW shall be provided with monorail. No monorail should normally be provided for pumps outside rack and sufficient space below rack shall be available for pump maintenance.

4.4.1 **Access to Pumps**

Clear access of 3.8M vertically and 4.5M horizontally shall be provided centrally under main pipe rack for small mobile equipment to service pumps, wherever these are put under pipe ways with prior specific approval. Pumps outside rack shall be approachable by small cranes etc. from under the pipe rack.



4.4.2 **Access to lower items to grade (Lowering Area)**

Clear access shall be provided at grade on the access side for lowering external and internal fittings from tall elevated equipment by providing pipe davits.

4.4.3 **Layout & Access Requirements for Platforms ladders and Stairs**

For providing platform ladder & staircase following guidelines shall be followed.

- Two means of access (i.e. two ladders or one ladder and one stair case) shall be provided at any elevated platform which serves three or more vessels & for B/L valves operating platform.
- Platforms, ladders and stairways shall be the minimum, consistent with access and safety requirements.
- Stairway for tanks to be provided on upstream of predominant wind direction.
 - i) Platform at elevated structure
 - a) Dual access (i.e. one staircase and one ladder) shall be provided at large elevated structure if any part of platform has more than 22.65M (75 ft) of travel.
 - ii) Platforms with stair access shall be provided for:
 - a) Location at which normal monitoring (once a day or more) is required or where samples are taken.
 - b) Locations where vessels or equipment items need operator attention "such as compressors, heaters, boilers etc.
 - iii) Platforms with ladder access shall be provided for:
 - a) Points which require occasional operating access including valves, spectacle blind and motor operated valves, heater stack sampling points.
 - b) Man ways above grade on equipment.
 - iv) Ladder location

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- a) Wherever practicable, ladder shall be so arranged that users face equipment or platform rather than facing open space.
- b) Landings shall be staggered. No ladder shall be more than 6 M in one flight.



4.5 Unit Piping

The following objective shall be ascertained during piping layout.



- Proper access to all operating points including valves, and for all orifice tapping points and instruments in particular.
- Proper access to interrelated operating points for specific purpose and for maintenance.

4.6 Pipe Ways/Rack piping



- 4.6.1 Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.
- 4.6.2 Predominantly process lines are to be kept at lower tier and, utility & hot process lines on upper tier.
- 4.6.3 Generally the top tier is to be kept for Electrical (if not provided in underground trench as per electrical design basis) and Instrument cable trays. Cable tray laying to take care of necessary clearances for the fire proofing of structure.
- 4.6.4 Generally the hot lines and cold lines shall be kept apart in different groups on a tier. .
- 4.6.5 Generally the bigger size lines shall be kept nearer to the column.
- 4.6.6 Minimum spacing between adjacent lines shall be decided based on O.D of bigger size flange'(minimum rating 300# to be considered), O.D of the smaller pipe, individual insulation thickness and additional 25 mm clearance, preferably. Wherever even if flange is not appearing the minimum spacing shall be based on above basis only. '
- 4.6.7 Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non expansion of adjacent line.
- 4.6.8 Non expansion / thermal contraction may stop the free expansion of the adjacent line at "L' bend location.
- 4.6.9 Anchors shall be provided within unit on all hot lines leaving the unit.
- 4.6.10 Process lines crossing units (within units or from unit to main pipe way) are normally provided with a block valve, spectacle blind and drain valve which shall be accessible.
- 4.6.11 Provision of block valves, blinds etc. shall be as per Process Design Basis and P & IDs.
- 4.6.12 All small bore piping shall be have space for maintenance and operation and intermediate support between portals.
- 4.6.13 Minimum branch size for tapping including for instruments e.g PG/ PTI TE etc. shall be of 3" NPD and 150 mm height on internal cement lined pipes.
- 4.6.14 Aboveground lines shall be grouped to run on pipe racks or sleepers in so far as practicable.
- 4.6.15 Hot lines on pipe racks or sleepers shall be grouped and expansion loops shall be nested together. The number of expansion loops shall be kept to a minimum.
- 4.6.16 Piping handling corrosive fluids shall be run under piping handling non corrosive fluids, and shall not, where possible, be run overhead across walkways or normal passages for personnel.

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- 4.6.17 All process and utility piping will be located aboveground within the plant battery limit, except water mains.
- 4.6.18 All piping shall be arranged in horizontal banks, where possible, to facilitate supporting.
- 4.7 **Pump Piping**
- 4.7.1 Pump drives shall have clear access.
- 4.7.2 Pump suction piping shall be as short as possible and shall be arranged with particular care to avoid vapor pockets.
- 4.7.4 Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.
- When a suction vessel operates under vacuum, the vent connection of the pump has to be permanently connected to vapour space of the suction vessel to allow possible filling of the pump with liquid before it is started.
- 4.7.5 Type of strainers for pump suction piping shall be as per pump manufacturer.
- 4.7.7 All small bore piping connected to pump shall have break up flanges for removal of pumps.
- 4.7.8 Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values as per API 610.
- 4.8 **Steam and Condensate Systems Piping - Indian Boiler Regulations (IBR)**
- 4.8.1 IBR system to comply IBR regulations as well as ASME B31.3. All design calculations towards the same must be approved by IBR authority.
- 4.8.2 Expansion loops are to be provided for thermal expansion
- 4.8.3 Condensate draining facility shall be provided.
- 4.8.4 Drip legs shall be provided with steam traps at low points in the system.
- 4.8.5 Steam Tracing & Steam Jacketing System shall be as per process requirements.
- 4.9 **Supports and Anchors**
- 4.9.1 Supports and/or anchors shall be provided close to changes in direction of lines, branch lines and, particularly, close to valves to prevent excessive sagging, vibration and strain.
- 4.9.2 Allowable spans between pipe supports shall be determined to keep the maximum deflection within 16 mm.
- 4.9.3 In cases where periodic maintenance requires removal of equipment, such as pumps and relief valves, and where lines must be dismantled for cleaning, piping shall be supported to minimize the necessity of temporary supports.
- 4.9.4 Spring-loaded hangers may be used on piping subject to thermal expansion or contraction. In cases where the movement is very large, or the limitation of reaction and stress are very severe, constant support spring hangers shall be used.
- 4.9.5 Suction and discharge lines of rotating equipment shall be supported as close as possible to equipment nozzles, and shall be relieved of excessive strains by using proper pipe supports.
- 4.9.6 Supports shall not be directly welded to pipes. Where welding is unavoidable, supports having the same chemical composition as pipe shall be carefully welded.

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- 4.9.7 All piping shall be properly supported to minimize vibration.
- 4.9.8 Outlet piping of safety and relief valves shall be supported so that the inlet piping is capable of withstanding the reaction caused by operation of safety and relief valves. Furthermore, the supports shall be designed to minimize the stresses due to thermal expansion and the stresses in the valve body due to the weight of piping.
- 4.9.9 Expansion joints shall be guided and anchored to the extent necessary for their proper operation and alignment.
- 4.9.10 Anchors shall provide sufficient fixation to substantially transmit all load effects into the foundations.
- 4.9.11 Underground piping shall be given special anchoring consideration for differential settlement.
- 4,10 **Utility Stations**
- Utility Stations shall have three connections [one for LP steam (SL), one for Plant Air (AP) and one for Service Water (WS)) each of 1" unless otherwise specified in P&ID, located adjacent to pipe-rack column & on elevated structures. The approach of utility station shall be considered 15M all around the station location. Number of utility stations shall be such that all equipments shall be approachable from at least one utility station.
- 4.11 **Offsite & Yard Piping**
- In general, offsite piping (except tank ages area), electrical cable and instrumentation cable shall also be laid either on pipe rack or pipe sleepers.
- Wherever piping is laid on pipe sleepers, it shall have hard surfacing below it keeping a gap of 300 mm from the bottom of the pipes. Hard surfacing should be completed before start of pipe laying. Width of hard surfacing shall be about 1.0 meter more than the piping corridor. This extra hard surfacing shall be for movement of operating personnel along the piping corridor.
- 4.12 **Flare Piping**
- Flare header shall be sloped. Only horizontal loop shall be provided for thermal expansion.. Flare header shall be supported on shoe of height ranging from 100mm to 300mm.
- 4.13 **Underground Piping**
- 4.13.1 Underground piping shall be provided with wrapping & coating (min. 4 mm thick), "Holiday Tested" before Hydro Test, break flange at + 500 MM from floor level connection to isolate underground pipe from above ground piping with rubber insulating gasket kit, with cathodic protection, Sand Bed (min. 150 mm) all around the pipe , laid at least 1.0 meter earth cushion in open ground and 1.5 meters earth cushion under the roads and crane movement areas with Hume Pipe Sleeves at road crossings & crane movement areas
- 4.13.2 Cooling water (> 16"NB), Sewage lines (oily and chemical), Fire water lines in Process areas large Potable Water Line, and / or lines as per process requirements, shall be underground.
- 4.13.3 Piping in Trenches shall be provided piping located below grade, requiring inspection & servicing or provided with protective heating, Drain lines requiring gravity flow , Suitable draining scheme , Sump for valves and trenches shall be provided.

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5.0 FLEXIBILITY ANALYSIS AND SUPPORTING

5.1 Pipe Supporting Criteria & General Guidelines.

Piping system shall be properly supported taking into account the following points:

1. Load of bare pipe + fluid + insulation (if any).
2. Load of bare pipe + water fill.
3. Load of valves and online equipment and instrument.
4. Thermal loads during operation.
5. Steam-out condition, if applicable.
6. Wind loads for piping at higher elevation, e.g. transfer lines, column over head lines, flare headers, etc.
7. Forced vibration due to pulsating flow.
8. Vibration due to two phase flow.
9. Loads due to internal pressure.
10. Any external loads/concentrated loads and cold load of springs.

Pipe supporting shall preferably follow the minimum basic span as given in Annexure-1 except for flare line in off site on trestles in which case the maximum basic span shall be restricted to 18.0 meters, irrespective of line size.

For sizes not covered in Annexure-1, basic span shall be established based on project requirement. For piping on rack or sleeper, as a minimum, providing resting support on every grid of pipe rack / sleeper is mandatory. Depending on the pipe size, as a rule, guides shall be provided on straight run of pipes at intervals as specified in Annexure-3 unless specifically becomes non-viable due to flexibility problems.

Additional supports, guides, anchors, special supports like spring supports and sway braces shall be provided after detailed analysis of piping system to restrict the forces experienced on nozzles of critical items like pumps, compressors, turbines, exchangers, air fin coolers etc.

For lines which do not need any support otherwise but become unsupported by opening of flange, etc, during maintenance and thereby may transfer the total load on a small branch off, a permanent support shall be suitably provided which may be a spring support also. Bare pipes of size 14" and above on elevated structures shall be supported with pad or shoe. While bare pipes of size 6" and' above, on sleepers, corrosion pads shall be provided.



Pads shall be provided for insulated pipes before welding the shoes for sizes 8" & above.

Adequate stiffening shall be provided for the following:

- a) Lines in above 600#,
- b) Lines having two phase flow,
- c) Lines having Pulsating flow such as discharge of reciprocating compressors & reciprocating pumps,

For pulsating flow lines detailed thermal and vibration analysis by analog study shall be done to decide location of anchor supports and guides etc. Pulsating flow lines shall be as identified by licensor/owner.

Wherever two phase flow in piping is expected, piping design shall be checked by dynamic analysis to prevent vibrations.

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Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm, in any case, between two adjacent supports.

As far as possible long trunnion types of supports (more than 0.5 metre) are to be avoided. In case long trunnion support is unavoidable in straight length of pipe, trunnion height to be restricted to 0.5 M and balance height to be made up by providing extended structure.

In the heaters where steam air decoking provision is there, the main lines and decoking lines should be supported in a way so that either of the lines should not be in the hanging position while connected to other one. Same philosophy shall be adopted for similar type of switch over arrangement.

Piping passing through the technology structure or passing near the concrete column etc. should have adequate annular space to avoid restriction of line movement during thermal expansion. The gap should take care the thermal expansion along with insulation thickness.

High density PUF blocks shall be considered for cold piping supports. Use of wood blocks shall be avoided.

All pipes supports shall be so designed that there is no undue tension on equipment flanges. Flange joints should not move away from each other in case of unbolting of the joint.

5.2 Flexibility Analysis Criteria & General Guidelines

5.2.1 The directions of forces and moments shall be in accordance with Welding Research Council Bulletin 107 (WRC 107), with the exception that the radial force (P) shall be away from the vessel. All forces and moments shall be assumed to act simultaneously and apply at the nozzle/vessel interface.

5.2.2 Piping stress analysis and equipment nozzle loading analysis shall be in accordance with ASME B31.3 and the relevant API, ANSI/ISO and NEMA Codes.

5.2.3 API 610 Pumps

The allowable nozzle loads on centrifugal pumps shall meet the load criteria of API 610. Heavy duty base plate shall be specified where the pump design temperature is in excess of 150°C.

ASME or Manufacturer's Standard Pumps

The allowable nozzle loads on horizontal centrifugal pumps design to ASME B73.1 shall be specified by the manufacturer. For preliminary layout and analysis NEMA SM 23 criteria shall be used for individual nozzles.



Other Horizontal Centrifugal Pumps

The allowable nozzle loads shall meet the load criteria specified by the manufacturer.

Vertical Turbine, Can-Types Pumps

The combined bending and tensional thermal stress in the piping attached to the nozzle shall be limited to 25 percent of the allowable stress range shown in ASME B31.3. The combined stress due to dead load and other sustained loads shall be limited to 25 percent of the allowable hot stress.

5.2.4 For piping design purposes, differential settlement between items of major equipment on separate foundations shall be taken as 10 mm.

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5.2.5 Cold springing in piping shall not be permitted without written permission from the Owner. Cold springing of piping directly connected to rotating equipment is not permitted under any circumstances.

Piping shall be analyzed for expansion, contraction, differential settlement, relief, valve reaction and effects.

The design of piping systems shall take into account the different conditions expected during operation, start-up, shut-down, cold branch in case of standby pump, tracing, etc. Hydrocarbon lines shall be designed for steam-out conditions, if specified in line schedule. The use of expansion joints shall be considered only when space or pressure drop

limitation does not permit pipe bends. Expansion joint of axial type shall be avoided.

Forces and moments due to weight, thermal loads and other imposed loads on the equipment nozzle must not exceed the allowed loads for the equipment.

Minimum analysis temperature shall be the design temperature of the line as per line list.

5.3 Personnel Protection

5.3.1 Eyewash and emergency safety showers shall be provided in areas where operating personnel are subject to hazardous sprays, emissions or spills.

5.3.2 Personnel protection insulation shall be provided on un-insulated lines and equipment operating above 70 deg C when they constitute a hazard to the operators during normal operation of the facility.

5.4 Mechanical Handling

5.4.1 Handling facilities such as davits and monorails shall be provided on vessels over 10m in height where the weight of removable internal and/or external equipment is greater than 35 Kg.

6.0 MATERIALS



6.1 General

6.1.1 Basic material selection of particular line depending on its service, temperature and corrosivity shall be spelt out in process package. Material specification shall follow the requirements as per process parameters & Piping material specification of this document.

6.1.2 Only piping materials listed in ASME B31.3 shall be used for Category 'M' and Normal Service piping. Unless otherwise specified in PMS, For Category 'D' utility piping, where scaling and impurities are to be avoided (such as, potable water and deluge water) hot dipped galvanised and threaded fittings may be used in sizes up to and including 4" NB. Galvanised piping shall not be used in environments containing acids or other corrosive commodities. In corrosive environments stainless steel piping material shall be used for such utility systems.

6.1.3 Austenitic Stainless Steel items shall be solution annealed & pickled.

6.1.4 Austenitic Stainless Steel items shall be with Inter granular Corrosion' (IGC) Test.

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6.1.5 In absence of specific requirement, Natural Rubber shall be used for lining in rubber lined piping items, wherever applicable. Unless otherwise specified, rubber lining shall be in accordance with IS4682 Part-I.

6.1.6 Unless otherwise specified, HDPE pipes & fittings shall be in accordance to ASTM D3035/ ASTM D3261/ASTM D3350 or equivalent.

6.1.7 Pipe thickness of FRP material , if any, shall be according to vendor's norms and standard calculations but not be lower than indicated in DIN 16965 Part 4. External FRP layer shall be protected against ultra-violet light. Anticorrosion Barrier of Polymer veil having minimum thickness 2.5 mm shall be provided for chemical resistance. Mechanical resistance to be sustained by FRP.

6.1.8 No cast iron items shall be used in any service.

6.2 Pipe

6.2.1 Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding. 100% radiography for all welds except for pipes for category D service.

6.2.2 Double seam 180° apart is allowed for sizes 36" and larger only.

6.2.3 Galvanized Pipes shall be only Hot Dip galv. to ASTM A53.

6.2.4 Hydrostatic tests shall be applied to each length of pipe and be in accordance with the requirements of ASTM A530/A530M, unless otherwise specified.

6.2.5 Check analysis shall be carried out as per ASTM-A-530 for pipes as per ASTM-A-312 and pipe size > 8" and thickness > Sch.120, Check analysis shall also be carried out as per supplementary requirement S1 of ASTM-A-312.

6.3 Fittings

6.3.1 Type of fittings shall be equivalent to pipe type. All fittings shall be seamless similar to pipe specification in construction unless otherwise specified.

6.3.2 BW fittings to match pipe thickness

6.3.3 Socket weld and screwed fittings shall be in accordance with ANSI B16.11 to the extent covered in the specification , otherwise as per MSS-SP.

6.3.4 All pipes employed for manufacturing of fittings shall be required to have undergone Hydro test to ASTM A530.

6.3.5 All welded fittings shall be 100% Radio-graphed on all welds.



6.4 Flanges

All flanges shall be of forged one piece material (seamless), and plate may not be substituted without written approval from the Purchaser.

6.5 Gaskets

Gaskets shall be as per piping material specification/ applicable standard.

6.6 Stud, Bolts, Nuts and Jack Screws

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6.6.1 All bolting shall be as per ASME/ANSI 818.2.1 for Studs, M/C Bolts and Jack screws, and ASME/ANSI B18.2.2 for nuts. Machine Bolts shall not be used in piping flange joint, except for lug type Butterfly Valves, having UNC Threads in lugs facilitating opening of flanges from both sides.

6.6.2 Screw threads of bolting shall be unified coarse threads in accordance with ANSI / ASME B1.1 having Class 2A for bolts and Class2B for nuts. Screw threads in size 1/8 and larger shall be 8 threads per inch.

6.7 **Valves**

6.7.1 **General**

All flanged valves (except forged) shall have flanges integral with the valve body. Valve Castings/Forgings purchased shall be from Local approved foundries/forging shop. Yoke material shall be at least equal to body material. Forgings are acceptable in place of Castings but not vice-versa. Valves in saline water (if applicable) service shall be with non ferrous trims and all wetted parts other than trims shall be epoxy coated.

6.7.2 **Ball/Plug/Butterfly/Check Valves**

Use of soft seated ball/plug/butterfly valves shall be suitably selected based on temperatures handled.

Butterfly valves shall be suitable for throttling application.

Lug type Butterfly valves shall be with threaded lugs only.

High performance metal-seated Butterfly valves flanged/ lugged design to be used for Hydrocarbon service. Soft seated Butterfly valves lugged design to be used for category 'D' fluid service for sizes 10" and above.

PN equivalent rating for Class150# valves shall be minimum PN16.

As an alternative to swing check valves, dual plate check valves can be used, if permitted by process requirements.

Ball valves Fire safe type to be used for hydrocarbon services.



6.7.3 **Non Destructive Testing of Valves**

6.7.3.1 Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME/ANSI B16.34.

All valve castings shall be of radiographic quality.

The minimum requirement of radiography shall be as under:

Class	Size	Qty
150	Up to 24"	5%
150	26" & above	100%
300	Up to 16"	10%
300	18" & above	100%
600 & above	All	100%

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6.7.3.2 The welds of body-to-bonnet and body-to-end flange shall be subjected to 100% NDT; both radiographic and magnetic or liquid penetrant examinations.

6.7.3.3 Beveled ends on each butt welding end valve shall be subjected 100% magnetic particle or liquid penetrant examination.

6.7.3.4 Each valve shall be pressure tested in accordance with API 598.

6.7.4 **Criteria for Isolation Valves**

Installation	Process Isolation	Drain/ Vent	Pressure Taping	Level Taping	Flow Element	Safety Valve	Control Valve
150 / 300#	Single	Single	Single	Single	Single	Single	Single
600 #	Single	Double	Double	Single	Double	Single	Single
Above 600#	Double	Double	Double	Double	Double	Double	Single

Note: For S/D & at battery limit, it will be as per process requirements.

6.8 **Traps**

All the Traps shall be of compact assembly type with thermodynamic trap with In-built strainer, In-built piston valve for trap by-pass, trap vent, trap test, inlet isolation and outlet isolation valve. All traps shall be hydrostatically tested to twice the design pressure.

6.9 **Hoses**

All hoses shall be marked with service and working pressure at minimum two ends clearly. Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations. Complete Hose assembly shall be tested at two times the design pressure. Steam hoses shall be subject to steam resistance test.

6.10 **Expansion Joints(Metallic)**

The applicable codes are ASME B31.3 and EJMA (Expansion Joint Manufacturer's Association).

Bellows shall be formed from solution annealed sheet conforming to the latest ASTM Spec. Any longitudinal weld shall be 100% radiographed. The finished longitudinal weld must be of the same thickness and same surface finish as the parent material.



Circumferential welds are not permitted. Bellows are to be hydraulically or expansion (punched) formed. Rolled formed bellows are not acceptable. Noticeable punch or die marks resulting from expansion operation are not acceptable.

The out of roundness shall be limited to ± 3 mm. This is the max deviation between the max & min diameter. The actual circumference of the welding end shall be maintained to ± 3 mm of the theoretical circumference.

Apart from the usual requirements, the vendor shall also furnish

- a) Design calculations to justify stiffness and fatigue life.
- b) Axial, lateral stiffness, angular stiffness, effective pressure thrust area.
- c) Installation/maintenance manual.

6.11 **Supports & Spring Assemblies**

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The Material, Design, Manufacture and Fabrication shall be generally as per MSS-SP-58/ MSS-SP-89 and/or BS 3974. Testing of springs shall be as per BS1726.

6.12 Non Destructive Examination

10% radiography of butt welds and 10%DP/ MP test of fillet welds shall be done for pipe Classes in 150# & 300#.

100% radiography on butt weld joints and 100% DP/MP for fillet welds test shall be done for Pipe Classes in 600# & above.

7.0 PAINTING

Painting shall be as per attachment provided elsewhere in NIT.

8.0 WELDING

Welding shall be as per ASME BPV- Sec. IX

9.0 INSPECTION

9.1 Inspection authority means the Third Party Inspection Agencies (TPIA) approved by the Owner to carryout inspection of materials.

9.2 Quality Assurance plan (QAP) / Inspection Test Plan (ITP) shall be submitted by bidder for approval by Third Party Inspection Agency (TPIA).

9.3 Scope of Inspection by TPIA:

Review of MTC (all batches).

Visual check for surfaces, external appearance (10% random witness).

Dimensional check (10% random witness).

Positive Material Identification (PMI) for alloy steels (10% random witness).

Hydrostatic test (10% random witness).

Packing: Report review.

Documentation (MTC, Inspection Release Note): 100% Review



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TABLE OF BASIC SPAN - ANNEXURE - 1

Pipe Size In.	SCH/Thickness (in)	PIPE- VAPOR INSULATION			PIPE- LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		BASIC SPAN (L)M			BASIC SPAN (L)M			SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
		UPTO 175°C	176°C TO 315°C	316°C TO 400°C	UPTO 175°C	176°C TO 315°C	316°C TO 400°C					
3/4"	SCH 40	3.5	3.5	2.5	3.5	3.0	2.0	4.5	1.68	4.0	2.04	3/4"
1"	SCH 40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	3.07	1"
1-1/2"	SCH 40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	5.4	1-1/2"
2"	SCH 40	5.5	5.0	4.5	5.0	4.5	3.5	8.5	5.47	5.5	7.65	2"
2-1/2"	SCH 40	6.5	6.0	5.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	2-1/2"
3"	SCH 40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3"
4"	SCH 40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4"
6"	SCH 40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6"
8"	SCH 40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8"
10"	SCH 40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10"
12"	3/8" w	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12"
14"	3/8" w	15.0	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14"
16"	3/8" w	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16"
18"	3/8" w	17.0	16.5	15.0	13.5	13.0	12.0	18.0	106.5	13.5	258.3	18"
20"	3/8" w	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20"
24"	3/8" w	20.0	19.0	17.5	14.5	14.5	13.0	21.0	1425	15.0	418.2	24"
3/4"	SCH 80	3.5	3.5	2.5	3.5	3.0	2.0	4.5	2.20	4.0	2.49	3/4"
1"	SCH 80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1"
1-1/2"	SCH 80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	1-1/2"
2"	SCH 80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2"
2-1/2"	SCH 80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	2-1/2"
3"	SCH 80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3"
4"	SCH 80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4"
6"	SCH 80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6"
8"	1/2" w	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11.0	94.8	8"
10"	1/2" w	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10"
12"	1/2" w	14.5	13.5	13.0	12.5	12.0	11.5	15.0	98.13	13.0	168.64	12"
14"	1/2" w	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.15	13.5	194.4	14"
16"	1/2" w	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16"
18"	1/2" w	17.5	17.0	16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18"





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TABLE OF BASIC SPAN - ANNEXURE – 1

Pipe Size In.	SCH/Thickness (in)	PIPE- VAPOR INSULATION			PIPE- LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATER FILLED		Pipe size in.
		BASIC SPAN (L)M			BASIC SPAN (L)M			SPAN(L) M	WEIGHT KG/M	SPAN(L) M	WEIGHT KG/M	
		UPTO 175°C	176°C TO 315°C	316°C TO 400°C	UPTO 175°C	176°C TO 315°C	316°C TO 400°C					
20"	½" w	18.0	17.5	17.0	15.0	14.5	14.0	19.0	157.5	15.0	341.8	20"
24"	½" w	20.0	19.0	18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24"
1"	10S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	2.7	1"
1-112"	10S	5.0	4.5	3.5	4.5	4.0	3.0	5.5	3.12	5.0	4.57	1-112"
2"	10S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33	2"
2-112"	10S	6.5	5.5	4.5	5.5	5.0	4.5	7.0	5.26	6.0	8.85	2-1/2"
3"	10S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91	3"
4"	10S	7.5	7.0	6.0	6.0	6.0	6.0	8.0	8.34	7.0	17.87	4"
6"	10S	9.5	9.0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54	6"
8"	10S	11.0	10.5	10.0	9.5	9.5	8.5	11.5	19.94	10.0	55.5	8"
10"	10S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.53	11.0	83.4	10"
12"	10S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6	12"
14"	10S	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6	14"
16"	10S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2	16"
18"	10 S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1	18"
20"	10 S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5	20"
24"	10 S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8	24"



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ACCESSIBILITY FOR VALVES AND INSTRUMENTS - ANNEXURE - 2

VALVES, INSTRUMENTS, EQUIPMENT TO BE OPERATED	CENTRELINE OF ITEM TO BE OPERATED, LOCATED LESS THAN 3.6m ABOVE GRADE, 2.75 m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM	CENTRELINE OF ITEM TO BE OPERATED, LOCATED MORE THAN 3.6m ABOVE GRADE, 2.75m ABOVE FLOOR OR PLATFORM OR 1.8m ABOVE WING PLATFORM
EXCHANGER HEADS	NIL	PLATFORM
OPER.VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
OPER. VALVES 3" & ABOVE	PLATFORM	PLATFORM
MOTOR OPERATED VALVES	PLATFORM	PLATFORM
CONTROL VALVES	PLATFORM	PLATFORM
RELIEF VALVES 2" & SMALLER	FIXED LADDER	FIXED LADDER
RELIEF VALVES 3" & ABOVE	PLATFORM	PLATFORM
BLOCK VALVES 2" & SMALLER	PORTABLE LADDER	PLATFORM
BLOCK VALVES 3" & ABOVE	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)
BATTERY LIMIT VALVES	PLATFORM	PLATFORM
PRESSURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2m HEIGHT	FIXED LADDER
TEMPERATURE INSTRUMENT	FIXED LADDER IF ABOVE 2.2 M Ht	FIXED LADDER
SAMPLE POINTS	PLATFORM	PLATFORM
GAUGE GLASSES	FIXED LADDER	FIXED LADDER
LEVEL CONTROLLERS	PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 2" & SMALLER	PORTABLE LADDER / PLATFORM	PLATFORM
PROCESS BLINDS AND SPACERS 3" & ABOVE	PLATFORM	PLATFORM
MANWAYS/MANHOLES	PLATFORM	PLATFORM
HANDHOLES/INSPECTION HOLES	PLATFORM	PLATFORM
NOZZLES (process}	PLATFORM	PLATFORM
VESSEL VENTS	PORTABLE LADDER	FIXED LADDER
LINE DRAINS & VENTS	PORTABLE LADDER	PORTABLE LADDER
ORIFICE FLANGES	PLATFORM (NOTE-1)	PLATFORM (NOTE-1)

NOTE -1:-BLOCK VALVES / ORIFICE FLANGES, IF LOCATED, WITH CENTRE LINES GREATER THAN 2 METER FROM THE OPERATING FLOOR / OPERATING PLATFORM, SHALL BE PROVIDED WITH PORTABLE PLATFORM OR CHAIN FOR OPERATION.

NOTE -2 : PLATFORM SHALL BE PROVIDED FOR THE ORIFICE FLANGES ON PIPE RACK.



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MAXIMUM SPACING OF GUIDES FOR VERTICAL & HORIZONTAL PIPES - ANNEXURE-3



NOM PIPE SIZE IN INCHES	VERTICAL SPACING METRES	HORIZONTAL SPACING METRES
1	6.0	6.0
1 ½	6.0	6.0
2	6.0	6.0
3	8.0	12.0
4	8.0	12.0
6	8.0	12.0
8	8.0	12.0
10	12.0	18.0
12	12.0	18.0
14	12.0	18.0
16	12.0	18.0
18	12.0	18.0
20	16.0	18.0
24	16.0	18.0
26 & ABOVE	16.0	18.0

NOTES:-



1. These spacings may be varied to suit column spacing of rack. The above spacing is for straight runs of pipe & does not include guides which are used for control of thermal movements, as decided by stress group.
2. The guide spacings given in the above table are indicative only.

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CLEARANCES -		ANNEXURE – 4
Minimum clearances for piping, equipment, structures, platforms, and supports shall be in accordance with the following table:		
Item	Description	
Roads	Headroom for primary access roads wherever heavy duty crane movement is required.	9 M
	Headroom for primary access roads	7.5 M
	Width of primary access roads excluding shoulders.	Refer Civil
	Headroom for secondary roads	5 M
	Width of secondary roads excluding shoulders.	Refer Civil
	Clearance from edge of road shoulders to platforms, equipment, pipe associated with equipment, or similar features.	1.5 M**
	Minimum Clearance beneath pipe rack	3.8 M.
	Minimum Road clearance shall be wherever heavy duty crane movement is required during construction and future maintenance.	9 M
	Minimum Road clearance shall be for main roads.	7.5 M
	Minimum Road clearance shall be for secondary roads.	5 M
	T-Portal's width (max)	2.5 M
	T-Portal's height (min)	3 M
Maintenance Aisles at Grade	Horizontal clearances for equipment maintenance by hydraulic crane (12t capacity)	3 M
	Vertical clearance for equipment maintenance by hydraulic crane (12t capacity)	3.6 M
	Horizontal clearance for fork lift and similar equipment (2500 kgs capacity)	2.4 M
	Vertical clearance for fork lift and similar equipment (2500 kgs capacity)	2.4 M
	Horizontal clearances for equipment maintenance by portable manual equipment (A-frames, hand trucks, dollies or similar equipment)	1 M
	Vertical clearances for equipment maintenance by portable manual equipment (A-frames, hand trucks, dollies or similar equipment)	2.4 M
Walkways	Horizontal clearance (not necessarily in a straight line)	750 mm
	Headroom (except for hand wheels)	2.2 M
Platforms	Minimum width	1200 mm
	Headroom from stairwell treads.	2.2 M
	Minimum clearance around any obstruction on the platform.	500 mm

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CLEARANCES -		ANNEXURE - 4
Minimum clearances for piping, equipment, structures, platforms, and supports shall be in accordance with the following table:		
Item	Description	
Platforms	Headroom	2.2 M
	Maximum vertical distance between platforms	6 M
	Minimum toe clearance behind a ladder.	210 mm
	Minimum handrail clearance.	100 mm
Equipment	Minimum maintenance space required between flanges of exchangers or other equipment arranged in pairs.	500 mm
	Minimum maintenance space required for structural members or pipe.	300 mm
	Clearance from edge of road shoulder (the extreme projection)	1.5 M
	Clearance (clear gap) between two adjacent pumps	900 mm
Fired Equipment	Horizontal clearance from hydrocarbon equipment (shell to shell)	15 M
	Exception: Reactors or equipment in alloy systems shall be located for the most economical piping arrangement.	
	Clearance from edge of road to heater shell.	3 M
Valve Hand wheels	Clearance between the outside of the hand wheel and any obstruction.	25 mm*
Pipe (aboveground)	Clearance between the outside diameter of the flange and the outside diameter of pipe insulation.	25 mm*
	Clearance between the outside diameter of the pipe, flange or insulation and a structural member.	50 mm*
	Clearance between the outside diameter of the flange and the outside diameter of bare pipe.	25 mm*
	Minimum distance from underside of pipe to grade or platform.	300 mm
Control Valve Arrangement	Centreline of control valve above grade or platform.	450 mm
	Minimum centreline of control valve from face of column or wall.	600 mm
	Where process conditions require steam or hydrocarbon vapours to be discharged to atmosphere at a safe location, the tail pipe shall terminate as below:	
	Distance above nearest operating platform.	3 M
	Within radius of nearest operating platform.	7.5 M
** Verify conformance with local regulations. * With full consideration of thermal movements		

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ANNEXURE – 5

1.0 Special Requirements For Hydrogen Service

These requirements are applicable in addition to the requirements specified for respective Piping Material.

1.1 Pipes, Flanges And Fittings

1.1 STAINLESS STEEL PIPES, FITTINGS AND FLANGES

1.1.1 All weld joints shall be 100% radiographed in accordance with paragraph UW-51 of ASME Boiler and pressure vessel code, Section VII, Division 1.

1.1.2 All welds shall be post weld Heatreated (PWTHT'D) at 1550-1650 Deg. F (843-899 Deg.C), 1 hour per inch of thickness, 1 hour minimum.

1.1.3 All pipes, flanges & fittings shall be solution annealed and pickled.

1.1.4 Weld deposits shall be checked for ferrite content. A ferrite number (FN) of not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during post weld heat treatment and high temperature service. FN may be determined by use of a ferrite scope or may be calculated using Schaeffer or DeLong diagrams (The DeLong Diagram should be used if "FCAW" welding is performed). Ferrite scope measurements must be made prior to post weld heat treatment to be meaningful.

1.2 Alloy Steel (Cr-Mo) Pipes, Fittings And Flanges

1.2.1 The alloy content of welds shall be verified by chemical analysis. Tests shall be conducted when changes in weld wire and/or weld flux are made, or when a new set of electrode is used.

Maximum room temperature tensile strength of all pressure containing components and welds shall be 100,000 PSI.

Serration on the flange face shall be concentric for hydrogen service. Spiral serration is not acceptable.

1.3 Method of Manufacture



1.3.1 All carbon steel pipes, forgings & fittings having wall thickness 9.53 mm (0.375") and above shall be normalized. Cold drawn pipes & fittings shall be normalized after the final cold draw pass for all thickness. The normalizing shall be a separate heating operation & not a part of the hot forming operation.

1.3.2 All alloy steel (Cr-Mo) pipes, forgings & fittings shall be normalized and tempered. The normalizing and tempering shall be a separate heating operation and not a part of the hot forming operation. The maximum room temperature tensile strength shall be 100,000 psi.

1.4 Post Weld Heat Treatment

All carbon steel pipes & fittings having wall thickness 19mm (0.75") and above shall be post weld heat-treated.

All alloy steel (Cr-Mo) pipes & fittings shall be post weld heat treated irrespective of type or thickness of weld.

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All stabilized grades of stainless steel shall be given a stabilizing heat treatment in addition to solution heat treatment at 900°C.

1.5 Impact Test

- 1.5.1 For Pipe and fittings of carbon steel of thickness over 19mm and alloy steel of all thickness, Charpy-V notch impact testing shall be carried out in accordance with paragraph UG-84 of ASME Section VIII, Div-1 for weld metal and base metal from the thickest pipe, forging & fitting per heat of material and per heat treating batch. Impact test specimen shall be in complete heat treated condition and accordance with ASTM A370. Impact energies at 0°C shall average greater than 27J (20 ft-lb) per set of three specimens, with a minimum of 19J (15 ft-lb).
- 1.5.2 If welding is used in manufacturing, impact test of Heat Affected Zone (HAZ) and weld metal shall also be carried out.

1.6 Hardness

- 1.6.1 For carbon steel pipes & fittings, hardness of weld and HAZ shall be 200 BHN (max.).
- 1.6.2 For alloy steel pipes & fittings, hardness of weld and HAZ shall be 225 BHN (max.).

1.7 Radiography

All welds, longitudinal & circumferential, shall be 100% radiographed in accordance with UW-51 of ASME Section VIII, Div-1 and ASME Section V. Radiography shall be performed after post weld heat treatment.

1.8 Ferrite No. Test

For all austenitic stainless steels, the weld deposit shall be checked for ferrite content. A Ferrite No. (FN) not less than 3% and not more than 10% is required to avoid sigma phase embrittlement during heat treatment. FN shall be determined by Ferritescope prior to post weld heat treatment.

2.0 Valves

2.1 General

- 2.1.1 All valve castings shall be of radiographic quality. The requirement of radiography shall be as under:



50%	-	Up to 24" size in 150# rating and 16" size in 300# rating.
100%	-	Beyond above range.

- 2.1.2 All cast valve flanges and bodies of rating 900# and greater shall be examined in accordance with Appendix 7. ASME Section VIII, Div-1, regardless of casting quality factor.

- 2.1.3 A high pressure Helium leak test on valve body to be conducted on all valves (cast as well as forged) of rating 900# and above. Test shall be conducted with Helium mass spectrometer (detector probe technique) in accordance with ASME Sec. V, subsection A, article 10, Appendix 5. Acceptance criteria shall be in accordance with ASME Sec. VIII, Div-1, Appendix 7.

2.2 Austenitic S. S. Valves

- 2.2.1 Casting and test bar shall be heat treated together. Casting shall be in the solution heat-treated and pickled condition.

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- 2.2.2 Critical body and bonnet casting section typically defined in ANSI B-16.34 shall be radio graphed and shall meet the requirement of ASTM E446 (up to 2" thick) category A, B & CA Level 2, category CB, CC & CD Level 3, category of D, B & F Level 0. For wall thickness 2" to 4.5" comparable plates of ASTM E186 shall be used. ASTM E94 & ASTM E142 shall be used for recommended practice & controlling quality of radiography as a guide.
The entire surface of all casting shall be dye-penetrant inspected after pickling.
- 2.2.3 Repair welds shall be 10% radio graphed and evaluated in accordance with paragraph 334.5 of ASME B31.3 with a minimum casting quality factor of 0.95. Dye-penetration Test shall be as per ASTM E-165 Procedure B-2, Interpretation as per Appendix 8 of ASME VIII Div 1.
- 2.3 **C. S. & A. S. Valves**
- 2.3.1 Bend test and magnetic particle inspection of the entire surface of body and bonnet casting shall be in accordance with ASTM A-217. Supplementary requirement S3 & S4, evaluation of magnetic particle inspection shall be in accordance with MSS-SP-53 except that no linear discontinuities shall be allowed.
- 2.3.2 The Brinell hardness of heat-treated casting shall not exceed 200 BHN for carbon steel & 225 for alloy steel.
- 2.3.3 Repair of defective casting shall be outlined in writing to the purchaser before commencing repair. Repair method to be approved prior to welding.
- 2.3.4 Casting shall be preheated to a minimum of 400°F prior to welding and all chromium-molybdenum alloys shall be post weld heat treated after welding is complete.
- 2.3.5 Carbon steel and alloy steel shall be normalized and tempered.
- 2.3.6 Dye-penetrant test shall be in accordance with ASTM B165 Procedure B-2. Interpretation shall as per Appendix-8 of ASME VIII Div. 1.
- 2.3.7 The tensile stress for A. S. shall be less than 100,000 psi.
- 2.3.8 For alloy steel valves Charpy-V notch impact testing to be done for valve body material as per clause 1.3.1.
- 2.3.9 For radiography as per ANSI B-16.34 and acceptance criteria for valve casting refer clause 2.2.2. above.

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PART - II: TECHNICAL

SECTION – 1.10

ENGINEERING SPECIFICATION - ELECTRICAL



**PROJECT : COAL TO METHANOL (C2M) PROJECT
THROUGH COAL GASIFICATION ROUTE AT
DANKUNI COAL COMPLEX WEST BENGAL,
INDIA**

0	24.09.2020	25.08.2020	Issued for Tender	RK	SS	SKB
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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1.0 GENERAL

This document defines broadly the scope & the specific interface requirement for developing detailed design and engineering for complete electrical facilities along with Fire Alarm, Plant Communication System, Public Address etc. required in Installation of Coal gasification based Methanol Plant. All data required in this regard shall be taken into consideration for acceptable, satisfactory, reliable, safe and trouble free operation of the system as per good engineering practices.



2.0 STATUTORY REQUIREMENTS, CODES & STANDARDS

The design and the installation shall be in accordance with established codes, good engineering practices and shall conform to the statutory regulations applicable in the country. BOO OPERATOR shall be responsible for obtaining necessary approvals from the statutory authorities. e.g. Central Electricity Authority (CEA) / Electrical inspectorate, Chief Controller of explosives (CCE) as applicable before commissioning of electrical facilities.

Liaison with CIL / PMC electrical engineers in charge / other contractors for implementing interfaces as required.



2.1 Latest version of main codes, standards and statutory regulations to be considered as minimum requirements are as given below :

- OISD standards -Indian Standard Specification
- Indian Electricity act
- Indian Electricity rules
- Indian Standard Specification or equivalent IEC Standards
- Publications of IEEE
- The Indian Explosives Act.
- Indian Boiler Regulation Act
- Statutory requirement of Govt of West Bengal and Govt. of India.
- Guidelines, instructions, directions issued by Pollution control Boards of state as well as central government. Guidelines, instructions, directions issued by Chief Controller of Explosives (CCoE), CPCB, CMRI, DGMS, CEA etc.
- Guidelines of Tariff Advisory Committee
- Guidelines of Insurance Companies Association.
- National Electrical safety Code(NESC)
- Standards of Underwrites laboratory(UL)
- American Society for Testing Material (ASTM)
- American National Standards Institute (ANSI)
- Other International Standards
- The Factory act
- API Standards / IEEE
- NFPA
- Any other applicable Rules/Acts/Regulations.
- Requirements of other authorities concerned with the Project
- All statutory provisions of India / Govt of West Bengal

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2.2 Some of the bare minimum relevant Indian Standards / OISD Standards are as listed below. However, system / equipment design shall be in line with latest edition of all applicable standards.

IS: 325, IEC:60034	Three phase induction motors
IS: 335	New insulating oil for transformers and switchgears
IS: 722	AC electricity meters
IS: 732	Code of practice for electrical wiring installations system voltages not exceeding 650V
IS: 737	Specification for wrought aluminum and aluminum alloys, sheet and strip (for engineering purpose)
IS: 996, IEC:60034	Single phase AC motors
IS:1248	Direct acting analogue electrical measuring instruments and their accessories:
IS: 1367 Part- 13	Hot dip galvanised coatings on threaded fasteners.
IS: 1646	Code of practice for fire safety of buildings and electrical installations
IS: 1913	General and safety requirements for Luminaries (Tubular fluorescent Lamp)
IS: 2071	Method of high voltage testing
IS: 2099	High voltage porcelain bushings
IEC:62305	Code of practice for the protection of buildings and allied structures against lightning
IS/IEC60079	Electrical apparatus for Explosive gas atmosphere
IS: 2544	Porcelain post Insulators for system with normal voltage greater than 1000 volts
IS: 2633	Methods of testing uniformity of coating on zinc coated articles
IS: 2705	Current Transformers
IS: 3034	Code of practice for fire safety of industrial buildings, electrical generating distributing stations.
IS: 3043	Code of practice for earthing
IS: 3156	Voltage Transformers
IS: 3177 IEC60034	Crane duty motors
IS: 3347	Dimensions for porcelain transformer bushings
IS: 3637	Gas operated relays
IS: 3639	Fittings and accessories for power transformers
IS: 3646	Interior illumination: Part I & Part II

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IS: 3716	Application guide for insulation co-ordination
IS: 4691	Degree of protection provided by enclosure for rotating electrical machinery
IS: 4722	DC motors
IS: 4759	Hot dip zinc coating on structural steel and allied products
IS: 5082	Specification for wrought Aluminum alloys bars, rods, tubes and sections for electrical purposes
IS: 5561	Electric power connectors
IS: 5571	Guide for selection of electrical equipment for hazardous areas
IS: 5572	Hazardous areas other than mines for electrical insulations area having flammable gases and vapours
IS: 5578	Guide for marking of insulated conductors (1st rev)
IS: 6362	Designation of methods of cooling of rotating electrical machines
IS: 6600	Guide for loading of oil immersed transformers
IS: 6665	Code of practice for Industrial lighting
IS: 7689	Guide for control of undesirable static electricity
IS: 8084	Interconnecting Bus bars for AC voltage above 1 KV upto and including 36 KV
IS: 9676	Reference ambient temperature for electrical equipment
IS: 10028	Code of practice for selection, installation and maintenance of transformers
IS: 10322-1	Specification for Luminaries,Part-1,General requirements
IS: 11353	Guide for uniform system of marking & identification of conductor & apparatus terminals
IS: 11448	Application Guide for AC electricity meters
IS: 12360	Voltage bands for electrical installations including preferred voltage and Frequency
IS: 12459	Code of practice for fire protection of cable runs
IS: 12615	Energy efficient motors
IS: 13234	Guide for short circuit calculations
IS: 13346	General requirements for electrical apparatus for explosive gas atmosphere.
IS: 13408	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
IS: 13947	Low voltage switchgear and control gear
IS: 60034-5	Degree of protection provided by Integral design of rotating electrical machines
IS: 60079-0	Explosive atmospheres, Equipment General Requirements

IS: 60079-1	Explosive gas atmospheres – Part-1 Equipment protection by Flame
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	proof enclosures “d”.
IS: 60079-7	Equipment protection by increased safety “e”
SP: 30	National Electrical Codes (NEC) - BIS Publication
IEC 62271-203	Gas insulated metal enclosed switchgear for rated voltages of above 52 kV.
IS/IEC 62271	HV Switchboard.
IEC 60947	LV switchboard.
IEC 61439-1/2	LV switchboard (PCC/PMCC/MCC) for TOTAL TYPE TESTED (TTA). Type Test Certificates for short circuit withstand of 50kA for 1 sec. along with ACB mounted in the Switchboards shall apply.
IEC 61641	Switch Board with INTERNAL ARC CONTAINMENT test.
ANSI C-37:23	Metal enclosed bus
ANSI C-37:24	Effect of Solar radiation on metal enclosed bus.
IEC 60034	Rotating Electrical Machinery
IEC 61131	Programmable controllers
SP 30	National Electrical Code (NEC) - BIS Publication.
OISD 113	Classification of areas for electrical installation at hydrocarbon processing and handling facilities
OISD RP 147	Inspection and safe practices during electrical installations.
OISD RP 149	Design aspects for safety in Electrical system.
OISD 173	Fire prevention and protection system for electrical installation.
OISD GDN 180	Lightning protection.

2.3 Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

3.0 CONSTRUCTION POWER

- 3.1 CIL, at its expense, shall provide temporary construction power to BOO OPERATOR from the Existing DCC Plant Sub-station up to a total maximum load of 10MW at Single Point (33kV) within CIL Battery Limit on chargeable basis, subject to availability, as per prevailing rate of power. However, BOO OPERATOR, at its own cost, shall arrange alternative source of power to meet interruptions, if any in construction power supply provided by OWNER
- 3.2 BOO OPERATOR shall include adequately rated sub distribution boards, power supply cables, other associated material, trenches, overhead structures, road crossings etc. for feeding loads to carry out construction, fabrication activities, etc.
- 3.3 BOO OPERATOR shall provide adequate area lighting at site of construction, fabrication yards, office, etc. by means of high flood light masts, flood lighting poles, etc. which are to be supplied and maintained by the BOO OPERATOR.

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4.0 ELECTRICAL SYSTEM DESCRIPTION & SCOPE

Normal Power supply shall be provided by CIL at 132 KV level from State Electricity Board. However, 132 kV Switchyard and further Distribution to 33kV / 6.6kV / 415V shall be in BOO Operator's scope.

The Emergency power shall be arranged by the BOO OPERATOR through adequately rated DG set at requisite voltage through suitably rated Switch board transformer. In addition to power required for safe shut down of plant the Emergency DG set shall also cater to the load of emergency lighting, Fire alarm & communication system, Critical load for process, UPS system, battery charger etc.

5.0 SYSTEM DESIGN PHILOSOPHY

5.1 The electrical installation shall be designed to provide:

- Necessary amount of power
- Flexibility
- Service reliability
- Ease of expansion
- Ease of operation and maintenance & inter changeability of equipment
- Safety of personnel



The design of electrical installation shall ensure provision of a safe, efficient and reliable supply of electricity at all times including adverse system conditions. Safe conditions shall be ensured under all operating conditions including those associated with start up and shut down of plant as well as those arising out of failure of electrical equipment. The isolation of part of system of electrical equipment due to either maintenance or shut down shall not compromise safety aspects.

5.2 System shall be designed considering following aspects in general: -

- To facilitate inspection, cleaning and maintenance with the care to safety in operation and personnel protection.
- To minimize turnaround time.
- To provide safety, reliability and flexibility of service.
- Adequate provision for future extension and modification.
- Maximum interchangeability of equipment.
- Desired level of operator interface to achieve coordinated efficient and fail-safe operation, data logging and maintenance of the equipment.
- To decide redundancy, stand by, spares and overload capacities to achieve desired reliability and flexibility requirement.
- To get cost effective and techno commercially proven technology. Economic considerations shall cover capital and running costs and an assessment of the reliability of the system.

5.3 All the electrical consumers within the battery limit shall be identified and listed to have complete details of rating, efficiency, power factor, operating duty cycle (continuous, intermittent, standby), category of supply required (emergency, normal, critical) etc.

5.4 Required redundancy (based on specific process/operating needs) shall be built in substation which feeds power supply to process units/important facilities so that in case of tripping of one

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feeder, the unit may not be adversely affected and continuity in operation at full capacity is achieved.

- 5.5 While sizing the system necessary consideration shall be given to restrict the system voltage drop within permissible limits during starting of large rated motors. At the same time, the short circuit current shall be kept within limits keeping in view of the market availability of switchgears rating. For this purpose current limiting reactors/unit ratio transformers if required may be used.

5.6 Load Grouping

Electrical consumers shall be classified as 'normal / non-essential, emergency / essential or vital / critical loads as per the concepts defined below:

- 5.6.1 'Emergency' or 'essential' loads shall be identified on the criteria that, when failing in operation or when failing if called upon, will affect the continuity of operation, the quality or the quantity of product. For such loads, reliable source shall be ensured. Such feeders shall be grouped on a separate bus section in the respective Switchboards/ MCCs / PCCs.

- 5.6.2 Some of the loads which can be identified as emergency / essential load but not essentially limited to following:

- Electrical loads required for continuous operation of process plants utility.
- Electrical loads required for safe shut down of facilities in case of normal supply failure.
- Emergency lighting & communication facilities.
- Fire Detection and Alarm System.
- AC & DC UPS / Battery charging equipment.
- Control room AC equipment -Essential ventilation system for offices / Manned areas of other buildings.
- Motorised valves as per process requirement
- PA & Paging system.
- Barring gear
- AC Emergency Lub Oil Pump
- I.D. Fan Lub Oil Pump
- F.D. Fan Lub Oil Pump
- A.C. Seal Oil Pump
- Compressors
- Flame Scanner Cooling Air Fan
- Any other load

- 5.6.3 Critical' or 'vital' loads shall be identified on the criteria that, when failing in operation or when called upon, can cause an unsafe condition of the installation, jeopardize life or cause a major damage to the installation. For critical loads if any, UPS shall be provided to facilitate uninterrupted supply. The loads on UPS are AVR / PLC / DCS / Auxiliary supply for drives etc. Critical drives if any shall be provided with DC motors.

- 5.6.4 Some of the load which can be identified as critical / vital load but not essentially limited to following:



- Loads providing control and protection to plant equipment.
- Loads serving critical equipment for safety of plant, equipment and / or personnel

- 5.6.5 Non-essential service is a service, which is neither 'essential' nor 'vital'. Hence the non-essential load does not require any special measure such as standby feeder or standby source to safeguard the continuity of service.

5.7 SYSTEM VOLTAGES

Following factors shall be taken into account while selecting the voltage levels:

- Short circuit level



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- Availability of the switchgear with suitable current rating and short circuit rating.
 - Existing available voltage levels in the refinery.
 - Utilisation voltages of various equipment
 - Provision of future extension.
 - Size and location of loads
 - Choice of voltage may also be affected by local regulations, standards as well as the voltage of existing installations
 - Overall economy for optimum voltage selection.
- 5.8 All the components of electrical system shall be designed to take into account following :
- After Diversity Maximum demand (ADMD) after diversity under most severe operating and ambient conditions with an additional 10 % contingency
 - Intermittent service loads, if any.
 - 30 % spare for future addition.

5.9 PLANT UTILITY LEVELS

5.9.1 The various voltage levels for in plant power distribution shall be as follows:

A. Normal Power (State Grid Power)	Grid power shall be available at 132KV. Necessary outdoor type switchyard shall be in BOO Operator's scope. BOO Operator shall co-ordinate with WBSEDCL.
B. Emergency Power	Voltage Variation $\pm 5\%$, 50Hz $\pm 3\%$, 3Ph, 3 W Voltage Level of DG shall be based upon actual voltage level of emergency loads. (DGs shall be in BOO Operator's scope)
C. Distribution Equipment	a) 6.6KV $\pm 10\%$, 50 Hz $\pm 5\%$, 3 Ph, 3 W with resistance earthed neutral b) 415V $\pm 10\%$, 3 Ph, 4 W/240V $\pm 10\%$, 1 Ph, 2W, 50 Hz $\pm 5\%$ solidly grounded neutral.
Combined variation in voltage & frequency	$\pm 10\%$
Control Supply for: - 415V motors	AC 240V $\pm 10\%$, 50 Hz $\pm 5\%$, 1Ph (For contactor controlled motors) DC 110V $\pm 5\%$ (For breaker controlled motors)
- Switch Gear Breaker controlled feeders: a. Closing, tripping & spring charging motor b. Auxiliary power	DC 110V $\pm 5\%$, 2 W AC 240V $\pm 10\%$, 50 Hz $\pm 5\%$, 1Ph, 2W
- Instrumentation and	AC 115 V $\pm 10\%$, 50 Hz $\pm 3\%$ 1Ph, 2W



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Automation, DCS & Auxiliaries	
Voltage Ratings	
- Motors above 150 KW	6.6 KV, 3 Ph AC
-Motors up to150 KW	415 V, 3 Ph AC
- Space heaters	240V, 1 Ph AC
- Lighting	415V/240V AC
- Panic Lights	110V DC/230V Ac from UPS
- Power Sockets/Receptacle	415V, 3 Ph AC/240V, 1 Ph AC
- Portable safety lamps & Tools	24V AC

5.9.2 VOLTAGE DROP

The maximum voltage drops in various sections of the electrical system shall be within the limits stated in the following table:

Sl.No.	System Element	Maximum Permissible Voltage Drop
a)	Extra High/High voltage cables for general distribution	1 %
b)	Bus duct / Cable between transformer secondary and Switchboards	0.5%
c)	Cable between PMCC and MCC or auxiliary switchboard i) MCC / Auxiliary Switchboard near PMCC ii) MCC / Auxiliary Switchboard situated remote from PMCC	0.5% Note-3b 2 to 2.5% Note-3a
d)	Cables between HV Switchboard and HV Motor (during running)	3%
e)	Cable between PMCC and motor (during running)	5%
f)	Cable between MCC (situated near PMCC) and motors	5%
g)	Cable between MCC (situated remote from PMCC) and motors	3%
h)	Cable between Auxiliary Switchboard / MLDB and Lighting Panel / Power Panel	1 to 1.5% (Note-2)
i)	Circuit between lighting panels and lighting points	4% (Note-2)
j)	DC Supply Circuit (electrical Controls)	5% and/or as per instrumentation requirement
k)	DCDB to Control Room	2% (Note-1)
l)	UPS outgoing circuit	5% (Note-1)

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Note-1

Minimum voltage available across any instrument in the field / control room / satellite rack room shall be as per instrumentation design basis. Distribution system for instrumentation supplies shall be designed accordingly. In case of any conflict between electrical equipment specification sheet and instrumentation design basis report, the latter shall govern regarding instrumentation power supplies.

Note-2

In case of difficulty in achieving specified voltage drops in cables up to lighting panel, 5% drop from Auxiliary Switchboard / MLDB up to lighting points may be permitted.

Note-3



- a) Higher voltage drop may be permitted between PMCC and remote mounted MCC / ASB; if overall voltage drop up to motor (from PMCC) is limited within 5.5%.
- b) For large substations 1% drop may be permitted.

The maximum voltage drop at various buses during start-up of large motor and / or motor reacceleration conditions shall be within the limits stated below:-

Sl. No.	System Element	Operating Condition	Maximum Permissible Voltage Drop
a)	At the bus bars of the worst affected Switchboard	Start-up of the large HV motor with other loads on the bus or reacceleration of a group of HV motors (Simultaneous start-up or group reacceleration of HV motors is not envisaged)	10%
b)	At the bus bars of the worst affected LV Switchboard (PMCC / MCC)	Start-up of large LV motor with other loads on the bus, or reacceleration of a group of LV motors.	10%
c)	Cables between HV Switchboard and motor	Motor start-up or reacceleration	5% (Note-a)
d)	Cable between MV Switchboard (PMCC / MCC) and motor	Motor start-up or reacceleration	10% (Note-a)

Notes:

- a) Higher voltage drop in motor cables may be permitted, in case the conditions given in Note b), c) and d) are complied.
- b) The voltage available at the motor terminals during start-up must be sufficient to ensure positive starting or reacceleration of the motor (even with the motor fully loaded, if required), without causing any damage to the motor.
- c) For medium voltage motors, the voltage available at the motor terminals must not be less than 80% of the rated value during start-up or reacceleration.
- d) For high voltage motors, the voltage available at the motor terminals must not be less than 85% of the rated value during start-up or reacceleration.

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- e) Soft Starter / VFD Starter shall be considered for starting large HV motors if essential / unavoidable as per system design requirement / equipment design limitation. For cases other than starting limitation, requirement of soft starter / VFD for any drive shall be confirmed by Process Department.
- f) Unless otherwise specified as in clause e), all HV motors and MV motors shall be suitable for Direct on Line (DOL) starting.

5.9.3 Design Criteria for Cables / Bus Duct & Short Circuit Withstand Time

Sr.No.	Design Criteria	132kV	33kV	6.6 kV	415 V
1.	Loads beyond 1000A rating and located near the transformer	1-core cable	Bus Duct / 1-core cable	Bus Duct / 1-core cable	Bus Duct / 1-core cable
2.	Loads located up to 200 M	1-core cable	Cable	Cable	Cable
3.	Loads located 200 - 1000 M	1-core cable	1-core cable / 3-core cable	1-core cable / 3-core cable	1-core cable / 3.5-core cable
4.	Loads located beyond 1 KM	Cable	Cable	Cable	Cable
5.	Recommended limiting size of multi-core cable (sq.mm) / Single Core (sqmm)	1C X 630 Sqmm.	3 Core x 300 / 1 Core x 630	3 Core x 400 / 1 Core x 630	3.5 Core x 300 / 1 Core x 630
6.	Insulation voltage grade	132 kV Unearthed	33 kV Unearthed	6.6 kV Unearthed	1100 V Earthed
6.	Type of cable insulation	XLPE	XLPE	XLPE	Power: XLPE Control: XLPE
7.	Power, Control & Earthing Cables	Armoured	Armoured	Armoured	Armoured

For breaker control motor circuits the selection of size will be made ensuring that the cable shall withstand a short circuit fault directly for 0.2 sec.

Suitable derating factors based on the site ambient conditions, method of laying and the no. of cables laid together shall also be applied.



Short circuit withstand time (seconds) shall be as follows for Breaker controlled feeders.

Bus duct	1 Sec.
Feeders to motors and transformer	0.25 sec
Feeders from PCC/PMCC to MCC	0.6 sec
132kV feeder	3 Sec.
Main 33 KV switchgear feeders	1 sec
Main 6.6 KV primary distribution feeders	0.7 sec
6.6 KV cable from generator & transformer to switch board	1 sec
Incomer from other switchboard	0.6 sec

5.10 Electrical System

BOO Operator shall carry out following minimum Electrical System Studies using latest software preferably ETAP and the result of the same shall be furnished.

- Load Flow Studies
- Short Circuit Studies

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- Transient Stability Studies
- Motor Starting Studies
- Relay Co-ordination and Relay settings.
- Harmonic studies.
- Arc Flashing.

Electrical Equipment shall be designed as per worst operating conditions.

5.11 All the switchgears shall be designed for following Minimum fault level withstand capacity.

33 kV Switchgear. : 1800MVA for 3 Seconds

6.6 kV Switchgear – 500MVA for 3 Seconds.

The fault level for 415V switchboards shall be 50KA for 1 sec.

5.12 Sizing of high voltage cables shall be based on short circuit withstand capacity in addition to the current capacity.

5.13 33 kV, 6.6 KV systems shall be non-effectively earthed through resistance. The earth fault current of 6.6 KV shall be limited to full load current of the transformer or 400 A, whichever is less.

The neutral of 415V supply system shall be solidly earthed.

5.14 INSULATION SYSTEM

Following factors shall be considered while designing the Insulation of Electrical system.



- System voltage
- System grounding
- Switching over voltages
- Lightning surges
- For HT motors (VCB controlled) surge arresters shall be provided.

For resistance grounded systems, the resistance value shall be chosen to limit the earth fault current to a value recommended by motor manufacturer for insulation protection and sufficient for selective and reliable operation of earth fault protection system. The value of limited earth fault current shall generally not exceed 50 % of transformer or generator full load current.

5.15 AUTO CHANGE OVER SCHEMES

The normal operation of the 33 kV, 6.6 kV Switchgears, Power & Motor Control Centre (PMCC) and Motor Control Centre (MCC) shall be as under:

- i. Bus-coupler shall be provided between all the sources. Incomer and Bus-coupler breaker rating shall be same for all the switchboards. Each incoming feeder shall independently feed the loads on respective buses with full rated bus tie breaker open and the load on each bus balanced. In order to ensure maximum degree of reliability and continuity, automatic transfer from one incoming feeder to other shall be possible through auto/manual closing of bus tie breaker in case of sustained loss of power on any bus section.
- ii. The bus tie breaker shall be provided with auto/manual selection. The bus tie breaker shall be independent in manual mode. In auto selection mode, the bus tie breaker is electrically interlocked with incoming circuit breakers, so that it cannot be closed unless one of the incoming breakers is open.
- iii. When one of the incoming feeder trips, the bus tie breaker is closed automatically based on the philosophy described below and the total load is transferred to other healthy incoming

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feeder which is capable of carrying the entire load. Sufficient switchgear capacity is to be provided.

- iv. Motors requiring reacceleration as per process requirement shall be provided with starter suitable for reacceleration.
- v. Auto Change Over scheme shall be provided for incomer feeders and bus coupler feeder of 33 kV switchboard, 6.6kV Switchboards and 415V Switchboards. Under normal operating conditions, incomer-1 and incomer-2 breakers shall be closed and bus coupler breaker shall remain open with 'Local-Remote-Off' switch in 'Remote' position. The bus coupler breaker shall close automatically under the following conditions being fulfilled:
 - Either of the incoming breaker trips due to under voltage (70% or below).
 - Voltage on the healthy bus is more than 80% for the set period.
 - Residual voltage on the bus with no power supply comes down to 30% or below.

Required nos. of bus PT, line PT and under voltage relays shall be provided to achieve the desired automatic changeover.
- vi. Auto transfer shall take place only on sustained loss of power on either of bus sections. Auto transfer shall be blocked in case of fault on either of bus sections or no power on both incomers.
- vii. Paralleling of two incoming feeders is not foreseen. However, facility for momentary paralleling shall be provided for intentional changeover without interruption of supply with synchro check relay in Bus Coupler panel. There shall also be provision of selective tripping of one feeder out of three feeders (two incoming feeders and one Bus Coupler).

5.16 PROTECTION AND METERING SCHEMES

5.16.1 Selection and co ordination of Protection and metering system shall be such as to ensure :

- Selective and sensitive and reliable protection of equipment against damage due to internal or external faults or atmosphere discharge.
- Isolation of fault in the shortest possible time.
- Simplicity of the scheme with maximum protection at minimum cost.
- Uninterrupted operation of healthy system.
- Personnel & plant safety.



5.16.2 Important plant feeders in particular, which are connected to power generation bus, shall be provided with differential protection. The CT arrangement / locations provided for differential protection shall be such that overlapping zones are formed for differential protections provided for HT feeders, incomers, bus couplers, tie feeders etc so that the protection zone gets extended up to the last breaker / zone for which differential protection is provided. Restricted earth fault protection shall be provided for transformer secondary.

5.16.3 Protective relays shall be of latest version, numerical / communicable type with non-volatile memory, comprehensive unit providing protection, metering, control as per IEC 61850 compatible to communicate with MMI and ECS. 100% redundancy shall be provided for communication. Relays shall support features like remote relay parameterization, disturbance recorder etc. It shall be possible to set / operate the relay from the front facia. A separate convention type lock out relay shall be provided with hand reset facility.

Numerical relay shall indicate MWH, MVAR, MVA, V, A, Hz, PF. It shall have future provision for connecting with substation HMI. Separate multifunction meter with communication (for centralized energy monitoring) shall be used and shall not be part of protective device.

Relays shall support features like remote relay parameterization, disturbance recorder etc. It shall be possible to set/operate the relay from the front facia. Lock out relay shall be conventional type with hand reset facility.

5.16.4 Special protection for any feeder such as differential, restricted earth fault, directional distance

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power relays etc. shall also be through numerical relay having serial port for monitoring.



5.16.5 In general, fast acting relays (with time delays if required) shall be used and all fault tripping shall be done through high speed tripping relays.

5.16.6 Bare minimum Protection devices for power distribution system shall be as indicated below, however, BOO OPERATOR shall provide any other necessary protection relays required for complete protection of system :



Sl. No.	Relay Description	Relay No.	HV Tr. Fdr. Sec Wdg. Volt=> 6.6 KV	HV Tr. Fdr. Sec Wdg. Volt=< 6.6 KV	HV /LV Motor Fdr., HV Breaker controlled contactor controlled	O/G Bkr. HV Plant Fdr.	O/G Bkr. MV PMCC	I/C EHV/ HV	I/C MV PMCC
1.	IDMTL Over-Current Relay	51	YES	YES	-----	YES	YES	YES (2)	YES
2.	IDMTL Earth-Fault Relay	51N	YES (4)	YES	-----	YES	YES	YES (2)	YES
3.	Standby / Backup Earth Fault Relay (earthed neutral)	51G (11)	YES (23)	YES (23)	-----	-----	-----	-----	-----
4.	Motor Protection Relay with (50, 50N, 46, 49, 50L/R, 95)	99	-----	-----	YES	-----	YES	-----	-----
5.	Instantaneous Restricted Earth Fault Relay (Earthed side)	64R (11)	-----	-----	-----	-----	-----	YES (25)	YES
6.	Instantaneous Over current Relay	50	YES	YES	-----	-----	-----	-----	-----
7.	Instantaneous Earth Fault Relay	50N	YES (5)	YES	-----	-----	-----	-----	-----
8.	Differential Protection Relay	87	YES (6)	-----	YES (7)	YES (8)	-----	-----	-----
9.	High speed tripping relay	86 (20)	YES	YES	YES	YES	YES	YES	YES
10.	Trip Circuit Supervision Relay	95 (20)	YES	YES	YES	YES	YES	YES	YES
11.	Transformer Auxiliary Relay	63	YES	YES	-----	-----	-----	-----	-----
12.	Under Voltage Relay with timer	27 / 2	-----	-----	YES	-----	-----	YES (9)	YES (9)
13.	Check Synchronisation Relay	25	-----	-----	-----	-----	-----	YES (10)	YES (10)
14.	Busbar Differential	87B & 95B	YES (16)	YES (16)	YES (16)	YES (16)	-----	YES (16)	-----

Notes for Relay Protection Philosophy

- All the numerical relays shall be of communicable type and connected to LMS on IEC 61850 (Ethernet based) communication protocol with time stamping and time synchronization.
- In case of HV switchboards with continuous parallel operation of incomers, following additional relays shall be provided:
 - One set of 87B (Bus differential) and 95 B (Bus wire supervision) for each bus section.
 - 32 (Directional IDMTL over current and earth fault) relays for the incomers.
- In case of grid power supply EHV incomer following additional relays shall also be provided:
 - Relay 21 for distance protection, Relay 59 for overvoltage protection with timer, Relay 67 for directional over current protection, Relay 67N for directional earth fault protection, Relay 81 for under frequency / df/dt protection and Relay 98 as dead bus charging relay.
 - Minimum protection relays for EHV Transformer shall be 50, 50N, 51, 51G, 51N, 63TX, 64R, 86, 87T, 87F & 95.

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4. Instantaneous earth fault (50N) shall be provided only for transformer with delta primary.
5. Directional IDMTL earth fault (67N) shall be provided for transformer with star primary.
6. For transformers rated 5 MVA and above.
7. For motors rated 1500 kW and above, excluding VFD fed motors.
8. For critical/long feeders and plant feeders connected to main power generation and distribution bus. A plant feeder implies outgoing feeders from one switchboard to another switchboard of same voltage level.
9. Wherever auto-transfer feature is provided.
10. For switchgears where continuous or momentary paralleling of Incomers is envisaged, check synchronizing relay shall be provided.
11. 51G and 64R relays for input transformer of VFD system shall be decided by VFD Manufacturer.
12. The bus tie feeders in HV switchboards shall be provided with 51, 51N, 86 and 95 relays.
13. HV capacitor bank feeders shall be provided with 51, 51N, 59 (over voltage), 60 (Neutral displacement), 86 and 95 relays.
14. The following feeders shall be provided with timers for delayed tripping on bus under voltage while the under voltage relay shall be common for the bus
 - a. HV and MV capacitor feeders.
 - b. HV and MV breaker controlled motor feeders.
 - c. Contactor controlled motor feeders with DC control supply.
 Numerical relays where ever provided for motor and capacitor feeders shall use in built under voltage relay and timer for delayed tripping on bus under voltage.
15. One no. DC supply supervision relay (80) shall be provided for each incoming DC supply to the switchboard.
16. One set of bus differential relays (87B) and bus wire supervision relay (95 B) for each bus section shall be provided for HV switchboards connected directly to generation buses.
17. In case of numerical relays, all relays shall be comprehensive units including all protection, metering and control.
18. Under voltage and over voltage function along with associated timer shall be part of the numerical relays.
19. Auto changeover scheme control & logic between Incomers and bus coupler shall be built in the numerical relay.
20. Tripping relays (86) & Trip Circuit supervision relay (95) shall be separate relay. There shall be two nos. high speed tripping relay for motor feeder. One for electrical fault and one for process fault. Electrical fault relay shall be hand reset type and process fault relay shall be self reset.
21. 2 Nos. of 86 relays shall be considered for HV and MV breaker fed motors for ease of differentiating between process & electric trip. Process trip relay shall be electromechanical, self reset type.
22. Breaker control switch shall be hardwired type.
23. Stand by earth fault relay 51G shall be provided in the incomer of switchboard fed from transformers where transformer & switchboard both are located remotely from HV substation as well as in same HV substation.
24. For transformers located remotely away from HV Substation, a local power isolating device in the form of breaker panel without any protection relay shall be provided before transformer. A local emergency stop push button shall also be provided in transformer bay for tripping remote breaker.
25. Restricted earth fault relay 64R shall be provided for transformer rating ≥ 1 MVA in the incomer of switchboard fed from transformers having secondary winding star connected. This shall trip the HV side breaker.
26. 6.6kV DG set shall be provided with protection but not limited to 51V,51G,40,46,86,95,80,64R etc. for generator rated above 500KVA and Generator rated less than 500KVA shall have 51V,51G,40,46,86,95,80 unless otherwise agreed with the owner.



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27. Relay 87 and 64R shall be separate numerical relay. Hence shall not be part of main comprehensive numerical relay. CT for 87 and 64R can be clubbed, as two core of single CT.
 28. Accuracy class of the current transformers shall be
 - Class PS for differential and special requirements.
 - Class 1.0 / 0.2 S for metering purpose.
 - Class 5P20 for protection purpose
 All the CTs shall have rated burden of minimum 15 VA and secondary rated current of 1 A.
 29. Accuracy class of the potential / voltage transformers shall be
 - Class 5P for protection purpose.
 - Class 1.0 for metering purpose.
 All the PTs shall have secondary voltage 110 V or 110 V / sqrt.3 and rated burden of minimum 50 VA per phase for both metering and protection core.
 30. All the incoming, outgoing and tie breaker feeders of any HV & MV Switchboard shall be provided with numerical relays only with communication facility as protection devices. Releases shall not be acceptable in any case. The relays for outdoor 66 kV EHV switchyard shall also be of numerical type with communication facility.
 31. Numerical relays in all HV motor feeders shall be suitable for RTD / BTD inputs.
 32. Each bus section shall be provided with separate under voltage relays.
 33. Multifunction meter shall be provided to keep a record of power consumption and supervision of all concerned parameters like current, voltage, power, frequency, power factor etc. as specified. All the metering instruments shall be flush mounted.
 34. All metering shall be a part of comprehensive relay, if accuracy for metering in LAN can be obtained within 1.0%. If not, separate digital meters or comprehensive metering unit shall be provided in various feeders. These meters shall also be communicable type with open protocol, suitable to communicate with LMS system.
 35. The protection of generator and generator isolation transformer shall be effected thru' redundant (2 x 100%) numerical Relays.
 36. Motors shall also be provided with Unbalanced (-Ve) Sequence Protection Relay (46), as required.
 37. Numerical under voltage relays (27) with time delay relay including VT fuse failure relay shall be provided for Bus VTs.
 38. Reverse power protection relay shall be provided in all incomer feeders of 33 kV Switchgear.
 39. No Meters, transducers or measuring equipments to be installed in the Protection CT circuit.
- 5.17 Metering instruments shall be provided to keep record of power consumption and supervision of all concerned parameters like current, voltage, power (Active, Apparent and Reactive), frequency, power factor, Energy (Active & Reactive) etc. All the instruments shall be flush mounted. All meters shall be digital multifunctional meters with communication port for Load management at remote location. Additionally digital type ammeter, voltmeter and Hour Meter shall be provided separately for various feeders as indicated below :

The metering devices in EHV control & relay panel, HV and MV switchboards shall be as below:

- Type of metering: Analogue/As part of the Numerical relay
(Figure inside bracket refers to note below) (YES - Applicable)



Sl.	Feeder type	A	V	Hz	PF	MW	MWH	HM	MVAR	MVAH	MVA
-----	-------------	---	---	----	----	----	-----	----	------	------	-----

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No.											
1.	Grid Incomers	YES	YES	YES	YES	YES (2)	YES	----	YES (2)	YES (2)	YES (1,2)
2.	Grid Bus Tie	YES	----	----	----	----	----	----	----	----	----
3.	Grid Transformer	YES	----	----	----	YES	YES	----	----	----	----
4.	Grid Bus PT	----	YES	----	----	----	----	----	----	----	----
5.	HV Incomer	YES	YES	YES	YES	YES	YES	----	YES	YES	YES
6.	HV Bus Tie	YES	----	----	----	----	----	----	----	----	----
7.	HV Transformer	YES	----	----	----	YES	YES	----	----	----	----
8.	HV Bus PT	----	YES	----	----	----	----	----	----	----	----
9.	HV Plant Feeder	YES	----	----	----	----	YES	----	----	----	----
10.	HV Motor	YES	----	----	----	----	YES (kWh)	YES	----	----	----
11.	HV Capacitor	YES	YES	----	----	----	----	----	YES	----	----
12.	PMCC Incomer	YES	YES	----	YES	----	YES (kWh)	----	----	----	----
13.	PMCC Bus Tie	YES	----	----	----	----	----	----	----	----	----
14.	PMCC Bus PT	----	YES	----	----	----	----	----	----	----	----
15.	ACB Outgoing (Non Motor)	YES	----	----	----	----	YES (kWh)	----	----	----	----
16.	MV Motor (>55 KW)	YES	----	----	----	----	----	----	----	----	----
17.	MCC / ASB Incomer	YES	YES	----	----	----	----	----	----	----	----
18.	MCCB O/G (250A)	YES	----	----	----	----	YES (kWh)	----	----	----	----
19.	MLDB Incomer	YES	YES	----	----	----	YES (kWh)	----	----	----	----
20.	DG Set - HV	YES	YES	YES	YES	YES (kW)	YES (kWh)	YES	----	----	----

Notes for Metering:-

- MVA meter in external power supply incomers shall include maximum demand indication also.
- Separate MW, MVAR, MVA and MVAH meters shall be provided for EHV external power and STGs incomers supply only.
- Separate analogue type voltmeters with voltmeter selector switch and analogue type ammeters with ammeter selector switch shall be provided for incomers of all switchboards.
- Ammeter (size 48mm x 48mm) shall be provided in space heater circuit of breaker fed HV & MV motors.
- Apart from metering which shall be part of the numerical relays, digital multi-function meters shall be provided in all the breaker feeders of HV & MV Switchboard i.e. in incomers, bus coupler, outgoing plant feeders, transformer feeders, motor feeders, capacitor bank feeders, etc.
- Multi function meters with serial communication over RS-485 or fibre optic cable, preferably with IEC protocol shall be provided in all the breaker feeders.
- Power factor meter shall be provided for synchronous motors in addition to the metering provided for induction motors.
- For current feedback to DCS and VFD feeders motor current transducers shall be provided and mounted in switchgear panel.
- CT operated Ammeter for all motor feeders above 5.5 KW, all MOV and LOPs shall be provided at both LCS and feeder end of switchboard.

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10. All ammeters for LV motors shall be connected through CT. Only HV motors shall have 3 ammeters or ammeter selector switch or Voltmeter and Voltmeter Selector Switch.

11. Hour run meter shall be provided in all breaker controlled motor feeder.

5.18 CONTROL AND MONITORING

The following provision shall be made for control and monitoring of following electrical equipments.

- Transformers



- TNC switch in primary & secondary side of switchgear.
- Emergency trip from secondary side for tripping primary side of transformer.
- VCB with all required protection to be considered in all the 33kV, 6.6kV switchboards. .
- Lockable 'OFF' push button in transformer room to trip sending end switchgear.
- Indication lamp for 'ON' 'OFF' 'Auto-trip', 'Non-trip' and 'Trip Circuit Healthy'.
- Ammeter and voltmeter on both primary and secondary side.
- Load break switch with Earthing Switch on transformer primary side (only where primary side circuit breaker is not located in the same sub-station).
- Annunciator for each feeder of switchboard

- Motors Controlled Through Circuit Breakers

- OFF- ON switch with Ammeter on LCS
- - OFF-AUTO/MAN-L/R-ON switch with Ammeter on DCS.
- Ammeter in LCS and in switchgear.
- Current monitoring at DCS, where required from process point of view.
- Indication Lamps in switchgear for 'ON', 'OFF', 'Auto-trip' and 'Trip Circuit Healthy', 'Ready for Service', 'Test', 'Service', 'Space Heater ON'.
- Emergency trip in switchgear.
- Winding and bearing temperatures of motors shall be available at DCS in control room.
- Process interlock in CCR, where required.
- Indication lamp for 'ON', 'OFF' and 'TRIP' in remote (DCS/PLC etc.)
- Motor space heater & Panel board space heater Ammeter in switchgear, where required
- Motors controlled through Circuit breakers should also be provided with ammeter, KVAh, KWH and running hour counter.
- Annunciator for each feeders switchboard

- Medium Voltage Motors Controlled Through Contactors

- OFF- ON switch on LCS
- Ammeter in LCS for motors of 1.5 KW and above or as required from process point of view.
- - OFF-AUTO/MAN-L/R-ON switch on DCS.
- Current monitoring in DCS, where required from process point of view.
- Emergency Trip in PCC/MCC.
- Process interlock in CCR, where required shall be wired through separate auxillary relay..

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- Indication lamp for 'ON', 'OFF' and 'Fault' in switchgear.
- Indication lamp for 'ON', 'OFF' and 'TRIP' in remote (DCS/PLC etc.)
- Motor space heater & Panel board space heater shall be provided with Ammeter & LED in Switchgear.

5.19 DC POWER SUPPLY

5.19.1 110 V DC system shall be provided for control of circuit breaker feeders and panic lighting.

It shall be obtained from Ni-Cd batteries to be located in respective Substation in a separate room. Separate dedicated Battery, Battery Charger and DC Distribution Board shall be provided in each substation.

5.19.2 The battery shall be provided with SCR controlled automatic rectifier-cum battery chargers and shall consist of load-cum-float-cum-boost charger and stand by unit for the same and one common battery bank of 100% capacity having backup time of 2 hours.

5.19.3 Each rectifier-cum- battery charger shall have independent power supply to be fed from the emergency source.

5.19.4 Each Substation requiring 110V DC shall have 2 sources with auto changeover facility in case of failure of 1 source, Redundant battery chargers with separate battery banks shall have to be provided.

5.19.5 DC Battery Charger, AC UPS and HVAC for control room shall be fed from emergency switchboard.

5.19.6 Battery end cell voltage shall 1.1V. Aging factor shall considered 120% and spare capacity shall have 125%.

5.19.7 For Temperature derating factor shall be based upon Minimum Ambient Temperature i.e. 5⁰ C.

5.20 EMERGENCY POWER SUPPLY

The emergency power supply system shall be designed to feed the following types of loads as required:

- Electrical loads essential for safe shut down
- Emergency lighting
- Fire alarm / communication system
- DC supply system
- UPS system
- Loads critical for process, plant and personnel safety.

5.21 SUB-STATION

5.21.1 Substations shall be located at a safe distance from the process areas, hazardous areas and dusty areas, near the load centres.



5.21.2 Substations shall be two storeys building with ground floor mainly used as a cable gallery with minimum height of 3 meters.

5.21.3 The switch room shall have vitrous glazed tiles flooring.



5.21.4 Staircases shall be paved with anti skid tiles.

5.21.5 All door and windows shall have anodized aluminium frame and provided with toughened glass.

5.21.6 Arrangement shall be provided for lifting heavy equipment to be brought into substation.

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- 5.21.7 Switchgears and MCCs etc. shall be located on the first floor of the building.
- 5.21.8 Cables shall penetrate walls and floor via fire resistant barriers rated for 1 hour fire capacity.
- 5.21.9 The batteries shall be located in a suitable room provided with exhaust fan for the vapours released by the batteries. Battery room shall have Acid / Alkali resistance Tiles for floor and wall up to 2.0 M.
- 5.21.10 Oil immersed transformers shall be located outdoor and under shed. The transformers shall be separated from each other by a fireproof wall. All the building walls surrounding transformers shall also be fireproof walls. The transformer basements shall be provided with oil collecting system. The transformer yard shall be fenced.
- 5.21.11 Dry type transformers shall be housed in a separate room in an enclosure.
- 5.21.12 The substation shall be provided with rubber mats in front of switch boards, safety signs, exist signs and danger signs etc. to satisfy local regulations and statutory requirements.
- 5.21.13 The layout of equipment shall be such that it shall have adequate space for installation, operation, maintenance and future expansion
- 5.21.14 In all substations HV Sw gear equipment shall be segregated from LV switchgear equipment as per IE rules.
- 5.21.15 The clearance of equipment from the walls / other equipment shall be adequate to ensure safety of working personnel and shall be as per IE rules.
- 5.21.16 Sufficient nos. of entrances (Min. 2) shall be provided for each floor.
- 5.21.17 Epoxy flooring shall be done to reduce the heat load and improve the aesthetic look.
- 5.21.18 The Sub-Station shall house all the Electrical Power, Control and Monitoring equipment except those required for operation in the field. The equipment shall broadly include the following depending on the requirement :
- Step up / Step down Transformers, Special type Transformer etc. each located in separate Bay/room outside the substation.
 - High Voltage Switch Boards
 - Power Control Centres
 - Power & Motor control centres
 - Emergency Power & Motor control centres
 - Motor Control Centres
 - Auxiliary Service Panel Boards
 - Lighting Transformer (Indoor / Outdoor as per requirement)
 - Main Light Distribution Board
 - Lighting Distribution Boards
 - Lighting Sub-Distribution Boards
 - Battery Sets
 - Rectifier-Cum-Battery Charger
 - DC Distribution Boards
 - Rectifier-inverter Sets
 - UPS System alongwith UPS distribution board.
 - Neutral Earthling Resistors (Indoor / Outdoor as per requirement)
 - Input / Output Panels
 - VFD System / Soft Starter
 - Any other equipment required
- 5.21.19 All static devices such as Rectifier-Cum-Battery Chargers, Static Inverter Sets, Programmable Logic Controller, Variable Speed Drive Panels etc., shall be housed in air conditioned room.

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However, complete switch room shall be air pressurised type. All equipments shall be suitable for operation under specified ambient condition even on failure of air conditioning system.

5.21.20 Substations shall be provided with smoke detectors and fire alarm system.

6.0 AREA CLASSIFICATION

6.1 Following factors shall be considered for proper selection of electrical equipment for use in hazardous areas :

- Area classification (Zone 0 / Zone1 / Zone2)
- Gas classification (Gr. II A / IIB / IIC) – Characteristic of the gas / vapour involved
- Temperature classification (T1 to T6)
- Environmental conditions – selected electrical equipment shall be protected against corrosive and solvent agencies, water ingress, dusty, chemically polluted atmosphere as determined by the environmental conditions.

6.2 All electrical equipment installed in classified areas shall be selected as per IS 5571, OISD 113 and other relevant standards. For Zone 2 areas as a minimum Ex (e) type of equipment shall be used. However, Ex (e) type of equipment shall not be used for Zone – 1 area.

6.3 Pressurised type of motors Ex(p) may be considered in case flameproof motors in required kW rating and gas gr. are not available. All pressurised motors shall be complete with flameproof pressurisation panel, control valves, flow meter, pressure switch etc. DC power supply shall be considered for the pressurisation panel of the pressurised motors. Pressurisation system shall have parallel filter and draining arrangement prior to purging. Necessary interlock shall be provided such that on failure of pressurisation system, electrical equipment will be switched off with audiovisual alarm.

6.4 Selection of equipment for hazardous areas shall be as follows :



Area Classified	Type of protection	Symbol
Zone 0	- No electrical equipment to be installed.	
Zone 1	- Flameproof enclosure	‘ d ‘
	- Intrinsic safety category	‘ I ‘
	- Pressurised	‘ p ‘
	- Other electrical apparatus specifically designed for Zone 1	‘ s ‘
Zone 2	- Increased safety	‘ e ‘

6.5 Increased safety apparatus located outdoor shall be provided with minimum IPW55 protection as per IS 4691.

6.6 All electrical equipment for hazardous areas shall be certified by testing authorities like CMRI, PTB, BASEEFA, UL / FM for the service and the area of installation and shall be approved by CCE. All indigenous flameproof equipment Ex (d) shall be under BIS license.

6.7 As additional safety features, the following requirements for electrical equipment shall be followed:

6.7.1 All electric motors for agitators, mixers, LPG Pumps and metering pumps handling flammable material shall be flameproof type irrespective of the area being classified as Zone-2 or Zone-1.

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- 6.7.2 All electric motors for vertical oil sump pumps shall be flameproof type Ex-d.
- 6.7.3 Irrespective of the area classification (whether Zone-1 or Zone-2) all motors and lighting fixtures within the storage areas, pump house associated with storage areas and within the loading / unloading gantries shall be flameproof type.
- 6.7.4 Even though fired heaters in process units are not considered for area classification, all electrical equipment associated with fired heaters in process units shall, as a minimum be suitable for installation in Zone-2 area.
- 6.7.5 All electrical equipment installed for an analyser room shall be flameproof type suitable for gas group-IIA, IIB, IIC irrespective of the area being classified as Zone-1 or Zone-2.
- 6.7.6 All equipment inside the process units shall be suitable for Zone-2 Ex (e) temperature class T3 irrespective of area being safe.
- 6.7.7 Process units having different types of gas groups like IIA / IIB/ IIC or different area classification like Zone-1 or Zone-2 or safe shall have electrical equipment to meet all gas groups / area classification to facilitate installation and minimum spare inventory and uniformity.

7.0 EQUIPMENT DESIGN PHILOSOPHY

Brief specification of the equipment has been mentioned. Equipment design shall be in line with latest edition of all applicable Indian / International standards.



7.1 General Constructional Features

- 7.1.1 The equipment shall be suitable for tropical climate conditions and corrosive and saline atmosphere.
- All electrical equipment accessories and wiring shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion. Fine mesh screen of corrosion resistant material shall be furnish on all ventilating openings to prevent entry of insects.
- 7.1.2 The equipment to be installed in indoor plant area shall be enclosed in dust, damp and vermin proof enclosure equivalent to IP 54 as per relevant Indian Standards/IEC.
- 7.1.3 The equipment excluding motors to be installed in outdoor plant area shall have IP 65 enclosure. Motors of Coal Conveyor, Coal Handling Section, Ash Handling Section shall have IP 65 enclosure. Motors of other sections of plant shall have IP 55 enclosure.
- 7.1.4 4 mm FRP (fire retardant and UV stabilized) canopies shall be provided for all outdoor equipments like motors, starters, LCS, SDBs, sw. sockets etc. PA stations shall have acoustic hood.
- 7.1.5 The switch boards, to be installed inside the building shall have enclosure IP 4X for HV switchgear, for LV switchgear degree of protection shall be IP 52 up to 1600A rating and IP-4X above 1600A rating. Equipment requiring ventilation opening such as battery charger/UPS etc. located in air conditioning room may have IP 43 enclosure however, opening for the ventilation shall be covered with fine wire mesh.
- 7.1.6 Creepage distance shall be 31mm/kV (for highest system voltage) for all equipment.
- 7.2 D.G. SET :
- 7.2.1 In order to meet the emergency power requirement for critical loads and also for safe shut down of plant. There shall be One no. of DG set each rated for full emergency power requirement, in

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the event of the failure of normal power one DG set will supply the total emergency power requirement ,other DG set shall be stand by.

- 7.2.2 DG Sets, Diesel tanks and associated switchgears shall be located at centralized place away and at a minimum safe distance from substations and hazardous areas as per relevant IS/IEC of hazardous area classification. Emergency power from DG Set shall cater to:-
- Loads of emergency shut down
 - Essential loads of the package
 - Loads of emergency and aviation lighting
 - UPS Loads
 - Battery Charger & DCDB Loads
- 7.2.3 The DG Sets control shall have PLC/microprocessor based latest state of art technology. Brushless excitation system shall be used in generator.
- 7.2.4 The engine shall of high speed increase the efficiency of DG set, a system of air preheating (turbo charger etc.) shall be employed.
- 7.2.5 The starting of engine shall be air charging type. Battery start engines are not acceptable.
- 7.2.6 DG set shall have all its auxiliaries installed and controlled from same place. The control of DG set shall be based on 110 V DC which shall be supplied from the DC panel.
- 7.2.7 The auto starting time (i.e. the time between actuation of loss of power in case of failure of main power to the time of loading of total emergency load) shall be in accordance with the requirement of process. The maximum starting and synchronising time of Sets shall be 30 seconds even after 3rd attempt and shall be able to take full load within lower of two i.e process and 45 seconds. The DG power shall be made available within such a period that none of the plant unit is affected due to failure of normal power.
- 7.2.8 The auxiliary power supply board to feed the auxiliaries of DG set shall have dual power supply:- one from the normal power supply source of plant and other from the DG set itself. There shall be a provision of auto changeover in the incoming supply of auxiliary power supply board of DG set. The Emergency power distribution board shall be kept in a separate room near to engine room of DG set. The outgoing feeders for 400 A and below in Emergency power distribution board shall have Switch Fuse unit. The incomer and larger rated feeders shall be provided with Air Circuit Breaker. A comprehensive electrical protection system shall be provided to protect the generator as well as individual feeder. The incomer shall have a kwh meter along with ammeter, voltmeter etc.
- 7.2.9 There shall be a separate control panel to control the auxiliaries and comprehensive alarm and fault indication system shall be provided to indicate the status of auxiliaries as well as Diesel Generator set.
- 7.2.10 The quick start auto-mains failure DG set of adequate rating shall be battery/compressed air started and radiator cooled type suitable for supplying emergency load.
- 7.2.11 DG set shall be supplied with day oil storage tank (12 Hr. capacity at full load continuous operation), bulk oil storage tank ,associated piping ,valves, accessories, earthing of all equipments, all power and control cables as required.
- 7.2.12 Emmission from DG set shall met the requirement of Local Pollution norms.
- 7.2.13 DG set / DG Building shall be provided with suitable acoustic enclosure to restrict the noise level to 85db at 1Mtr.
- 7.3 TRANSFORMERS

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- 7.3.1 The transformers except lighting transformers shall be ONAN / ONAF, 3 phase, oil immersed, double wound type suitable for outdoor installation. Lighting transformers shall be dry type.
- 7.3.2 Transformer sizing shall be such as to take care of minimum 8 hour maximum demand, starting of highest rated induction motor with other load in running condition and minimum 25% spare capacity for future requirement.
- 7.3.3 The ONAN rating of ONAN/ONAF type power transformers shall be equal to or higher than maximum demand. ONAF rating shall be equal to or higher than 125% of ONAN rating.
- 7.3.4 In general, rating and % impedance of each transformer shall be selected to limit the short circuit current to values within the current rating and rupturing capacity of switchgear available and also to ensure the voltage drop within permissible limit. The transformer impedances shall be as per Indian standards unless otherwise required.
- 7.3.5 Power transformers shall be of low losses type. Usually no load & load losses shall be optimised for operation around 40 – 50 % of their ONAN rating.
- 7.3.6 Grid Transformers shall be equipped with 'ON' load tap changer (OLTC) and RTCC Panel . For on load tap changer, provision shall be made for Auto – Manual and Local – Remote electrical operation of the tap changer.
- 7.3.7 Routine test on all transformer and heat run test on one transformer of each rating shall be performed.

7.4 Neutral Earthing Resistor (NER)

- 7.4.1 The NER shall be provided to earth the neutral of 33kV, 6.6 KV systems. Neutral of 415V supply system shall be solidly earthed.
- 7.4.2 Neutral earthing resistor shall be outdoor type made of AISI 304/406 punched stainless steel grid element. . The earth fault current of 33kV & 6.6 KV shall be limited to full load current of transformer or 400 A, whichever is less.
- 7.4.3 Neutral earthing resistor shall be designed to carry continuously 20% of the rated short time current.

7.5 HT SWITCHGEAR

- 7.5.1 All switchgears and associated equipment shall be rated for the rating of motor being fed from it under any circuit configuration.
- 7.5.2 There shall be three positions for Breaker/Contactor trolley: - Service, Test and Isolate. In service position, the power connections shall be made; but in test and isolate mode, the power connection of bus bars shall be automatically removed.



ACB feeder for PCC, PMCC & MCC shall be single front for ease of operation & maintenance. Non-ACB feeders for motors or power may be double front type.

Breaker duty cycle shall be O-0.3sec-CO-3min-CO.



Separate CT shall be provided for differential and REF protection.

LV circuit breaker shall be 4 Pole type except for outgoing motor feeders which shall be 3 Pole type.



- 7.5.3 Suitable shutter arrangement shall be provided to protect the person from accidental contact with live bus in trolley chamber.
- 7.5.4 The degree of protection shall be IP 4X for HV switchboards and IP 52 for LV Switchboard up to 1600A rating and IP-4X for LV switchboards above 1600A rating.
- 7.5.5 All HV, MV & LV Switchboards shall be LOTO compliance.

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- 7.5.6 33kV & 6.6 kV Switchboard shall conform to IS/IEC 62271-200, IAC-A FLR-50KA/40KA 1 Sec, PM, LSC 2B which means that the switchgear panels shall be four side internal arc tested, shall have metal partitions and shall conform to loss of service continuity. LV switchboard shall conform to IEC 60947.
- 7.5.7 LV switchboard (EPMCC/PMCC/MCC) shall be TOTAL TYPE TESTED (TTA) design as per IEC 61439-1/2. Type Test Certificates for short circuit withstand of 50kA for 1 sec along with ACB mounted in the Switchboards shall be provided.
- 7.5.8 LV switchboard (EPMCC/PMCC/MCC) shall comply with Internal Arc Containment test as per IEC 61641.
- 7.5.9 The minimum thickness of sheet steel used in HV and LV switchgear including charger, UPS, ASPB etc. shall be as under:-
- a) Base Channel minimum 3.0 mm
 - b) Load Bearing Members minimum 2.0 mm
 - c) Doors and covers minimum 1.6 mm
- 7.5.10 A bottom channel of not less than 100 mm shall be provided.
- 7.5.11 Minimum 25 % spare feeders or one no. of each rating and type on each side of the bus section whichever is more shall be provided.
- 7.5.12 In case of HT vacuum circuit breaker, adequate provision shall be made for motor switching to limit the over voltage to 2.2 per unit of rated peak line to earth voltage. Required surge arrestors may be provided for this purpose.
- 7.5.13 The rating of Circuit breakers /contactors used in Motor feeder shall be at least 125% of the maximum continuous motor rating.
- 7.5.14 Electrical running loads shall be uniformly distributed on each bus and it shall be ensured that running and standby loads are fed from two different bus sections.
- 7.5.15 One panel of highest breaker rating shall be subjected to type test. This test can be exempted only in case of extension of existing panels.
- 7.5.16 Switchgears shall be supplied with necessary earthing trollies / earthing rods / breaker lifting trollies.
- 7.5.17 For tie feeders, receiving end circuit breaker shall have ON / OFF control and indicating lamps for sending end circuit breaker with selective closing of sending end breaker.
- 7.5.18 Antipumping relay used, if any, shall be considered as part of Breaker mechanism.
- 7.5.19 LT Switchgears shall have rating atleast equal to maximum demand under any circuit configuration and provision for 30 % future requirement
- 7.5.20 Internal physical separation / segregation of LT Switchboards shall be 3 B for Non-ACB feeders and 4 B for ACB feeders.
- 7.5.21 Separate feeders shall be provided in the switchboard for each load / motor. However, max. 2 nos. welding receptacles may be looped from single feeder.
- 7.5.22 All ACBs shall be electrically operated- EDO type only. All ACBs shall be without any internal releases. The required protections shall be wired by means of external numerical relays.
- 7.5.23 Service breaking capacities (Ics) for all breakers and MCCBs shall be equal to or higher than the maximum fault level at the point of installation.
- 7.5.24 For feeders rated above 630A, ACBs shall be provided and that below and including 630A, MCCB shall be provided.

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- 7.5.25 All the switchgear components shall be designed to withstand maximum expected fault level for a minimum time of 1 second.
- 7.5.26 All motor feeders shall be provided with IEC type 2 co-ordinations.
- Motors rated above 55 kW & upto 160 kW shall be controlled through ACB & motor protection relay and shall be fed from PCC.
- All motors feeders rated above 22 kW & upto 55 kW shall be controlled through switch fuse unit, contactor, overload relay with CBCT, ELR for earth fault protection & shall be fed from MCC.
- All motors feeders rated upto & including 22 kW shall be controlled through switch fuse unit, contactor & overload relay. All loads upto 22 KW rating shall be provided with ELCBs.
- All motor feeders rated above 5.5 kW shall be provided with CT for remote metering.
- 7.5.27 The maximum rating of incomers / bus couplers of motor control centres / auxiliary switchboards / power distribution boards / lighting distribution boards shall be preferably limited to 800A. The incoming / tie feeders shall be with heavy-duty type load break switches / ACB suitable for key interlocks.
- 7.5.28 Motor Control Centres with breaker incomer and breaker buscoupler shall be provided with synchro check relay for momentary paralleling during auto transfer. Switching off shall be manually.
- 7.5.29 Electrical running loads shall be uniformly distributed on each bus and it shall be ensured that running and standby loads are fed from two different bus sections.
- 7.5.30 All the MCCB feeders shall be provided with ammeter. All emergency / critical drives, irrespective of their ratings shall be provided with ammeters.
- 7.6 MAN MACHINE INTERFACE (MMI)**
- 7.6.1 MMI shall include CPU, Keyboard, Monitor, Mouse, Printer etc. Four number Man Machine Interfaces shall be provided in the substation, two number laptop for engineering workstation and two number PC for operator's workstation. System Configuration shall be latest proven model and upgradable. Power supply for Substation MMI shall be obtained from emergency / critical source available in the substation / nearby substation / control room.
- 7.6.2 MMI shall allow minimum of the following functions
- Feeder status monitoring
 - Data Logging
 - Relay parameterisation
 - Event recording
 - Annunciation
 - View of historical data and trends
 - Preparation of maintenance schedule.
- 7.6.3 Data concentrator for system relays shall be such as to get faster and effective communication for control, monitoring and supervising the electrical system. Suitable switching hardware shall be provided for selection of required data concentrator with click of a mouse from MMI.
- 7.6.4 User-friendly windows based software shall be provided for interactive display of substation data in multi-window feature. Software shall have the capability to display substation single line diagrams, display for electrical system parameters, reports, alarm annunciation, daily and monthly data logging, continuously polling, relay programming, relay monitoring, data logging, relay supervision, tripping features, fault disturbance record of each relay, graphic representation and trending of data etc. The display shall have electrical system overview and detailed information about its sub system. All softwares shall be written for operating on a common operating system platform plant wide and shall be able to communicate with existing ECS.A

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change of operating platform for MMI, CPU during detail engineering shall not have any commercial implications. Audio / Visual Alarm annunciation shall be provided along with hooter.

- 7.6.5 MMI system shall have two distinctive passwords one for viewing of data metering etc. and second for authorisation for change in relay setting etc.
- 7.6.6 All numerical relays shall communicate to its data concentrator serially on dual redundant RS 485, mod bus / proprietary protocol. All relays shall be as per IEC 61850. Data concentrator shall have dual redundant architecture including internal bus and processor for the reliability of data communication. Scan time of Relay LAN shall be less than one second. Data not available on relay LAN shall be acquired through hardwired connections to MMI / ELMS-RTU.
- 7.6.7 Data concentrator shall be interfaced with RTU of integrator's system on dual redundant RS485, mod bus protocol. In case relays are communicating serially to data concentrator on proprietary protocol, suitable protocol converter shall be supplied as a part of supply of data concentrator. Signals, data as required for MMI / ELMS system serially and through hard wiring as designed elsewhere shall be wired upto RTU panel.
- 7.6.8 The system shall be complied with standard IEC 60073 -Basic and safety principles for man-machine interface, marking and identification
- 7.6.9 Each relay / MMI system shall be time synchronised.

7.7 MOTORS

- 7.7.1 In general, three phase squirrel cage induction motors designed for direct on line starting shall be used. Motors shall be totally enclosed fan cooled suitable for outdoor application.
- 7.7.2 The type of enclosure for motors (i.e. indoor /outdoor, industrial / increased safety/ flameproof) shall be adequate for the application and area in which it is to be used.
- 7.7.3 The rating of LV and HV motors shall be selected from the sizes as recommended in relevant Indian Standard/IEC.
- 7.7.4 The margin between the installed power and absorbed power shall be as recommended by the driven machine supplier but shall not be less than the following:-

Motor Rating	Margin above Driven M/C Absorbed Power
Less than 22 KW	25%
22 KW to 55 KW	15%
75 KW and above	10%



7.7.5 Voltage Ratings:

Voltage rating for the motors of different ratings shall be as below:



Upto 160 KW:	415 V, 3-phase, 50 Hz AC
Above 160 KW:	6.6 KV, 3-phase, 50 Hz AC

All motors shall be designed for 3-Phase supply only.



- 7.7.6 The mechanical parameters such as duty, mounting type, shaft extension, direction of rotation, starting torque requirements etc. shall be adequate for the application. Sleeve or anti friction type bearings shall be used. Vertical motors shall have thrust bearings suitable for the load imposed by the driven machinery. Motors with sleeve bearings may require proximity probes to measure shaft vibration adjacent and relative to the bearings. Generally, all motors, except for application such as crane, hoist, turbine / engine starting, shall be designed for continuous duty with rated load.
- 7.7.7 All HT motors shall be provided with 6 nos. duplicate RTDs temperature detectors for winding :

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- i. temperature detection and 2 nos. for bearing temperature detection. Dual dial type temperature
 - ii. indicator without contacts for bearing also shall be provided for all HT motors. All LT motor including & above 75 KW shall be provided with PTC thermistors.
- 7.7.8 The terminal box of HT motor shall be designed to withstand the specified short circuit current for 0.25 second without damage. A separate neutral terminal box shall be provided for making star connection and it shall be adequately sized to accommodate the current transformers for differential protection.
- 7.7.9 For critical synchronous motors, excitation panels shall have reliable power supply either from dedicated three phases or single phase UPS or any other reliable source as feasible.
- 7.7.10 All the motors shall have class ' F ' insulation with temperature rise limited to class ' B ' .
- 7.7.11 Motors shall be capable for 20 % over speed without danger of mechanical failure.
Limiting Conditions for Motor start up (e.g. starting current limitation or method of starting): -
- 7.7.12 Starting current of motors rated upto 75 kW shall be limited to 700% (inclusive of +ve tolerance) of normal current.
- 7.7.13 Starting current of motor rated more than 75 KW and upto 150 kW shall be limited to 600% (inclusive of +ve tolerance) of normal current.
- 7.7.14 Any assisted type of starting method (e.g. soft starter, Auto transformer etc.) for HT / LT motors may be considered for regulation / voltage drop within limits, ensuring proper acceleration of the driven equipment .
- 7.7.15 Re-acceleration for identified critical motors shall be provided to cover brief interruption up to 5 seconds in normal power supply. Insulation for these motors shall be designed for 140 % of rated insulation level to take care of any over voltages that might result during changeover.
- 7.7.16 Outdoor motors shall be provided with canopy.
- 7.7.17 Motors of rating above 30 kW shall be provided with space heater. Ammeter shall be provided on the panel for the space heater circuit.
- 7.7.18 Motors shall be rated for starting at 80 % voltage at motor terminals.
- 7.7.19 Winding temperature and bearing temperature alarm and trip shall be provided for all HT motors. Minimum 10% additional RTD points shall be provided.
- 7.8 HT CAPACITOR BANK**
- 7.8.1 HT Capacitor bank shall be connected on bus to improve the power factor of the system.
- 7.8.2 HT Capacitor shall comprise appropriate nos. of basic single phase units (minimum 4 nos. basic units in parallel per phase) which shall be connected in star formation.
- 7.8.3 Capacitor banks shall be with necessary discharge resistors to reduce the terminal voltage of each unit to a value equal to or less than 50 V in 5 minutes.
- 7.8.4 Necessary rack assembly for housing Capacitor units with necessary post insulators, Discharge resistors, series reactors, etc. shall be provided for outdoor assembly. For indoor assembly, necessary panel to accommodate the basic capacitor units, interconnecting busbars, insulators, discharge resistors, series reactors, switching units, metering, protection units etc. The panel shall have minimum IP 55 protection and shall be constructed with sheet steel of minimum thickness 2.0 min.
- 7.8.5 Necessary series reactor shall be provided to limit in rush current and suppress harmonics.

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- 7.8.6 Capacitor dielectric medium shall be MPP or mixed dielectric. Impregnant in the capacitors shall be non – toxic.
- 7.8.7 Necessary protections include IDMTL over current with high set element for protection against short circuit, Instantaneous earth fault, under voltage, over voltage, built in fuse for each element, neutral unbalance voltage and current.
- 7.8.8 The capacitor bank feeders shall generally be tripped on bus under voltage / over voltage conditions. Necessary interlock / timer shall be provided for blocking re switching operation to take care of capacitor residual voltage.
- 7.8.9 The continuous current rating of fuses and switching devices for capacitors shall be 30 % higher than the normal full load current.
- 7.9 **BUS-DUCT**
- 7.9.1 LT bus ducts shall be phase segregated.
- 7.9.2 Bus bars shall be of electrolytic grade aluminium / copper.
- 7.9.3 It shall be suitably supported at regular intervals and both busbars and supports shall be adequately sized and clamped to withstand rated short circuit current without permanent deformation.
- 7.9.4 The bus insulators shall be nonhygroscopic, non-inflammable material. Earth bus shall run along the full length of bus duct without any break.
- 7.9.5 Outdoor bus duct shall be weatherproof to IP-55 and shall be provided with canopy, silica gel breather.
- 7.9.6 Busduct shall be supplied with busbar flexible links for connection at both the ends and expansion joints for every 3m of busduct and busduct support materials.
- 7.9.7 Openings with cover at suitable locations shall be provided on busduct for accessing the bus bars for maintenance.
- 7.10 **BATTERIES**
- 7.10.1 While sizing the batteries, temperature correction, ageing factor and maintenance factor shall be considered.
- 7.10.2 Batteries shall be complete with batteries and battery racks.
- 7.10.3 Float type of level indicators shall be provided for each cell in the battery bank.
- 7.10.4 Batteries shall be adequate to meet the requirements as per duty cycle, type of load and min. 20 % spare capacity for future requirement.
- 7.10.5 Batteries back-up time shall be 60minutes.
- 7.10.6 Isolator shall be provided for battery bank isolation near battery.
- 7.10.7 All Ni-Cd batteries are of suitable construction to suit the application.
- 7.11 **BATTERY CHARGER**
- 7.11.1 The Rectifier-Cum-Battery Charger shall be fully automatic using silicon controlled rectifier and shall consist of units as described below:-
- i) Main Float cum Load charger: To supply continuous load and keep the battery in healthy state.
 - ii) Standby Float cum Load charger: To supply continuous load & keep the battery in healthy state in case any abnormality in Main charger.



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iii) Boost charger: To charge the battery set initially and recharge (after meeting emergency or sudden application of heavy loads.)

- 7.11.2 Battery Charger shall have at least 30% extra capacity for future load requirement. Battery Charger shall have 110 V DC system.
- 7.11.3 Separate Rectifier-Cum-Battery Charger with DC Distribution Board and Battery Bank shall be provided for each Substation.
- 7.11.4 Each substation shall be provided with redundant battery charger with 2x100% battery banks and connected to each Charger.
- 7.11.5 DCDBs of all substations shall be interconnected with each other in such a way that in the event of failure of battery bank of any substation, the DC power requirement of that substation shall be met by the remaining healthy battery banks of other substations.
- 7.11.6 The battery and charger combinations shall be such as to ensure continuity of D.C. supply at load terminals without even momentary interruption.
- 7.11.7 AC Ammeter and AC Voltmeter on Charger Input; DC Ammeter, DC Voltmeter for charger output/ battery voltage and on demand type Battery Charge / Discharge Ammeter shall be provided.

7.12 UNINTERRUPTED POWER SUPPLY (UPS).

- 7.12.1 The UPS shall have duty and ratings of feeders adequate for the application and shall be suitable for indoor use. UPS system shall be sized to take care of the crest factor of the load current.
- 7.12.2 The UPS System shall have IGBT type with touch screen LCD display and shall be backed up by nickel cadmium (Ni-Cd) battery rated for 2 hour at rated capacity of the UPS. Battery (100% Capacity) shall be separate for each Inverter.
- 7.12.3 The UPS shall have REDUNDANT SCHEME WITH INDIVIDUAL BYPASS and 100% Battery Bank for each UPS. Under normal operating conditions, one Inverter Unit alongwith Bypass shall cater 100% load, while other Inverter Unit alongwith Bypass shall be in HOT Standby Mode.
- 7.12.4 On failure of one of the inverters, the faulty inverter shall get automatically disconnected from the load and healthy inverter shall supply 100% load. In the event of second inverter also developing a fault, a no-break load transfer to bypass supply (by second inverter) shall take place through static switch. In the event of bypass supply of second inverter also developing a fault, a no-break load transfer to bypass supply (by first inverter) shall take place through static switch.
- 7.12.5 All four sections, i.e. Rectifier-I, Rectifier-II, Bypass – I and Bypass - II shall be fed through four separate feeders of emergency bus of PMCC.
- 7.12.6 Fused disconnect switch shall be provided for each outgoing feeder of the UPS and the fuse shall be of fast clearing type. The fuse rating shall be selected to achieve co-ordination to protect the UPS during short circuit. The rating of the largest branch circuit shall not exceed 25% of the system rating.
- 7.12.7 The UPS rating shall be adequately sized considering 25% spare capacity for future load.
- 7.12.8 25% spare outgoing feeders for future use shall be provided in each ACDB for each rating and type of feeder.
- 7.12.9 AC distribution boards (Dual ACDB), fed from parallel redundant UPS shall be used for instrumentation power distribution system for the improved reliability of instrumentation system. Redundant outgoing feeders shall be provided in ACDB.
- 7.12.10 The distribution shall be designed such that the failure of a single sub circuit does not cause an unacceptable loss of control or loss of data display to the plant operator.



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7.13 LIGHTING, POWER & DC DISTRIBUTION BOARDS

- 7.13.1 No. of LPs, PPs & DCDB shall be provided for complete lighting & power distribution adequate for the plant.
- 7.13.2 Lighting distribution boards fed through 415/ 415 V lighting transformers with off circuit taps +10 % in steps of 2.5 % shall be planned for feeding the lighting system of the package units.
- 7.13.3 Each lighting transformers shall be sized to feed the entire plant normal lighting load with 30 % as a minimum spare capacity.
- 7.13.4 Lighting distribution board shall have two incomers and one buscoupler. One Incomer shall be fed from PCC and other bus section of PCC.
- 7.13.5 Normally both the incomers shall be 'ON' with bus coupler in open condition. In case of any problem to any of the incomer, tripping of the affected incomer followed by closing of bus coupler shall be done manually. Under voltage relay contacts of both the bus sections wired in parallel shall be used to switch on the DC lighting circuits. Where second incomer is from emergency PCC, Normal running condition normal incomer and bus coupler shall be in closed condition. During the fault on normal incomer, Bus coupler shall open and emergency incomer shall be switched 'ON'.
- 7.13.6 No. of LPs shall be considered based on location / area served and total loading.
- 7.13.7 Plant lighting circuits shall be fed from dedicated lighting distribution boards installed in a safe area. For LPs, incomer shall be provided with switch fuse unit / MCB and outgoing shall be with MCBs for control and protection of lighting circuits. ELCB shall be provided in each LDB outgoing circuits to lighting panels.
- 7.13.8 Plant lighting circuits shall be single phase (P & N) rated 240 V AC. Each circuit shall be rated to 16A but not loaded more than 8 A. A minimum of 25% of MCBs of each board shall be left as spares. Normally about 8-10 fittings shall be wired in each circuit.
- 7.13.9 Plant lighting distribution board shall include 25% spare outgoing circuits
- 7.13.10 Adjacent lighting fittings shall not be fed from the same circuit.
- 7.13.11 Plant lighting circuits (excluding level gauge lighting) for open to sky areas shall be designed for auto/manual switching through timer. In addition, it shall be possible to switch ON/ OFF entire lighting from ECS and local switchboard.
- 7.13.12 Lighting control scheme shall also be designed to trip the entire lighting system in case of air raid warning. Tripping signal for the lighting system shall be wired from the nearest existing substation.
- 7.13.13 Auxiliary relays as required for remote switching ON / OFF of lighting system shall be included in lighting distribution board.
- 7.13.14 Main Lighting distribution board shall feed Lighting Sub Distribution board having 63A TPN RCBO as incomer and 16Amp as SPN MCB as outgoing. The incomer ELCB shall have rating of 300 mA. Six, Nine or Twelve way Lighting Sub Distribution board shall be used having 30 % as spare outgoing MCB feeder.

7.14 LOCAL CONTROL STATIONS (LCS)

- 7.14.1. The local control stations shall be of aluminium alloy (LM6) construction.
- 7.14.2. The type and number of switchgear components such as push buttons, selector switches, ammeters, lamps etc. shall be based on the functional requirements of the control scheme and

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the type of equipment.



- 7.14.3. Control stations shall be provided for each motor in the field.
- 7.14.4. Enclosure of the control station shall be suitable for site conditions such as weather proof, dust proof, flame proof, corrosion resistant etc. All outdoor control stations shall be with canopy.
- 7.14.5. Stop push button shall be of stay put type, however it can be of momentary type in case of drives such as lube oil pump etc which are critical.
- 7.14.6. Two numbers of stop push buttons shall be provided for the motors, which are installed at elevated platforms, such as cooling tower fan etc. One of the push buttons shall be installed at ground level and the other near the motor.
- 7.14.7. Local control station shall be provided with ammeter for motors rated above 5.5 kW. LCS for all emergency / critical drives shall be provided with ammeters.
- 7.14.8. Weatherproof, break glass type emergency push button station shall be provided near transformers to trip the transformer feeder in case of emergency. Emergency trip push button shall also be provided for motors above 1000 kW rating if required.

7.15 Industrial Goods Lifts

- 7.15.1 Lifts shall have automatic centre opening doors, SS cabin with aluminium chequered plate flooring cabin and steel belts (rope), closed loop VFD, A low – inertia gear less machine with a permanent magnet (PM) synchronous motor, battery-operated rescue system with electronic speed monitoring, machine on the rails to transfer loads down to the pit.
- 7.15.2 Automatic Rescue Device shall be capable of moving the lift to the nearest landing on main power failure.
- 7.15.3 Lift Machine room shall be located at ground floor.
- 7.15.4 Following Control & Indication shall be provided on all landings and ground floor:
 - Digital Car position indicator for each lift on top as well as on side wall
 - Audio alarm & direction indicator for each lift
 - Common up/down call buttons
 - Fireman switch
 - Braille marking on all buttons
- 7.15.5 Following Control & Indication shall be provided in car:
 - Braille marking on all buttons inside the car
 - Voice announcement system with all necessary equipments.
 - Appropriate positioning of Car Operating Panel
 - Floor selector button
 - Emergency stop and alarm button
 - Combined digital position and direction indicator.
 - Wiring for telephone and telephone instruments (intercom) in lift car, machine room and ground floor, lift lobby
 - Lighting, emergency alarm and fan to be provided with emergency supply through inverter having at least half an hour battery backup.
 - Car Operating Panel (COP) should be on the front panel as approved by the owner.

7.16 Variable Speed Drives (VSD/VFD)



- 7.16.1 Microprocessor based variable speed drive shall be communicable type and shall be able to communicate with LMS/DCS. It shall be possible to set speed from process DCS for optimum performance through 4-20 mA signal. Speed/current/status feedback to DCS shall be provided. Drive will run at preset speed in the event of loss of signal from DCS.
- 7.16.2 System shall be highly reliable, efficient and shall provide high power factor, low harmonic distortion, low noise level etc.
- 7.16.3 System shall be provided with complete by pass circuit to ensure the power supply reliability in case of VSD/VFD failure.

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- 7.16.4 The system shall be suitable for load characteristics, continuous speed control. Drive shall be able to accelerate the load over the full speed range (0 – 100 %) with incoming line voltage regulation of 10%.
- 7.16.5 The system shall be designed for 150% over current withstand for 1 minute. The system shall be equipped with an automatic restart facility which will restart the system in case of voltage dip over 20% or power interruptions less than 4 seconds and recovery of voltage to 95% with a facility to block the automatic restart.
- 7.16.6 The system shall be suitably designed with due care for long length of cables, output filters, chokes, motor insulation, cable voltage grades etc.

7.17 CABLES (HT / LT)

- 7.17.1 Cables shall be sized considering the following factors.
- Maximum continuous load current
 - Voltage drop
 - System voltage
 - Laying conditions
 - (Derating due to ambient air temperature, ground temperature, grouping and proximity of cables with each other, thermal resistivity of soil etc. shall be taken into account).
 - Short circuit withstand criteria for HT cables
- 7.17.2 All power, control, data, signal cables shall be FRLS PVC outer sheath.
- 7.17.3 All LV power cables shall be with stranded aluminium/copper conductor with XLPE insulation, PVC inner sheathed FRLS type, armoured, PVC outer sheathed FRLS type and construction as per IS: 7098 (Part 1). Power cables with conductor size upto and including 16 sq. mm shall be with copper conductor, conductor size 35 sq. mm and above shall be aluminium conductor.
- Single core LV Power cable shall be of aluminium conductor. The construction of same shall be as per above
- 7.17.4 All control cables shall be with 2.5 sq. mm, stranded copper conductor with XLPE insulation, PVC inner sheathed FRLS type, armoured, PVC outer sheathed FRLS type and construction as per IS: 7098 (Part 1). Control cables shall be twisted pair or shielded wherever electro-magnetic/electrostatic interference is anticipated.
- 7.17.5 All control cables shall have 20 % spare cores. All cores shall be identified with numerical core numbers printed on core instead of colours.
- 7.17.6 All HT power cables shall be made of stranded aluminium or copper conductor with dry cured XLPE insulation, PVC sheathed armoured, conductor screen, insulation screen and construction as per IS 7098.
- 7.17.7 All cables shall be armoured and shall have extruded inner and outer sheath
- 7.17.8 Cables connected in parallel shall be of the same type, cross section and terminations.
- 7.17.9 All power and control cables shall be in continuous lengths (except for very long feeders) without any joints. The cables used for lighting and wires in conduits shall have appropriate junction boxes with adequately sized terminals. Cable joints in hazardous areas shall not be permitted.
- 7.17.10 In case of difficulty in connecting the cables to instrument or relay terminals, minimum cross section may be reduced to 1.5 sq.mm Cu. For lighting inside the building, minimum 1.5 sq.mm Cu conductor, PVC insulated wire shall be used in conduit system (for circuit and point wiring), with proper colour coding.
- 7.17.11 All LT power cables shall be 3 core / 3 1/2 core / 4 core with stranded aluminium / copper conductor with PVC insulation and construction as per IS 1554. For all LPs / PPs incoming power supply cable shall be 4 core of required cross section.

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7.17.12 HT cables shall be unearthed grade.

7.17.13 Size of Aluminium conductor cable shall be limited to 3.5C x 300 sq. mm in LT, 3C x 400 sq. mm in HT and 1c x 1000 sq. mm in LT/HT.

7.18 CABLE TRAYS

7.18.1 Cable trays shall be run in either cable trenches / on overhead cable rack or along the pipe rack to suit the site conditions.

7.18.2 Separate cable trays shall be selected for:-

- HT cables
- LT power cable
- LT control cable
- Instrumentation cables/communication cable
- Cable trays shall be sized considering single layer of cables.

7.18.3 The trays shall not show deflection / bend / deformation after laying of cables.

7.18.4 All cable trays and accessories shall be prefabricated, G.I. ladder type. For tray system design, in addition to self-load and wind forces, following guidelines for design shall be considered.

- Support span : 2000 mm
- Cable load for
- 150 mm wide cable tray : 30 kg/m
- 300 mm wide cable tray : 60 kg/m
- 600 mm wide cable tray : 90 kg/m
- 750 mm wide cable tray : 120 kg/m



7.18.5 In addition to this, 70 kg concentrated load at centre span shall be considered. All structural steel design shall be as per Indian Standards and shall be suitable / designed to withstand fire for a minimum period of 30 minutes.

7.18.6 Bends, tees, reducers, crosses, droppers etc. shall have the required bending radii as recommended by the manufacturer with 10% allowance for various cable sizes with a minimum of 300 mm.

7.19 LIGHTING EQUIPMENT

7.19.1 LED type lighting shall be provided. The average illumination levels in the various sections of the plants shall be as indicated in Annexure-I. All the plants and area lighting shall be energy efficient.

7.19.2 LED type lighting shall be provided for all areas. LED shall conform to the following types and standards:-

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Product Type	Safety Standard	Performance Standard
Self ballasted LED lamps for general lighting services > 50 V	IEC 62560 Latest Edition	IEC 62612 / PAS Publicly available specification
Control gear for LED modules	IEC 61347-2-13 Latest Edition	IEC 62384 Latest Edition
LED modules for general lighting	IEC 62031 Latest Edition	IEC / PAS 62717 Latest Edition
LED luminaries	IEC 60598-1 Latest Edition	IEC / PAS 62722-2-1 Latest Edition Luminaries performance – Part 2-1: particular requirements for LED
LEDs and LED modules	IEC TS 62504 Terms and Definitions for LEDs and LED modules in general lighting.	

Maintenance factor for indoor lighting shall be considered as 0.7 and for Outdoor lighting 0.6.

The colour rendering index shall not be less than 90%.

The LED lights shall work satisfactorily at the design temperature of 50 Degree Celsius.

All the LED fittings shall be selected in accordance with Hazardous Area Classification.

The life assessment of LEDs shall include control gears/ driver as well.



- 7.19.3 The specified illumination level shall be maintained after considering maintenance factor 0.5 for Coal Dust Area , 0.6 for plant & outdoor areas (other than Coal Dust Area) & 0.7 for indoor areas and utilisation factor as per manufacturer catalogues for size of room & type of fixture.
- 7.19.4 Voltage drop at the fixture from the MLDB bus shall not exceed 3%.
- 7.19.5 Aviation lights shall be provided on tall structures and all isolated structures. . Aviation Lighting shall be in accordance with International Civil Aviation Organization (ICAO) Publication Annexure 14 and to Indian Standards, together with the approval of local aviation authority.

LED type Low Intensity Aviation Obstruction Light suitable for 240V, 50 Hz supply. It shall be covered under Indian patent act (Govt of India) No. 188995. Degree of protection shall be IP-65.

The illumination intensity of aviation lights and mounting height shall be considered based on vicinity of civilian air terminal within 1 KM radius. Aviation lights at each location shall be fed from two separate and distinct DBs (one fed from normal bus and another fed from emergency bus of MLDB). In case aviation lights are not switched ON for any reason, whatsoever, a signal shall be sent to control room which will sound buzzer and also result in flashing of red light. On acknowledgement, buzzer shall stop but flasher will continue unless aviation lights are turned ON.

The fixtures shall have body of corrosion resistant aluminium alloy casting and shall be suitable for outdoor use and mounting on 40 mm NB G.I. pipe. Necessary electrical threading shall be tapped in the fixture for mounting.

- 7.19.6 Plant lighting circuits shall be single phase (Phase & Neutral) rated 240 V AC. Each circuit shall be rated to 16A but not loaded more than 8A. A minimum of 25% of MCBs of each board shall be left as spares. The load on one lighting sub-circuit of lighting sub-distribution board and junction box shall be limited to 1000W approx.
- 7.19.7 LED Tube Lighting Fixtures (inside Substations)

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- a) High quality LED fluorescent tube twin batten type complete with 2 X 20W tube eco friendly, no UV radiation as per the specification tabulated below:

Sl. No.	Parameter	Technical Specification
1.	Degree of Protection	IP-20
2.	Lumen output per Lamp	≥ 2000
3.	CCT	6500K
4.	Luminous efficacy	≥ 100 lm/watt
5.	CRI	>80
6.	Life	≥ 40000 burning hours
7.	PF	>0.95
8.	THD	<10%

7.19.8 Street Lighting And Security Lighting

7.19.9 63A TPN outlet from outdoor lighting bus of main lighting board shall be taken direct to the TPN junction box to be mounted on pole through cable and looped from pole to pole.

7.19.10 Hot dip GI octagonal poles of suitable mounting height shall be used for street light. However, for plant lighting (platforms/ structures/ access ways/ walk ways/ pump house/ pump bay etc.), steel tubular poles of suitable mounting height shall be used

7.19.11 Hot dip galvanized octagonal high mast lighting shall be used for yard and general area lighting. LED type fittings may be used.

7.19.12 LED Street Lighting Fixtures

- a) LED Street Light Fitting with cool white light in Pressure Die Cast Aluminium Housing with UV Stabilized Poly Carbonate Cover with in-built power unit of 3500 lumen suitable for 240V, 50 Hz, System shall be used.
- b) Lighting fixture shall have 50000 hrs. Life Time, CRI>75, IP-65.

7.20 JUNCTION BOXES

7.20.1 The Junction boxes/Telephone Tag boxes shall be MS with epoxy paint for safe areas or die cast aluminium alloy construction with IP 55 degree of protection suitable for installation in classified areas, hazardous areas. It shall be suitable for terminating or looping armoured signal/power cables. JB's shall be provided with earthing stud. It shall be suitable for wall/column/structure/ceiling mounting.

7.20.2 Junction boxes installed in classified hazardous area shall be explosion proof or increased safety type depending on area classification.



7.21 CONVENIENCE / WELDING RECEPTACLES

7.21.1 Enclosure of the convenient receptacle shall be suitable for site conditions such as weather proof, dust proof, flame proof, corrosion resistant etc. Necessary interlocks and earthing facilities shall be provided as per safety requirements. These receptacles shall be provided at selected locations in the plant.



7.21.2 Welding receptacles shall be provided at suitable locations to make sure the receptacle is accessible from any point of the process area with a trailing cable of 30 meters length. The welding receptacle shall be rated for 63A, 415V, 3 phase and shall have a scraping earth.

7.21.3 63A, 415V, 3 phase receptacle (with scraping earth) shall be provided at suitable location near major equipment like compressors, blowers etc to provide power for portable equipment.

7.21.4 15A, 240V, single phase, three pin sockets shall be provided at suitable locations to make sure that the receptacle is accessible from any manholes of the equipment, near static/rotary equipment with a trailing cable of 15 meters length. However for hazardous areas 240/24V transformer shall be provided with socket to supply 24V to the portable equipment.

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- 7.21.5 Bulk Power Point near Heat exchange area for Hydro blast purpose for use during plant running condition / shutdown.
- 7.21.6 Outdoor receptacles shall be provided with canopies.
- 7.22 **PUBLIC ADDRESS (PA) SYSTEM / PAGING SYSTEM**
- 7.22.1 Public Address system suitable to provide reliable and quick source of communication among operating personnel shall be provided. The system shall be microprocessor based with modular construction for ease of expansion capabilities and capacity. The system shall have speakers, calling points etc. suitable to area of classification for that location.
- Substation shall be connected with the PA System.
- PA system shall be located in respective control room.
- 1 Nos. Master Call Station shall be considered and to be install at each control room.
- 7.22.2 Stand alone systems shall be provided for different process units, substations etc. which shall be suitable for interfacing with Fire alarm system, EPABX system, Radio Paging system etc.
- 7.22.3 Paging speakers provided in areas having ambient noise levels shall produce a paging sound level at least 10 db above the anticipated ambient noise level. Where it is not possible to achieve the sound level of above 10 dB above the ambient, rotating beacons shall be installed such a way that that the operator is alerted in the area. The typical area where the provision of rotating beacons are envisaged as compressor house, generator house etc. Acoustic hoods shall be provided for call stations located in high noise areas.
- 7.22.4 Separate UPS with batteries shall be provided for each exchange.
- 7.22.5 The design of the system shall be such as to provide two channel communication i.e. Page & Party in each zone. Page & Party system shall comprise of one channel for paging & one channel for party talk.
- 7.22.6 Close talk mode shall be provided for conversation between two or more stations through close talk channel. Speeches from any hand set shall be heard over all the speakers. The system shall have the following facility:-
- i) Alert tone facility
 - ii) Paging facility
 - iii) Private conversation facility
 - iv) Loud speaker mute facility
 - iv) Emergency tone facility.
- 7.22.7 In the Party mode, conversation shall not be heard over the loud speaker but it shall be carried out on the handsets. This mode shall be used for actual conversation, exchange of information etc.
- 7.22.8 It shall be possible to make a paging call by lifting the handset, off the hook switch & pressing the “press to page” switch. The paging message shall get transmitted over all the loud speakers when the paging person speaks in the microphone of the handset. While paging, it shall automatically mute the loud speaker near the paging handset to eliminate the acoustic feedback.
- 7.22.9 It shall be possible to communicate between two field stations without the interference of the MCS / operator. Also it shall be possible to have direct communication with the MCS.
- 7.22.10 A facility to monitor the health of the system including field stations / speaker shall be provided in the system.
- 7.22.11 The equipment shall be sturdy, impact resistant, dust & damp proof generally conforming to minimum IP-55 degree of protection. For classified hazardous areas flameproof equipment

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shall be provided duly certified by recognised certifying authority for the area of installation. The equipment for outdoor shall be weatherproof type conforming to IP 55 degree of protection & shall be provided with canopy. All equipment & accessories shall be given tropical protection against fungus, insects & corrosion. Equipment shall be made tamper proof by use of non standard screws, which can be opened only by means of special keys supplied by the manufacturer. Solid state components shall be used throughout & assembled in plug-in type modules.

7.22.12 Paging system shall have battery backup for 8 hours in case of power failure.

7.23 FIRE ALARM SYSTEM

7.23.1 BOO Operator shall provide the Fire Detection and Alarm System which shall be an independent system comprising of individual break glass type manual call points, automatic sensors e.g. smoke and heat detectors, main panel, repeater panel, hooter, battery, battery charger and any other hardware.

7.23.2 The system shall be designed to provide audio-visual indication at the main panel to be located in sub-station and repeater panels shall be provided in fire station.

7.23.3 The manual call points shall be provided at strategic locations with access along all exit routes and roads.

7.23.4 Electrical sirens shall be provided to cover entire Coal to Methanol plant . Hooters and exit lights shall be provided at required locations in the buildings.

7.23.5 Panel design and component selection shall be done for future extension upto 10% of specified zones or one zone, whichever is maximum in each panel. The design of common facility and hardware shall be provided for required future extension of zones.

7.23.6 The fire detection system shall be interfaced with fire suppression system.

7.23.7 Fire Alarm system shall be microprocessor based, intelligent, analogue addressable type.

7.23.8 System shall be stand alone for entire plant area consisting of individual process units, utility areas, substation, control rooms etc. System shall be designed to provide necessary audio visual signals at the main control panel with mimic panel and repeater control panel. The system shall be hooked up with main fire control panel located at fire station control room.

7.23.9 However system shall be suitable for integration with CCTV, PA, EPABX, Gas Detection system, Fire suppression system and HTAC system.

7.23.10 System shall be comprising of individual break glass type manual call points, detectors main panel, repeater panel, hooter, siren, battery, battery charger and other hardware.

7.23.11 Battery and charger shall be provided for each panel separately, rated for complete fire alarm system operation for failure of power supply for at least 48 hours. FRLS armoured cables shall be used for the system.

7.23.12 Detectors & Manual call points shall be connected in separate loop.



7.24 COAL HANDLING AND ASH DISPOSAL HANDLING SYSTEM

7.24.1 The Electrical system shall be suitable for the full capacity of coal conveying and ash disposal system.

7.24.2 Suitable switchgears, motors, cabling etc, for these systems shall be as described in the Electrical design philosophy under these headings.

7.24.3 Conveyor Control Panel (PLC based).

7.24.4 The conveyor control panel (CCP) is required to perform the various control operation to obtain the material flow in the desired patterns. Vendor to develop control schematic diagram, trip/interlock logics and furnish the same for the safe & proper operation of all conveyor motors..

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7.24.5 Emergency Safety Devices

Following emergency safety device shall be provided at the provided at the specified intervals to trip the conveyor under abnormal operating conditions:-

- i. Pull cord switch
- ii. Belt sway switch
- iii. Zero speed switch
- iv. Emergency stop push button
- v. Gravity take up switch
- vi. Chute choking device
- vii. Bunker level indicating device

In addition status of all safety switches on CCP also to be also provided.

8.0 SYSTEM LAYOUTS

8.1 CABLE LAYOUTS / ROUTING.

8.1.1 Cabling system for various areas shall be generally as under.

- For process equipment RCC trenches with removable RCC covers shall be used.
- Lighting, fire alarm, communication cables shall be laid directly buried in road berms. The communication and fire alarm cables shall be laid in road berm opposite to the berm where street lighting cables are laid.

8.1.2 Cable trenches shall be sized depending upon the no. and voltage grade of cables used for different applications. Trenches in hazardous areas shall be filled up with sand. At road crossing, cables shall be laid through culverts / hume pipes / pre-cast RCC duct banks etc. Concrete lined trenches shall have suitable drainage arrangement to avoid water collection or these trenches shall be connected to nearest storm water drain. Concrete lined cable trenches shall be sealed against ingress of liquid and gases.

8.1.3 The top of cable trenches before entering the substation, shall be maximum 1m above the ground level and also all cutouts shall be properly sealed by a sealing compound. Pipes laid for mechanical protection shall be sealed at both the ends.

8.1.4 All entry and exit openings for cables crossing in substation, control room etc. shall be provided with fire barrier and it shall have minimum three hours rating.



8.1.5 Fire proofing / painting for all power cables on 3 meter length of cable at motor end and load end in the field and panel end in the substation shall be provided. Fire barriers shall also be provided below the opening of all HT and HT switchboard in all substations.

8.1.6 The offered painting and fire barriers shall be tested at site and comply to the requirement defined in the BS:476 (part – 20) Method of determination of fire resistance of element of construction and IS:12458 Fire resistance test of fire barriers and UL:1479 Fire test of through penetration fire barriers. Fire protection for cables shall be provided as per IS 12459 : code of practice for fire protection of cables.

8.1.7 For directly buried under ground cables, route markers shall be provided at every 30m interval all along the cable routes, at cable joints and where direction of cable trench changes. Cable joint pits shall be sand filled.

8.1.8 Whenever cables will be required to run above ground, these shall be run in a single layer form in covered G.I. cable trays. Separate cable trays shall be provided for HT power, LT power, control and communication cables. Necessary tees and bends shall be provided to have neat and easily accessible routing.

8.1.9 Above ground cables shall be well supported on cable trays and shall be suitably protected

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against mechanical damage. Routing shall be decided to avoid interference with hot surfaces or places subject to undue fire risk. Cable trays shall be covered whenever they are running below pipes.

- 8.1.10 Cable trays, racks and trenches shall be sized to allow for 30% future cables. Cable installations shall provide minimum cable bending radii as recommended by cable manufacturer. Separate trays shall be provided for HT / LT power, control & plant communication cables. Separate cables shall be provided for AC and DC signal / control circuits.
- 8.1.11 Wherever pipe rack / pipe sleepers are not available for laying of above ground cable trays, cable tray support shall be sized to ensure lowest tray level to be min. 2.7m above grade.
- 8.1.12 Cables running between cable tray and the equipment shall run through rigid GI conduits. Necessary supports shall be provided for the same. Cables shall be protected by conduit up to a length of at least 300 mm above the floor level.
- 8.1.13 Plant cables shall run in either of the two directions formed by main axis, avoiding as much as possible crossings with instrument cable trenches and pipelines and preferably away from restricted areas.
- 8.1.14 Underground cable routes shall be designed to avoid close pipe crossings and adjacent runs with underground pipelines. A distance of at least 30 cm between cable and pipe shall be maintained. Cables shall preferably cross underneath buried pipelines.
- 8.1.15 Parallel / Duplicate feeder cables shall be laid separately as far as possible.

8.2 CATHODIC PROTECTION SYSTEM

- 8.2.1 Entire underground pipe work including those laid in concrete trench and filled with sand, the steel structures (within battery limit), tank bottom etc. shall be provided with cathodic protection in their battery limit. The scope shall include, site surveying to collect required information, design, supply, installation, commissioning, maintenance, monitoring and performance guarantee of impressed current cathodic protection system as per relevant Indian/IEC/BS/NACE Standards and codes of practices. BOO Operator shall have to design and engineering of complete CP system for their battery limit. The design life of CP System shall be 30 years.



Following shall be excluded from Cathodic Protection system.

- Underground Pipes with SS material / GRP Material,
 - Above Ground reinforcements bars of reinforced concrete,
 - Reinforcements bars of reinforced concrete foundations.
 - Reinforcement bars in concrete piles.
- 8.2.2 Shed shall be provided for all Cathodic Protection equipment installed in the field. .
- 8.2.3 Solid State Polarization Cell shall have short time fault current withstand capacity:- 5 kA/ 5000 A @ 30 Cycles and Lightning Surge Current rating : 50000 A Crest for 8 to 20 μ seconds with DC Blocking voltage range of - 3.0 V to + 1.0 V.
- 8.2.4 Surge over voltage diverter shall be provided across each monolithic isolation joint.

8.3 EARTHING AND LIGHTNING PROTECTION

8.3.1 Earthing

- 8.3.1.1 Complete earthing installation shall be done as per IS: 3043, IEEE-80, IE Rules and IEC recommendations. The earthing system shall be designed to:
- (a) Provide a permanent & continuous path from equipment and conductor enclosures to earth from circuits for flow of fault current.
 - (b) Provide sufficient current carrying capacity to conduct safely any current liable to be imposed on it.

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- (c) Provide sufficient low resistance to earth to limit the potential between metalwork and earth within safe limits.
- (d) Provide equal distribution of potential and minimum potential difference for safety of personnel.
- (e) Ensure sufficient current in case of fault to facilitate the operation of relays, over current devices, fuses etc. provided in the circuit.

8.3.1.2 Common underground earthing grid shall be provided covering switchyard, sub-stations and plants which is further connected to overall Earthing Grid. The overall earth resistance (dry) shall be limited to 1 ohm.

8.3.1.3 Earthing rings shall be provided around sub-stations and plants which in turn shall be connected to the common earthing grid. Minimum size of main grid shall be 75mm×12mm.

Anti-corrosive bituminous paint shall be provided at each joint of earth flat after necessary finishing and priming treatment .

8.3.1.4 Earthing grid/ring shall comprise of buried GI earth strips and GI pipes/electrodes.

8.3.1.5 Separate earth electrodes shall be provided for system neutral earthing. For equipment earthing, minimum two numbers of electrodes shall be provided around each plant/section. However, all these earth electrodes shall be interconnected.

8.3.1.6 Inter-connecting pits having an earth bus in an enclosed brick chamber without earth electrode shall be provided in the common underground earthing grid for convenience of taking earth conductors inside the plants.

8.3.1.7 As far as possible, the reinforcement rods inside concrete column shall be connected to the earthing grid/ring to reduce the overall earth resistance.

8.3.1.8 Individual electrical equipment shall be earthed by GI strip/GI wire/Cu/Al cable. Earth buses shall be provided in plants for earthing groups of electrical/non-electrical equipment to earthing grid/rings.

8.3.1.9 Size of earthing grid/ring and earth conductors of equipment for generating station and sub-stations shall be as per relevant standards. The fault current magnitude shall be decided based on system fault level. The time duration shall be taken as 1 second for voltage level above 66 kV and 3 seconds for voltage upto 66 kV as per IS -3043.

8.3.1.10 All equipment rated above 250 V shall have two external earth connections and those rated up to 250 V shall have one external earth connection. However, for lighting fixtures, earthing shall be done through 3rd core of the cable in safe as well as in hazardous area.

8.3.1.11 Flameproof equipment, in addition, shall have one internal earth connection. This means that 4 core cables to be used for all the flameproof equipments and 3.5 core cables to be used for all flameproof motors located at hazardous area.



8.3.1.12 All steel structures, tanks, vessels, pipes, pipe joints, valves etc. shall be earthed against static charge accumulation by 50x6 mm GI strip. The no. of earth connections shall be as follows:

Equipment having diameter	Hazardous area	Non hazardous area
30 M	2	2
More than 30 M	3	2

8.3.1.13 Wherever process equipments are mounted on steel structures, the structures shall be earthed instead of earthing the individual equipment.

8.3.1.14 The pipe structures shall be earthed at not more than 25M apart.

8.3.1.15 For all equipment in hazardous area, in addition to external earthing one internal earthing shall be provided.

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8.3.1.16 Minimum sizes of earth conductors to be used shall be as given below.

Sl.No.	Equipment	GI conductor size	Al conductor Size
1.	HV/LV switch board, transformers, HV motors	50mm×8mm	150 sq. mm
2.	Motors rated 75 KW and above	50mm×6mm	150 sq. mm
3.	Motors rated 30 KW to less than 75 KW and vessel earthing	35mm×6mm	95 sq. mm
4.	Motors rated 5.5 KW to less than 30 KW	25mm×6mm	25 sq. mm
5.	Motors less than 5.5 KW	8 SWG	6 sq. mm
6.	All minor equipment rated 250V & above.	10 SWG	6 sq. mm
7.	Earth Grid	75mm x 12 mm.	-

However, vendor to calculate the actual size:-

All GI conductors shall meet the galvanizing requirement as per IS.

8.3.1.17 The main ground grid shall be buried in earth at a minimum depth of 1000 mm below finished grade level unless stated otherwise

8.3.2 Lightning Protection

8.3.2.1 All structure ,buildings like substation ,control room etc. shall be protected against lightning strokes by suitable lightning protection system to be designed and installed as per IS/IEC-62305.

8.3.2.2 The number of down conductors shall be minimum two. All the lightning protection earth pits shall be inter connected and same shall be connected with power system earth pits .The resistance at the earth pit shall not be more than 5 ohms .

8.3.2.3 Bare metallic structures shall not have any air termination rods at the top. The earth connections shall be welded to the bottom of structure at 300 mm above floor level. However, tall metallic columns with insulation at top shall be provided with air termination rods. Separate earth electrodes shall be provided for each down conductor of lightning protection. However, these shall be inter-connected with the other electrodes in main grid.

8.3.2.4 Air Terminal

The vertical air terminal rods shall be installed at the roof of buildings (including power house main building), at the top of chimney and cooling towers to protect these objects from lightning strokes.



The vertical air terminal except for chimney shall be made of 20 mm dia galvanized steel rod. The projected length of the rod shall be as required to protect the object (on which the rod is fixed) from lightning stroke.

The air terminal rods provided at the top of chimney/stack for lightning protection shall be 20 mm dia lead coated solid copper rod.

The air terminal rod shall be properly fixed on the top of the building/structure to withstand very high wind pressure. In case the air terminal rod is embedded at the top of roof of building: the portion embedded inside the concrete shall not touch the reinforcement bars and shall be duly insulated from them.

All the vertical air terminal rods shall be electrically connected together by means of horizontal conductors of size 50 x 6 mm galvanized steel flats.

The shielding angle for one vertical air termination shall be 45 degrees. For more than one rod, shielding angle between the rods shall be taken as 60 degrees.

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Horizontal air termination (i.e. G.S. Flat conductor) shall be so laid that no part of the rood will be more than nine (9) metres from the nearest roof conductor.

8.3.2.5 Shielding Masts

The shielding mast for lightning protection shall be installed at the top of steel columns cap plates of power house main building.

The shielding mast shall be made of galvanized steel pipe and the height of the same shall be decided considering the zones to be protected.

Each shielding mast shall be connected to grounding grid by a down conductor 50 x 6 mm. Galvanized steel flat run along the building column. In addition all power house building columns joints shall be electrically bonded.



8.3.2.6 Down Conductors

The down conductors shall be 50 x 6 mm galvanized steel flats. The connection between each down conductor and earth electrode shall be made via test link located at approximately 1500 mm above ground level.

8.4 LIGHTING LAYOUTS



8.4.1 The lighting layouts shall be designed to meet the illumination levels recommenced in IS 3046.

8.4.2 Average illuminations levels as specified below shall be achieved while designing the lighting system.

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Sl. No.	AREA	LUX
1.0	<u>ROADS</u>	
1.1	Plant roads	20
1.2	Security roads	20
2.0	<u>YARD</u>	
2.1	Marshalling yard	20
2.2	Loading/unloading areas	50
2.3	Open areas	20
3.0	<u>PLANT</u>	
3.1	Operating platforms	100
3.2	Non-operating platform/ general process areas & walk ways	50
3.3	Compressor house	150
3.4	Turbine Hall	200
3.5	Pump house/Pump bay	250
3.6	Top of cooling towers	60
3.7	Boiler gallery	100
3.8	Area near large rotating equipment/plant	200
3.9	Air Conditioning Plant Room	200
3.10	Elevator machine Room	200
3.11	Power House Coal conveyor floor	100
3.12	Conveyors, junction/transfer towers	100
3.13	ESP hopper area, platforms and ESP top	100
4.0	<u>SUB-STATION</u>	
4.1	Switch room - Front of panel	250
	- Back of panel	150
	- Battery room	150
4.2	Transformer room, cable room.	70
4.3	Outdoor/transformer bay	70
5.0	<u>CONTROL ROOMS</u>	
5.1	Front of panel	500
5.2	Back of panel	200
6.0	OFFICES	300
7.0	<u>STORES, BATH ROOM</u>	100
8.0	<u>STAIR CASES</u>	
8.1	Safe areas	100
8.2	Hazardous areas	100
9.0	<u>PANIC LIGHTING</u>	-

- 8.4.3 Lighting design shall conform to relevant International Codes & Standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance. A maintenance factor of 0.8 shall be assumed for lighting illumination level calculation for normal areas. However, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.
- 8.4.4 Generally plant lighting shall be classified as under: Normal lighting Emergency lighting Critical lighting
- 8.4.5 Normal & emergency lighting system shall be on 415 / 240 V system, where critical lighting shall be on 110 V DC.

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8.4.6 Sufficient lighting shall be provided so as to enable plant operators to move safely within the accessible areas of plant and to perform routine operations.

8.4.7 Lighting requirements provided during the failure of power supply for normal lighting shall be broadly,

- To facilitate carrying out of specified operations, for safe shutdown of the plant.
- To gain access and permit ready identification of fire fighting facilities.
- Escape route for safe evacuation of operating personnel.

Recommended areas for critical lighting :

- Fire station
- Fire water pump house
- First aid centre
- Emergency escape route.
- Operator cabin, plant area, pump house
- Any other specific areas requiring critical lighting .

Recommended areas for AC emergency lighting :

- Fire stations
- Staircases
- Platforms with ladder changing directions
- Strategic locations in process, utility areas where specific safety operations are to be carried out, such as Areas near heat exchangers, condensers, Barring gears of turbine.
- Areas around drives fed by emergency supply.
- Some portions of roads interconnecting substation and process plant.
- Any other specific areas requiring emergency lighting.

8.4.8 Generally 25 % of normal lighting load shall be considered for AC emergency load.

8.4.9 Wiring for lighting and convenience outlets in outdoor areas shall be carried out with copper conductor, PVC insulated, armoured cables run along the column/platforms and structures on GI perforated trays of required width. The armoured cable shall enter lighting fixture / JB through double compression gland for safe area and through flameproof glands for Ex(d) and Ex(e) equipment. Where required, suitable mechanical protection shall be provided for lighting fixtures (e.g. wire guard).

8.4.10 The lighting installations shall be designed to obviate stroboscopic effect.

8.4.11 Lamp fittings in structures shall be so located that maintenance and lamp changing can be effected without use of ladder or scaffolding.

8.4.12 The lighting fittings shall be situated in such a way that reflection on instruments / VDU etc. in control rooms and sub-stations is avoided.

8.4.13 All lighting fittings shall be wired using armoured PVC cable of suitable no. of cores and

8.4.14 size. Necessary type and no. of junction boxes shall be provided for branch connections.



8.4.15 DC critical lighting shall employ incandescent lamps.

8.4.16 Adequate no. of ceiling fan points shall be provided in offices, rooms allocated for operating and maintenance personnel etc.

8.4.17 Pole isolation devices shall be used for controlling fixtures in hazardous areas to isolate phase as well neutral.

9.0 INSTALLATION

Installation of all electrical equipment shall be carried out with high standard of workmanship,

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neat routing/layouts, and clearances/access as per recommendations by the manufacturer.

After installation the system equipment shall be tested for pre-commissioning test as recommended by the manufacturers & established practises. Further, commissioning tests shall be conducted to prove agreed performance within specified tolerance, temperature rise, noise and vibration.

10.0 FIELD TESTING AND COMMISSIONING

Field tests as per the procedures approved by CIL shall be performed on the electrical equipment before being put into service. Acceptance of the complete electrical installation shall be contingent upon inspection and test results. Field tests shall include but not be limited to the following:

- 10.1 A visual inspection at both ends of a cable/conduit run, and all intermediate joints to ensure that terminal chambers and other enclosures are clean, joints tight and sound, wiring correctly dressed and labelled and no obvious faults are present.
- 10.2 After visual inspection, all the covers shall be replaced and cover screw (and gaskets, if any) checked to be present and tight.
- 10.3 **ELECTRICAL TESTS SHALL INCLUDE :**
 - 10.3.1 An insulation test for each winding and circuit with a separate test for each core of power circuit
 - 10.3.2 Continuity test for all power circuits and windings.
 - 10.3.3 Earth continuity test for all circuits.
 - 10.3.4 An earth resistance measurement for each group of electrodes, and the earthing system as a whole.
 - 10.3.5 Lighting installation shall be tested for correct illumination levels with the fittings installed. Fittings shall be operated only with their designed size of a lamp or tube.
 - 10.3.6 All protective relays and meters shall be tested and calibrated. All relays must be checked settings.
 - 10.3.7 After the above tests and inspection are completed. Control circuit shall be tested for correct operation under all operating combinations and proved correct before applying power to main circuits.
 - 10.3.8 Main circuits shall be checked for correct phasing and rotation.
 - 10.3.9 All motors except those having sealed prefabricated ball bearings shall be checked for proper lubrication prior to energisation and shall be tested for correct rotation.
 - 10.3.10 A close visual inspection of all electrical equipment in hazardous area shall be made to ensure that the equipment is both suitable and correctly installed.
 - 10.3.11 Capacity test shall be carried out on UPS / batteries / battery charger after installation at site.
 - 10.3.12 After completion of tests BOO OPERATOR shall prepare a joint test report for each test carried out on each equipment and shall get signed by PMC/ CIL's representative. A copy of such test reports shall form a part of completion report.



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SECTION 1.11

ENGINEERING SPECIFICATION-INSTRUMENTATION

PROJECT: SUPPLY OF METHANOL (C2M) TO M/S COAL INDIA LTD AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO) BASIS

	ENGINEERING SPECIFICATION-INSTRUMENTATION SUPPLY OF METHANOL (C2M) TO M/S COAL INDIA LTD AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO) BASIS	PC176//E/4001/P-III/ SEC-1.11	0	
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Scope of Instrumentation job for BOO OPERATOR for supply of Methanol (C2M) To M/s Coal India Ltd at Dankuni Coal Complex West Bengal, India on BUILD-OWN-OPERATE (BOO) Basis

1. Standards to be followed for instrumentation jobs:

1.	API RP 520 Parts I & II	Design and Installation of Pressure Relieving Systems in Refineries
2.	API Std 526	Flanged Steel Safety Relief Valves
3.	API Std 527	Commercial Seat Tightness of Safety Relief Valves with metal-to-metal seats
4.	API RP 551	Process Measurement Instrumentation
5.	API RP 552	Transmission Systems
6.	API RP 553	Refinery Control Valves
7.	API RP554	Process Instrumentation & Control
8.	API RP 555	Process Analysers
9.	API RP 557	Guide to Advance Control Systems
10.	ANSI B1.20.1	Pipe Threads, General Purpose
11.	ASME B16.5	Pipe Flanges and Flange Fittings (for steel,
12.	ASME B16.10	Face-to-Face and End-to-End Dimensions of Valves
13.	ANSI/ASME B16.36	Orifice Flanges
14.	ASME B16.47	Large Diameter Steel Flanges (NPS 26 thru NPE 60)
15.	ANSI B40.1/ASME	Gauges and Pressure Indicating Dial Type Elastic Element
16.	ASME Boiler and Pressure Vessel Code: Part 1 .	Power Boilers
17.	ASME Boiler and Pressure Vessel Code: Part VIII	Unfired Pressure Vessels
18.	BS 3463	Observation and Gauge Glasses for Pressure Vessels

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19.	IEC 60529	Degrees of Protection provided by enclosures
20.	IEC 60534.1	Control valve terminology and general considerations
21.	IEC 60534.2.1	Flow capacity - Sizing equations for fluid flow under installed conditions
22.	IEC 60534.2.3	Flow capacity - Test procedures
23.	IEC 60534.2.4	Flow Capacity - Inherent flow characteristics and rangeability
24.	IEC 60534,2.5	Flow capacity - Sizing equations for fluid flow through multistage control valves with interstage recovery
25.	IEC 60534.3.1	Face-to-face dimensions for flanged, two-way, globe-type, straight pattern and centre-to-face dimensions for flanged, two-way, Globe-type, angle pattern control valves
26.	IEC 60534.3.2	Face-to-face dimensions for rotary control valves except butterfly valves
27.	IEC 60534.8.3	Industrial Process Control Valves- Aerodynamic Noise Prediction
28.	IEC 60534.8.4	Industrial Process Control Valves – Prediction of Noise Generated by Hydrodynamic Flow
29.	IEC 60751	Industrial Platinum Resistance Thermometer Sensors
30.	IEC 60079	Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres
31.	IEC 60584	Thermocouples
32.	IEC 61000.4.1	Testing and Measurement techniques- Overview
33.	IEC 61000.4.3	Testing and Measurement

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		techniques- Radiated, Radio Frequency, Electromagnetic Field Tests
34.	IEC 61000.4.4	Testing and Measurement techniques- Electrical Fast Transient/burst Immunity Tests
35.	IEC 61000.4.5	Testing and Measurement techniques – Surge Immunity
36.	IEC 61508	Functional Safety of Electrical, Electronic, Programmable Electronic Safety Related Systems
37.	IEC 61511	Functional Safety of Safety Instrumented Systems for the Process Sector
38.	IEEE C37.90.1 - 2002	Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
39.	ISA5.2	Binary Logic Diagrams for Process Operations
40.	ISA 18.1	Annunciator sequences and Specifications
41.	ISA S84-01-1996	Application of Safety Instrumented Systems in the Process Industries
42.	ISO 5167-All Parts	Specification for Square-edges Orifice Plates, Nozzles and Venturi Tubes Inserted in Circular Cross Section Conduits Running Full
43.	ISO 5208	Pressure Testing of Valves
44.	ISO 4266: 1994	Petroleum and liquid petroleum products- Measurement of temperature and level in storage tanks-Automatic methods
45.	NACE MR0175 ISO 15156	Petroleum & Natural Gas Industries – Material for Use H2 S-Containing Environments in Oil & Gas Production

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The latest published issue or amendment at the time of contract placement shall apply unless otherwise stated

PUBLICATIONS

AUTHOR	TITLE
R.W.Miller	Flow Measurement Engineering Handbook.
Fieldbus Foundation	AG-181 Foundation Fieldbus System Engineering Guidelines,

2. Statutory requirements to be followed

➤ All instrumentation shall be subject to SIL Assessment. The implementation of SIL requirements shall be in accordance with IEC 61508 & 61511.

➤ Notwithstanding the hazard classification assigned to the area in which an instrument is located, which is generally Zone 2 for hazardous areas subject to flammable gas / vapours, all instruments, except the drive section of motorised valves, shall be:

Certified, as a minimum, EEx'ib', suitable for Zone 1, with the Gas Group determine by the process area classification in which the instrument is located.

Certified EEx'ia' in locations specified as Zone 0.

The certification listed above, shall be provided by the Chief Controller of Explosives (CCOE), Nagpur, India, and an Internationally recognised authority,

➤ The drive section of motorised valves shall be certified EEx'd', suitable for Zone 1, with the Gas Group determine by the process area classification in which the instrument, for hazardous areas subject to flammable gas / vapours, or EEx'tD' for hazardous areas subject to flammable dust / fibres. These certifications shall be provided by the Chief Controller of Explosives (CCOE), Nagpur, India, and an internationally recognised authority.

➤ Electromagnetic Compatibility Requirements

All equipment shall meet the technical requirements as defined in the following specifications:

IEC 61000 Sections 4.1 thru 4.5 - Electromagnetic Compatibility.

IEC 61326 section 1 - Electrical Equipment Measurement, Control Laboratory use – EMC requirements

IEEE C37.90.1 - 2002 -Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

➤ Other requirements as per OISD & IBR standards

	ENGINEERING SPECIFICATION-INSTRUMENTATION SUPPLY OF METHANOL (C2M) TO M/S COAL INDIA LTD AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO) BASIS	PC176//E/4001/P-III/ SEC-1.11	0	
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3. Design requirements for flow instruments:

The reference conditions for standardised flows shall be
Liquids- 15 Deg C and 760mm HG
Gas/Vapours- 0 Deg C and 760mm Hg

4. All instrumentation requirement as per the NOC of Pollution control board and Environmental Clearance accorded by the MOE & F

5. Interfacing jobs

- Interfacing of control system for BOO units with Main project control system for critical data exchange for monitoring only. Necessary hardware for interfacing to be provided by BOO vendor in their control room.
- Interfacing of Fire Detection and Alarm system & Gas detection system with main project system for availability of data in Fire & safety control room. Necessary hardware for interfacing of Fire Detection and Alarm System & Gas Detection system shall be provided by BOO OPERATOR in their Control Room.

6. Custody transfer metering system:

For. Liquid/Gas Custody transfer, international standard like AGA5, AGA 7, AGA 8, AGA9, AGA 11 to be followed based on experience of similar application and concept.

BOO OPERATOR shall provide all the metering for all the interfaces given with relevant flowmeters and accuracies as specified elsewhere in the tender document.

BOO OPERATOR shall match all the material of construction at the battery limit.

7. Control room:

BOO OPERATOR shall be responsible for construction of SRR-810 for installation of System/ marshalling cabinets and all other control system related equipment under their scope of work. BOO OPERATOR shall install all the relevant hardware required for integration of BOO units with Main project control system.

BOO OPERATOR shall utilize the space inside SRR 810 for installing consoles for operation and control of units under their scope of work

8. Metering Equipment:

Following Instruments to be used for various measurements for Coal to Methanol Plant.

Sl. No.	Measurement of	Measurement through	Accuracy
1	Power	Energy Meter	Class 0.2S *

	ENGINEERING SPECIFICATION-INSTRUMENTATION SUPPLY OF METHANOL (C2M) TO M/S COAL INDIA LTD AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO) BASIS	PC176//E/4001/P-II/ SEC-1.11	0	
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2	Raw Water/Construction Water	Magnetic Flow Meter	0.5 %
3	Treated Effluent	Orifice Plate	0.5 %
4	Coal a. Through Wagon b. Unloading Ground Hopper	a1. In-motion weighbridge a2. Static rail weighbridge b. Belt Weigher	a1. +/-0.5% for Wagon, +/-0.2% for rake a2. +/-0.02% to 0.05% b. +/-0.25 %
5	Methanol a. Flow b. Analytic measurement of impurities in methanol	a. Coriolis Mass Flowmeter b. GC	a. 0.05 % b. 1%

*However same shall be in line with WBSEDCL.

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PART II: TECHNICAL

SECTION –1.12

CIVIL & STRUCTURAL WORKS



PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, (INDIA) ON BUILD-OWN-OPERATE (BOO) BASIS

0	24.09.2020	24.09.2020	ISSUED FOR TENDER	SK	SS	UPT
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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1.5	Disposal of Surplus Earth
1.6	Site Cleaning
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1.8	Surface Drainage
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2.3	Design Specification- Wind
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5.0	<u>APPENDIX-A</u> : Certificate of Safety ,Serviceability & Maintenance

ATTACHMENTS	
1.	Topographical Survey Report
2.	Geotechnical Report

	<u>SCOPE OF WORK</u> <u>COAL TO METHANOL PROJECT THROUGH COAL GASIFICATION ROUTE, DANKUNI COAL COMPLEX, WEST BENGAL</u>	PC176/E/4002/P-II/ SECTION 1.12	0	
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GENERAL DESCRIPTION OF SCOPE

This section of the Tender Documents deals mainly with the Scope and Technical Specifications needed for the Detail design, preparation of detailed Drawings and getting the design/ drawings approved by Owner/Consultant, execution and construction of complete Civil, Structural and other Allied Works on BOO basis.

The scope of Civil Structural and Architectural Works under this Contract shall include carrying out surveying, geotechnical investigation, Grading & Leveling, Detailed Design, Drawings, Supply, Procurement of all materials, Construction, Demolitions, Supervision of all relevant Civil and Structural Works including providing all labour, supervision, material, scaffolding, construction equipment, tools, tackles and plants, supplies, transportation, all incidental items though not indicated or specified but reasonably implied or necessary for successful completion of the project.

Scope of the CONTRACTOR shall include but not limited to the following:-

- a) Topographical survey and geotechnical investigation.
- b) Engineering related to site leveling & preparation.
- c) Specific soil Investigation, if required for specific design.
- d) Preparation of concept notes for design, engineering & construction.
- e) Structural Analysis and design calculations as per specifications and as per referred codes. for all Civil works including but not limited to pile, pile-cap, foundation, plinth beam, RC superstructure, steel super structure, RC underground structures and water retaining structures, trenches, drains, pits etc.
- f) Architectural design and drawings including details for doors, windows, partitions, false floor, false ceiling, toilet, finishes etc.
- g) General Arrangement and detail design drawings for pile, pile-cap, foundations, plinth beams etc, based on the soil investigation carried out by the bidder for the proposed site.

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- h) General Arrangement and structural drawings at grade level showing foundations, extent of paving, trenches, drains, pits etc.
- i) General Arrangement and detail design drawings for superstructure (RCC and structural steel) at all levels.
- j) RCC drawings showing all necessary details for all foundations and structures.
- k) Structural steel detail drawings for all steel structures.
- l) General Arrangement and detail drawings for access roads, storm water drains, effluent drains, cable trenches, sewerage, manholes, pits, sumps with all necessary details.
- m) Effluent Treatment Plant (having zero liquid discharge) and Sewage treatment plant within battery limit.
- n) Bar Bending Schedules for all RCC works.
- o) Fabrication drawings with all details for steel structures.
- p) Coordination with OWNER / PMC for various activities including approvals of design basis, concept note, drawings, material samples, laboratory test results etc.
- q) Procurement of all items necessary for completion of scope of work.
- r) Construction of all units / structures, items of work included in scope of work.
- s) Preparation of as built drawings & final documentation.
- t) Obtaining Statutory Approvals.
- u) Adherence to Quality Assurance Plan

1. DETAILED SCOPE OF WORK



1.0 SCOPE

1.1 SOIL INVESTIGATION

1.1.1 Soil Investigation Report

- v) The Geo- Technical Investigation for Dankuni Complex is attached with the NIT and may be viewed by the bidders, for guidance purpose only.

1.1.2 BOO OPERATOR shall design and construct all foundations as per requirements.

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1.2 **TOPOGRAPHICAL / CONTOUR SURVEY**

Required Topographical / Contour survey shall be done by BOO OPERATOR for micro grading & layout purpose. The plant battery limit co-ordinates shall be as per enclosed plot plan (plant).

Survey drawing of the Refinery area is attached with the NIT & can be viewed by the bidder, if desired.

1.3 **SITE DATA:**

1.3.1 **Site Conditions**

At bidding stage the contractor shall visit the site for studying the site condition & existing structures. Final plant elevation has been decided based on existing elevation of plant in consultation with the client.

1.3.2 **Road Levels**

BOO OPERATOR shall carryout contour survey of roads adjacent to the unit and also roadways around the unit as defined in plot plan drawing.

1.3.3 **Meteorological Data:**

For metrological data refer topographical survey report.

1.3.4 **Wind Loads**

Basic wind speed for structural design shall be taken as per BIS Codes.



1.3.5 **Earthquake Loads**

Earthquake loads for Dankuni Complex shall be considered as per BIS Codes.

1.3.6 **Design Rainfall intensity shall be as mentioned in the attached topographical report.**

1.3.7 **Portable water shall be made available at one point location on free/chargeable basis. Further distribution shall be in the scope of BOO OPERATOR.**

1.3.8 **Transfer of benchmark**

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The reference benchmark is available inside the premises. This reference benchmark will be shown to BOO OPERATOR during execution. Same shall be used to transfer the levels to new benchmark near or inside the unit.

1.4 Grading

The land shall be handed to the BOO contractor on 'As is where As' basis. BOO operator to develop the site as per requirement.

1.5 Disposal of surplus earth

BOO OPERATOR shall dispose-off all surplus and unserviceable earth (if any), at his own cost with the consent of Owner / Consultant .The location of disposal area of surplus earth / sand shall be provided by Owner. However, location of disposal area of unserviceable earth, sand, rubbish/debris shall be decided by BOO OPERATOR and the required necessary approvals from the local bodies shall be BOO OPERATOR's responsibility.

1.6 Site cleaning

During construction and on completion of construction (inclusive all internal and external finishes), cleaning all the debris, waste materials scattered in and around the site and disposal of the same shall be in the scope of BOO OPERATOR with the consent of the OWNER.



1.7 Roads

BOO OPERATOR shall be responsible for complete planning and construction of the roads for access to all buildings and units of the plant including necessary approach road from peripheral main roads to the site area from at least two sides. The recommended width of the roads including berms shall be as follows:-

	<u>Main Road</u>	<u>Access Roads</u>	<u>Tank/In-unit Areas</u>
Minimum width (m)	12	7.5	7.5

1.8 Surface Drainage

BOO OPERATOR shall ensure proper drainage of all parts of the Methanol Plant under reference. BOO OPERATOR shall provide proper drainage system for all roads mentioned in the above clause 1.7. Storm Water Drains shall be connected to

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the main drainage system by providing suitable tie-in points in consultation with Owner / Consultant.

1.9 Contaminated Rain Water System and Oily Water Sewer (OWS) System

BOO OPERATOR shall provide proper underground drainage system for contaminated rain-water and OWS. These shall be connected to Main CRWS & OWS networks at suitable tie-in points to be decided in consultation with Owner / Consultant during detailed engineering.

1.10 Sewage Disposal Scheme

BOO OPERATOR shall provide proper underground sewage disposal. This shall be connected to Main sewerage system at suitable tie-in points to be decided in consultation with Owner / Consultant during detailed engineering.

1.11 Paving

BOO OPERATOR shall provide RCC pavement for the complete area of the unit as job specific requirement. For the purpose of paving BOO OPERATOR's scope is not limited only up to Battery Limit, but shall extend up to the adjacent roads around the unit.

1.12 Structures buildings etc.



BOO OPERATOR's scope shall include are technological structures steel & R.C.C. structures, pipe rack, buildings, equipment foundations, pits, cable trench, sheds, etc. as required for the complete execution and commissioning of the plants.

1.13 Fire Proofing

BOO OPERATOR shall design, supply and apply fire proofing to steel structures wherever required as per OISD – STD – 164 standards, published by 'Oil Industry Safety Directorate, Government of India, Ministry of Petroleum & Natural Gas / Tariff Advisory Committee (TAC) rules and regulations and other Codes / requirements as applicable.

1.14 Surface Finishing

BOO OPERATOR shall be responsible for complete planning and detailing of all surfaces finishes viz. painting, flooring etc.

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1.15 Acid / Alkali Proof Lining

BOO OPERATOR shall be responsible for surface treatment of floors, exposed portion of foundations, pits and basins against acid / alkali as per process requirement.

1.16 Anti-termite Treatment / Damp proof course / Water proofing

BOO OPERATOR shall provide anti-termite treatment, damp proof course and water proofing as per requirement.

1.17 Miscellaneous

1.17.1 Boundary wall / Fencing / Gate / Security Room shall be provided by the bidder as per the prevailing refinery norms/plant requirements.

1.17.2 The scope shall include local platforms, pipe sleepers, local foundations, local supports, etc. as per requirement.

1.18 Engineering and construction



Preparation of detailed design, drawings, supply and construction of all civil, structural, architectural, plumbing and building works shall be in the scope of BOO OPERATOR's work.

1.19 Sizing of various facilities

Sizing, nos., location etc. of various facilities viz. buildings, pipe rack, structures, equipments, etc. shall be in the scope of the bidder.

1.20 Rules and regulations

All the facilities shall conform to all Local Rules and Regulations, Factory Inspector, Rules, TAC rules, OISD norms, etc. whichever is more stringent. Getting the approval of the various documents through the various authorities, including all statutory approvals shall be in BOO OPERATOR's scope, at no extra cost to OWNER.

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2.0 DETAILED ENGINEERING

2.1 General

2.1.1 BOO OPERATOR shall carryout Analysis and Design of the structures required and prepare all the required Architectural, Civil and Structural drawings needed for correct and accurate construction based on scope and requirements as indicated in the NIT, elsewhere as per Internationally accepted standards and engineering practices, all safety rules pertaining to Refinery, OISD Norms, BIS Codes, International Codes, wherever applicable and Design Specifications given in the Tender.

2.1.2 It shall be the responsibility of BOO OPERATOR, to accommodate all the functional requirements such as access, cutouts, clearances, interference etc. while designing / detailing of various structures / facilities.

2.2 REFERENCES & DOCUMENTS

2.2.1 Codes and Standards

The latest edition or revision of the following Codes and Standards relative to building design, specification and construction work at the time of contract award, shall form part of this specification. These shall include but not limited to:



➤ National Building Code

Technical Sections – Specifically:

- | | |
|---------|--|
| Part 4 | - Fire and Life Safety |
| Part 5 | - Building Materials |
| Part 6 | - Structural Design |
| Part 7 | - Constructional Practices and Safety |
| Part 8 | - Building Services |
| Part 9 | - Plumbing Services |
| Part 10 | - Landscaping, Signs and Outdoor Structures. |

➤ Bureau of Indian Standards (IS)

➤ Oil Industry Safety Directorate Standards (OISD)

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- British Standards Institution (BSI)
- IEE Regulations for Electrical Installations
- Steel Structure Painting Council
- State Government Factory Acts
- Local Municipality, Government Authorities and Bye Laws
- Bye Laws of Town and Country Planning Organization
- Building Bye Laws
- Tariff Advisory Committee Guidelines & Recommendations (TAC)
- Bureau of P/A Guidelines
- ISO 1999 Acoustics – Assessment of Occupational Noise Exposure for Hearing Conversation Purposes.

2.2.2 Indian Authorities Codes and Standards



Title
Factories Act; (As specific to Dankuni)
Indian Petroleum Rules;
Liquid effluent discharge, as per Minimal National Standards for liquid effluent and air emissions conforming to Pollution Control Board Standards;
Civil Aviation Rules;
Indian Boiler Regulations;
Indian Electricity Rules,;
Requirement of Chief Controller of Explosives;
Static & Mobile Pressure Vessels (SMPV) rules of the Chief Controller of Explosives
Requirement of Town & Country Planning Department;
Requirements of other authorities concerned with the Project as follows: <ul style="list-style-type: none"> • Indian Weights and Measures • Bhaba Atomic Research Centre

2.2.3 REFERENCE STANDARDS & PUBLICATIONS:

SL. NO.	CODES	
1.	Codes of practice for plain & reinforced concrete	IS:456

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2.	Code of practice for general construction in steel	IS:800
3.	Code of practice for use of cold formed light gauge steel structural members in general building construction	IS:801
4.	Code of practice for use of structural steel in overhead transmission line towers	IS:802
5.	Code of practice for use of steel tubes in general building construction	IS:806
6.	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel	IS:814
7.	Code of practice for use of metal arc welding for general construction	IS:816
8.	Code of practice for design loads	IS:875
9.	Code of practice for construction of stone masonry	IS:1597
10.	Fillers for expansion joints	IS:1838
11.	Criteria for earthquake resistant design of structures	IS:1893
12.	Code of practice for structural use of unreinforced masonry	IS:1905
13.	Recommended practice for hot dipped galvanizing on iron and steel	IS:2629
14.	Methods for testing uniformity of coating of zinc coated articles	IS:2633
15.	Code of practice for design & construction of raft foundations	IS:2950
16.	Code of practice for design & construction of machine foundations	IS:2974
17.	Code of practice for concrete structures for storage of liquids	IS:3370
18.	Code of practice for design and construction of foundation for transmission line towers and poles	IS:4091
19.	Code of practice for earthquake resistant design and construction of buildings	IS:4326
20.	Criteria for blast resistant design of structures for explosions above ground	IS:4991
21.	Criteria for design of RCC chimneys	IS:4998
22.	Code of practice for anti-termite measures in buildings	IS:6313
23.	Code of practice for design & construction of steel	IS:6533

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	chimney	
24.	Method for determination of mass of zinc coating	IS:6745
25.	Chlorpyrifos emulsifiable concentrates	IS:8944
26.	Recommendations for metal arc welding of carbon and carbon manganese steel	IS:9595
27.	Two parts polysulphide based sealants	IS:12118
28.	Code of practice for ductile detailing of reinforced concrete structures subjected to seismic forces	13920
29.	Control Room Safety (a publication of Oil Industry Safety Directorate)	OISD-STD-163
30.	Fire Proofing in Oil and Gas Industry (a publication of Oil Industry Safety Directorate)	OISD-STD-164
31.	Code of practice for Design and construction of Pile foundations	IS:2911
32.	Code of practice for structural safety of buildings - Shallow foundations	IS:1904
33.	Code of practice for determination of bearing capacity of shallow foundations	IS:6403
34.	Code of practice for calculation of settlements of foundations	IS:8009 (Pt I, II)
35.	Determination of dynamic properties of soil	IS:5249
36.	Fire Protection System for Electrical Installations	OISD-STD-173
37.	National Building Code (other relevant clauses)	



NOTE:

The above list is suggestive and nor exhaustive. Apart from these basic codes any other related codes shall also be followed wherever required.

2.3 DESIGN SPECIFICATION - WIND

2.3.1 SCOPE

- Design wind load for process structure & equipment shall be established from IS:875 Part III

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- This standard specifies the minimum design requirements for wind loadings to be imposed on buildings, equipment, vessels, structures and their foundations.
- Design loads shall be in accordance with the Refinery norms & the latest revisions of relevant Indian Codes and Standards.

2.3.2 INDIAN CODES AND STANDARDS

IS 6533		Codes of practice for design and construction of steel chimney
	Part 1	Mechanical Aspect
	Part 2	Structural Aspect
IS 875		Codes of practice for design loads (Other than Earthquake) for Buildings & Structures.
	Part 1	Dead Loads – Unit weights of building materials and stored materials
	Part 2	Imposed Loads
	Part 3	Wind Loads
	Part 4	Snow Loads
	Part 5	Special Loads & Load combinations
IS 802		Overhead Transmission Line Towers
	Part 1	Code of Practice for loading and Permissible stresses.
IS 1893		Criteria for Earthquake Resistant Design of Structures.
	Part 1	General Provisions and Buildings
	Part 4	Industrial Structures including Stack like structures
IS 4326		Code of practice for Earthquake resistant design and construction of Buildings
IS 13920		Code of practice for Ductile detailing of reinforced concrete structures subjected to seismic forces
NBC		National Building code of India 2005
	Part 6	Structural Design

2.3.3 OTHER STANDARDS AND CODES

In situation where sufficient information / guidance are not found available in Indian Codes and Standards, the following Standards and Codes of Practice

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shall apply. The revision current at the time of Contract Placement shall be used.

2.3.4 BRITISH STANDARDS

BS 4076		Specification for Steel Chimneys
BS 6399		Loadings for Buildings
	Part 1	Codes of practice for Dead and Imposed Loads
	Part 3	Code for Practice for Imposed Roof Loads
BS 6399-2		Loadings for Buildings : Code of Practice for Wind Loads
BS 8100		Lattice Towers and Masts
	Part 1	Code of Practice for Loading
	Part 2	Guide to the background and use of Part 1
BS CP 3		Code of Basic Data for the Design of Buildings
	Ch. V, Part 2	Wind Loads
BS DD 133		Code of Practice for Strength Assessment of Members of Lattice Towers and masts
BS EN 1991-1-4 Euro code 1		Action on Structures, General Actions – Wind Actions, Annex E. Vortex Shedding and aero elastic instabilities.

2.3.5 STANDARDS

American		Uniform Building Code
NZS 4230		Code of Practice for Structural Design and Design Loadings for Buildings
	Vol. 1	Code of Practice
	Vol. 2	Commentary

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2.3.6 TECHNICAL LITERATURE

- CICIND Model Codes for Stacks
- AC I Standards
- Engineering Specification Design Units. Wind Engineering, London ESDU International
- Cook N.J. The designers guide to wind loading of building structures. Part 2: Static structures. London: Butterworth Scientific, 1985
- Wiliford, M.R., and Allsop, A.C. Design guide for wind loads on unclad framed building structures construction (Supplement 3 to the designer's guide to wind loading of building structures). Garton: Building Research Establishment, 1990
- Blackmore P. Wind loads on unclad structures. BRE Special digest SD5 BRE Press
- ASCE - Wind Loads and Anchor Bolt Design for Petrochemical Facilities

2.3.7 CONFLICT IN STANDARDS

Where conflict exists between specification and Standards, the stringent of the two shall be followed.



2.4. DESIGN CALCULATION & DRAWINGS

2.4.1 BOO OPERATOR shall submit a List of Documents, & Drawings, which shall be prepared for this project in line with the overall Project Schedule given in the document.

2.4.2 Analysis and design of structures shall be done on latest version of STAAD-PRO SOFTWARE. For other miscellaneous works Excel and Word shall be used.

2.4.3 Before taking up any construction activity, AFC drawings of all the important buildings, technological structures & Equipments shall be submitted to the Owner / Consultant for information.

2.4.4 After the mechanical completion of the plants "As built drawings" pertaining to Civil, Structural and Allied works for the complete Methanol plant, shall be submitted to the Owner, for their records, bearing certificate for structural soundness, strength & serviceability, as per attached Performa in **Appendix A**.

	SCOPE OF WORK <u>COAL TO METHANOL PROJECT THROUGH COAL GASIFICATION ROUTE, DANKUNI COAL COMPLEX, WEST BENGAL</u>	PC176/E/4002/P-II/ SECTION 1.12	0	
		Document No.	Rev.	
		SHEET 17 OF 18		

3.0 CONSTRUCTION

3.1 General

- 3.1.2 Construction of all civil and structural works including all material, labour, supervision, tools and tackles etc. shall be carried out by BOO OPERATOR.
- 3.1.3 Materials of construction, construction method etc. shall be such, so as to protect the structures and foundations against the harmful effect of chemical, fumes etc. present in the plant, its vicinity, in ground and / or subsoil water.
- 3.1.4 Construction water & power shall be made available to BOO OPERATOR on free/chargeable basis.

4.00 SPECIAL CONSIDERATIONS FOR STORAGE TANKS



Seismic design of storage tanks shall be carried out as per the provisions of API 650 Appendix-E, API 620 Appendix-L, as applicable. For doubled walled tanks inner and outer tanks have to be checked separately and the outer tank has also to be checked for possible inner tank failure.

The value of Z and I (refer API 650 Appendix-E, API 620 Appendix-L) shall be taken as unity.

The values of C1 shall be taken as the site-specific seismic spectral ordinate of 2% damping curve corresponding to the calculated time period of the tank.

The value of C2 shall be taken as the site-specific seismic spectral ordinate for 0.5% damping curve corresponding to the natural period of sloshing.

The spectral acceleration values for periods greater than 3.0 seconds may be considered same as that per 3.0 seconds.

	SCOPE OF WORK <u>COAL TO METHANOL PROJECT THROUGH COAL GASIFICATION ROUTE, DANKUNI COAL COMPLEX, WEST BENGAL</u>	PC176/E/4002/P-II/ SECTION 1.12	0	
		Document No.	Rev.	
		SHEET 18 OF 18		

5.00

APPENDIX - A

Certificate of Safety, Serviceability and Maintenance

1. It is certified that the Design & Construction of all the Structural Steel & RCC Structures of the proposed COAL TO METHANOL PROJECT THROUGH COAL GASIFICATION ROUTE, DANKUNI COAL COMPLEX, have been checked for Structural soundness & serviceability requirements as per the relevant codal / safety provisions.
2. The functional viability of sewage system, storm water drainage, drainage systems for OWS, CRWS & CBD, road / paths, culverts, water supply schemes have been checked for design and optimization as per the relevant BIS codes.
3. BOO OPERATOR M/s shall be responsible for proper maintenance of all the Structural Steel & RCC Structures and ensure proper functioning of all the systems /schemes/ services, once completed, for the period mentioned in the contract.

Dated:

**(Signature & Seal of Authorised signatory)
For & Behalf Of BOO OPERATOR**

TOPOGRAPHICAL SURVEY REPORT

CONDUCTED AT THE SITE FOR



PROPOSED COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX, KOLKATA, WEST BENGAL

FOR

DY. CHIEF ENGINEER (PROJECT MANAGEMENT)

125, A-14, SECTOR-1 NOIDA - 201301,
DIST. GAUTAM BUDH NAGAR, U.P.

CONDUCTED BY



TECHPRO ENGINEERS PVT. LTD.

(An ISO: 9001-2008 certified Company and NABL accredited Laboratory)

103, RATANDHAM, 12/483, McROBERTSGANJ,
KANPUR-208 001

PHONES: 0512-2525759, 09793209918

e-mail: info@techproindia.com

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1. INTRODUCTION:



Coal India Ltd has decided to setup a facility for converting coal to methanol within the existing Dankuni coal complex at Dankuni. Projects Development India Ltd. (PDIL) has been appointed the nodal agency to setup the project facilities. A detailed survey of the proposed area is required by PDIL and the work of topographical survey and counter mapping has been awarded to us wide order No. 11/PNMM/P/4805/2019-20/4030000303 dated 20.09.2019.

2. SITE LOCATION:

Dankuni Coal Complex (DCC) is situated 22.711047°N and 88.281095°E in the state of West Bengal. The site is in close proximity of Janai road railway station. Durgapur expressway passes in the north of the site. The complex site spread over an area of 115 acres.

The survey area of coal complex is shown in the Google image below.



	TECHPROENGINEERS PVT.LTD. (AN ISO 9001: 2008 Certified Company)	TGS637_PDIL_DANKUNI	
		Revision-R0	
TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX			

3. PURPOSE OF SURVEY:

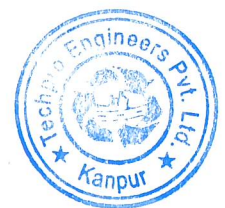
Coal India Limited intend for setting up a grass root Coal to Methanol Plant at its existing premises of Dankuni Coal Complex at Dankuni, West Bengal utilizing Coal as a basic raw material for the production of Methanol.



The purpose of topographical and contour survey is to study the nature and type of terrain at complex site to prepare the feasibility report for installation of methanol project in accordance with the policy by central Government.

4. SCOPE OF WORK:

The work consists of mobilization of all relevant and adequate equipment, plants, tools, machineries etc. and providing necessary engineering supervision though qualified and technical personnel, skilled and unskilled labour etc., required to match the work schedule and to carry out the complete work in all respects as per direction of Engineer-in-Charge.

- 4.1. Carrying out Topographical as well Spot Levelling by TOTAL STATION system of the proposed site area associated with the proposed Coal to Methanol Project at Dankuni Coal Complex.
- 4.2. Establishment of permanent bench marks at site with reference to approved existing permanent bench mark.
- 4.3. Establishment of grid pillars at site with reference to permanent bench mark.
- 4.4. Establishment of basic line, zero line and grid system for defining co-ordinates of various areas.
- 4.5. Transferring the mean sea level (MSL) from nearby railway station.
- 4.6. Collection of data for latitude and longitude.
- 4.7. Collection of data for Rain-Fall Intensity.
- 4.8. Demarcation of Coal heap with height.
- 4.9. Number of trees with their details.
- 4.10. Recording of Highest Flood Level (HFL) of nearby streams .
- 4.11. Preparation of survey and contour maps.



	TECHPROENGINEERS PVT.LTD. (AN ISO 9001: 2008 Certified Company)	TGS637_PDIL_DANKUNI	
		Revision-R0	
TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX			

5. FIELD WORK:

Topographic Survey on coal complex side was commence on 12th October 2019 and completed on 22th October 2019. The scope of survey was limited to the existing boundary of Dankuni coal complex. Total station instrument was used for the land survey and recording the reduce levels. All the levels in the reports for land survey have been reported in reference with the MSL and plotted in survey plan No. TGS637_PDII_DANKUNI.

5.1. Record of all permanent/ existing features:

All the permanent features comprising of existing building, steel structure, internal road, over ground pipe lines, railway lines, electric poles, storm water drains, culverts, dump yard, heaps of coal, water bodies/ pond, tanks, trees etc, have been taken and reported on aforesaid survey map in accordance with specification and in direction of Engineer-In-Charge.

5.2. Transferring of level with respect to MSL:

The mean sea level recorded 37.170 at the **Janai road railway** station and transferred by traversing to the complex site. Northing and Easting assumed at said station platform as 0.00, 0.00. All the local coordinates has been recorded in reference with this points marked at the station platform.

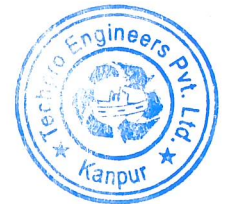
5.3. Spot Levels of land:



Spot levels have been taken randomly at interval of approximately 10m c/c both ways and represented on grid pattern at grid interval of 20m both ways. Spot levels also recorded at the top of coal heaps at several points and reported in survey map.

5.4. Highest flood level:

The highest flood level recorded at nearby Railway Bridge in section Kolkata Kharagpur rail section.

5.5. Detailed location of existing trees:



	TECHPROENGINEERS PVT.LTD. (AN ISO 9001: 2008 Certified Company)	TGS637_PDIL_DANKUNI	
		Revision-R0	
TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX			

Locations of trees having girth more than or equal to 300mm with their specifications have been marked on the survey drawing and listed in tabular form.

5.6. Permanent bench mark:

Two numbers of permanent bench mark pillars of size 1000 mm x 1000 mm x 1500 mm in plain cement concrete of nominal mix 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregates of 20 mm nominal size) with 500 mm below ground level and 1000 mm above ground including embedding steel plate of size 150 mm x 150mm x 10 mm on top , all complete as per technical specifications for the work have been established at the locations fixed by the Engineer-in-charge.

5.7. Grid pillars:

Fifty Nos. of grid pillars of 200 mm dia. and 1000 mm long RCC Hume pipe were grouted in h 400 mm dia. x 500 mm deep foundation of plain cement concrete of nominal mix 1:2:4 (1cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size). The pillars were embed 500 mm in the concrete bed.

6. SURVEY MAP:

Survey map/ drawings have been prepared on AutoCAD software comprising of following items:

6.1. Kay plan:

Key Plan of the surveyed area has been prepared showing the adjoining land /features and reported in drawing No. TGS637-R1-PDIL_DANKUNI.

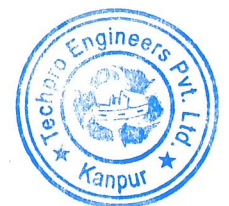
6.2. Horizontal & Vertical grid lines:

Horizontal and vertical grid lines have been drawn at interval of 20 meter including spot levels at each junction and illustrated in survey maps.

6.3. Contour lines:

Contours have been generated by auto plotter software as interval of 0.5m and illustrated in survey map.

6.4. Reduced levels:



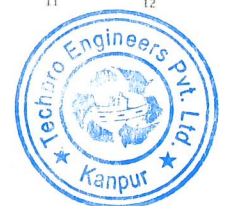
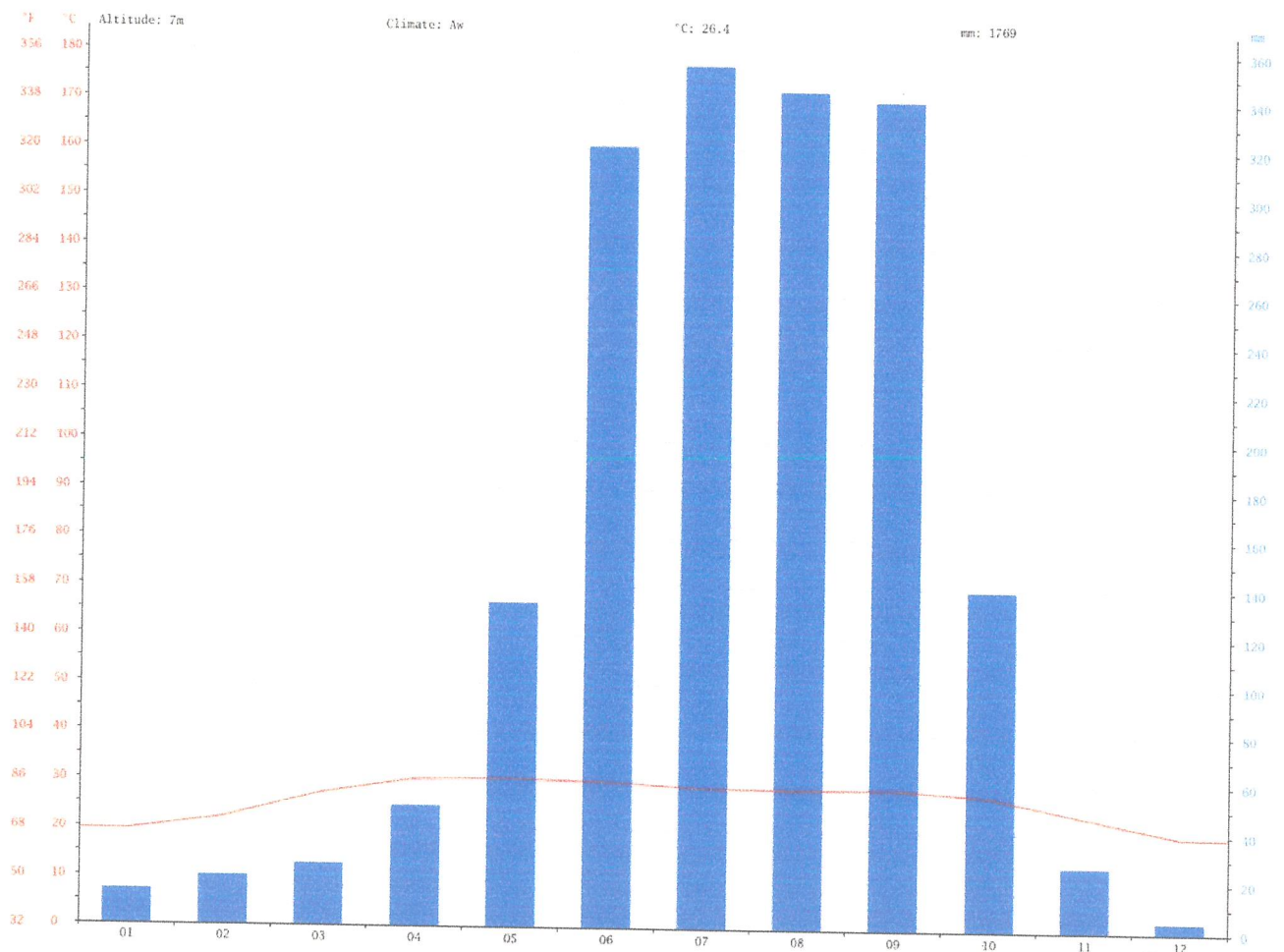


Reduced levels on each corner of land, permanent bench marks and grid pillars given have been reported in tabular form in survey drawing No. TGS637-R1-PDIL_DANKUNI.

7. METROLOGICAL DATA:

7.1 TEMPERATURE AND RAIFALL:

The Dankuni has a tropical climate. When compared with winter, the summers have much more rainfall. The temperature here averages 26.4 °C. Precipitation here averages 1769 mm.



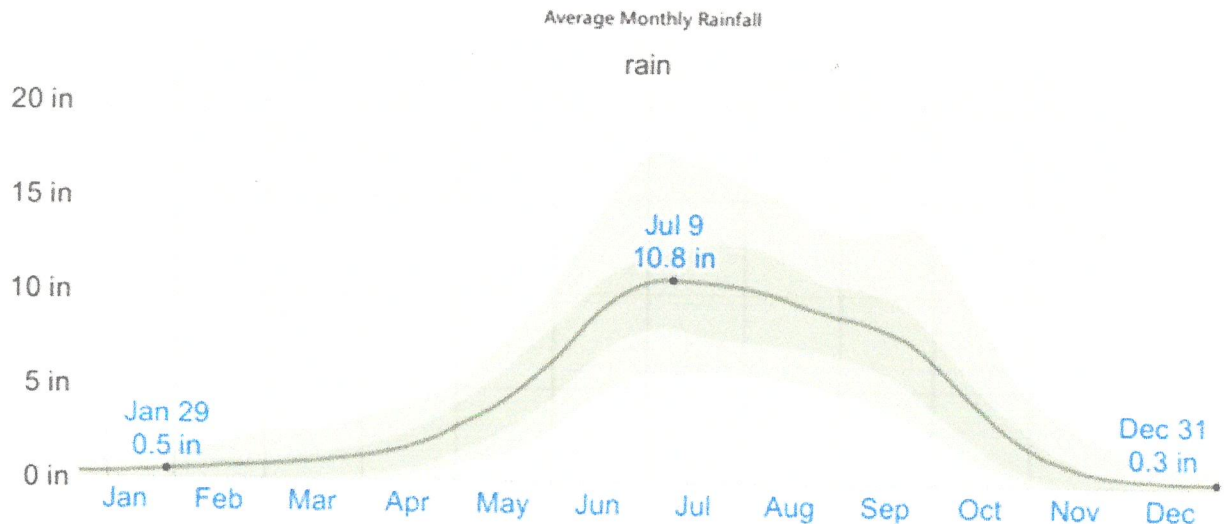


7.2. RAINFALL:

To show variation within the months and not just the monthly totals, the rainfall in Kolkata vicinity accumulated over a sliding 31-day period centered around each day of the year. Kolkata experiences extreme seasonal variation in monthly rainfall.

The rainy period of the year lasts for 10 months, from January 29 to November 30, with a sliding 31-day rainfall of at least 0.5 inches. The most rain falls during the 31 days centered around July 9, with an average total accumulation of 10.8 inches.

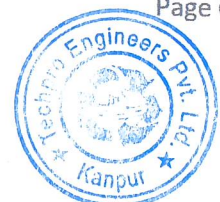
The rainless period of the year lasts for 2.0 months, from November 30 to January 29. The least rain falls around December 31, with an average total accumulation of 0.3 inches.



The average rainfall (solid line) accumulated over the course of a sliding 31-day period centered on the day in question, with 25th to 75th and 10th to 90th percentile bands. The thin dotted line is the corresponding average liquid-equivalent snowfall.

7.3. WIND ROSE DIAGRAM:

This section expresses the wide-area hourly average wind vector (speed and direction) at 10 meters above the ground. The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages.



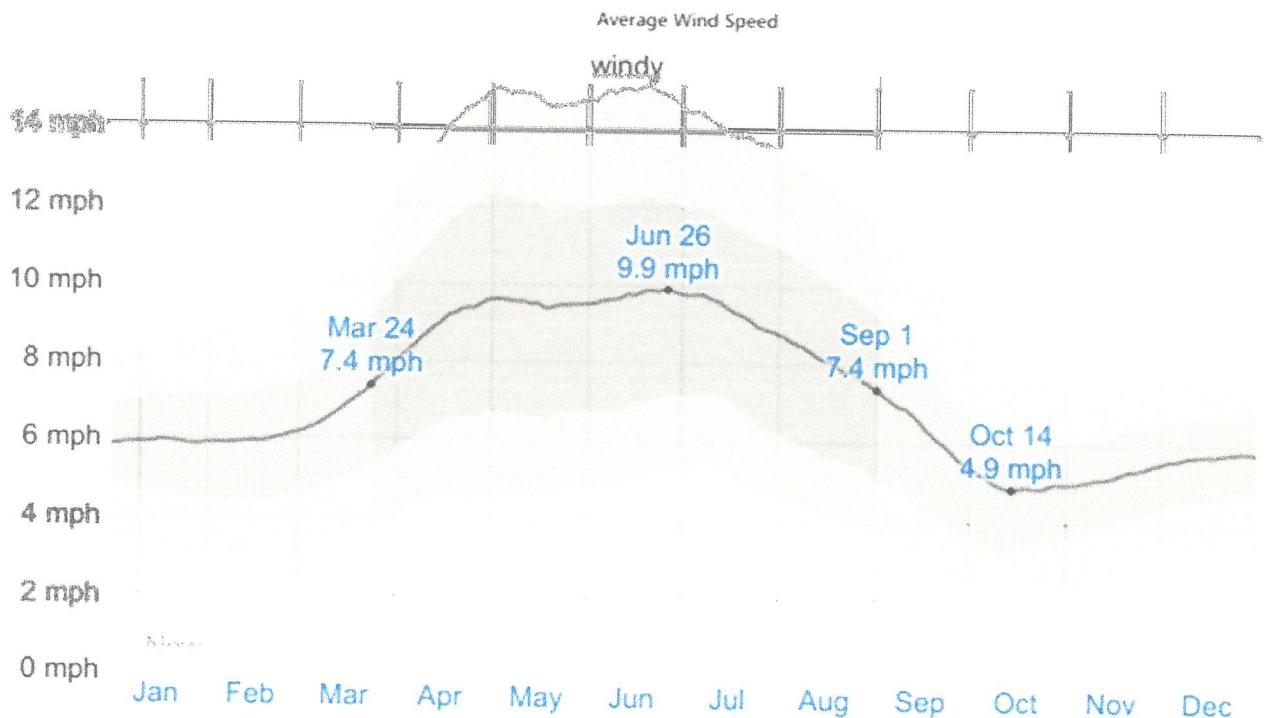


TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX

The average hourly wind speed in Kolkata experiences significant seasonal variation over the course of the year.

The windier part of the year lasts for 5.3 months, from March 24 to September 1, with average wind speeds of more than 7.4 miles per hour. The windiest day of the year is June 26, with an average hourly wind speed of 9.9 miles per hour.

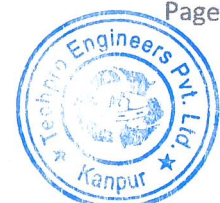
The calmer time of year lasts for 6.7 months, from September 1 to March 24. The calmest day of the year is October 14, with an average hourly wind speed of 4.9 miles per hour.



The average of mean hourly wind speeds (dark gray line), with 25th to 75th and 10th to 90th percentile bands.

The predominant average hourly wind direction in Kolkata varies throughout the year.

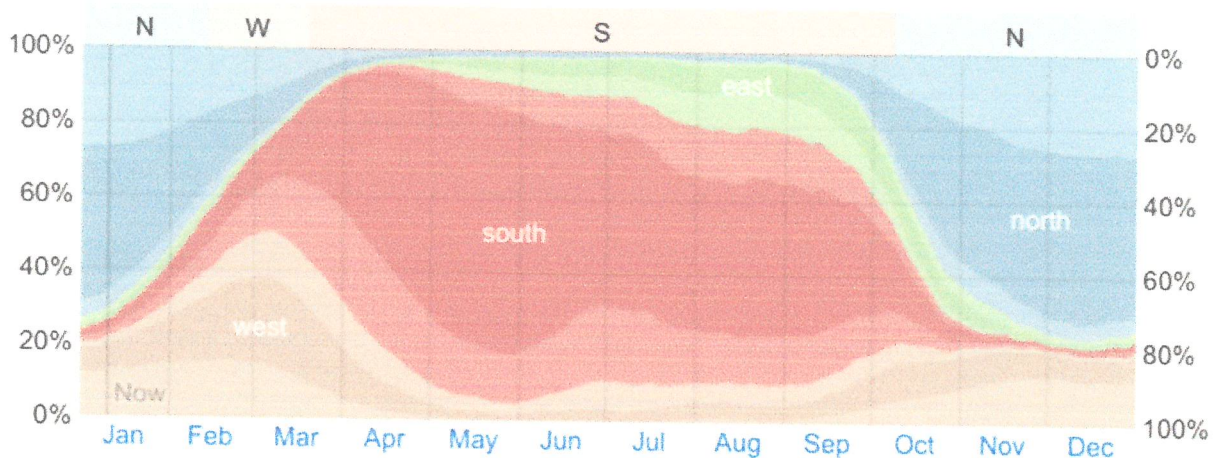
The wind is most often from the *west* for 1.2 months, from February 13 to March 19, with a peak percentage of 51% on March 5. The wind is most often from the *south* for 6.6 months, from March 19 to October 8, with a peak percentage of 87% on May 24. The wind





is most often from the *north* for 4.2 months, from *October 8* to *February 13*, with a peak percentage of 73% on *January 1*.

7.4. Wind Direction:



The percentage of hours in which the mean wind direction is from each of the four cardinal wind directions, excluding hours in which the mean wind speed is less than 1.0 mph. The lightly tinted areas at the boundaries are the percentage of hours spent in the implied intermediate directions (northeast, southeast, southwest, and northwest).

8. FINDINGS:

Being coal complex all the campus exist different type of permanent structure as illustrated in site photographs reported under para 10, however major features are as under:

- 8.1. The complex is covered with boundary wall with fencing at the top. The height of boundary wall varies from 2.1 to 2.5m height.
- 8.2. There were lot of trees find at the sites and major part covered with wild vegetation.
- 8.3. All the existing structures are well connected with internal road.
- 8.4. There are rail tracks connected with Anai road rail yard, which might be used for transportation of coal to the plant site.
- 8.5. Since the coal based plant, the thin layer of coal dust noticed at the top surface ground of entire campus.

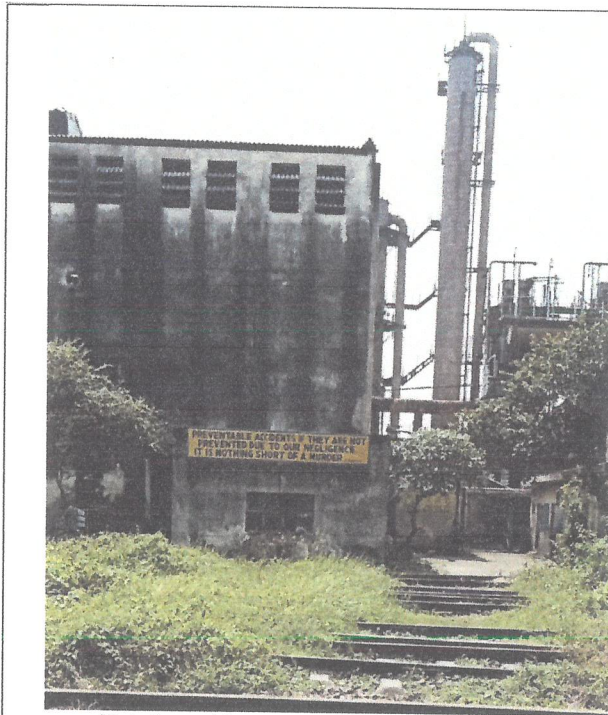




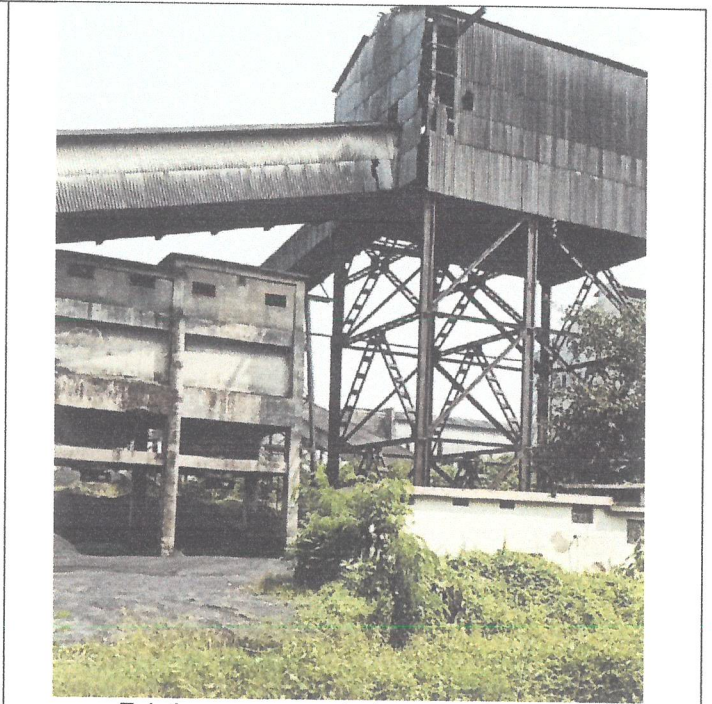
TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX

- 8.6. There are several heap of coal having varying height of 2.5m to 4.5m from elevated ground level.
- 8.7. The terrain of campus is almost flat however undulation of aprox. 2m.
- 8.8. There is a water body that may be a part of plant, having water up to the depth of aprox. 2.5m.


9. SITE PHOTOGRAPHS:

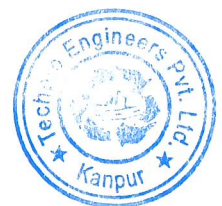


Existing chimney at plant complex area.



Existing conveyor at plant complex area


Sushil Tripathi
Sr. Engineer
Techpro Engineers Pvt. Ltd.





TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT
DANKUNI COAL COMPLEX



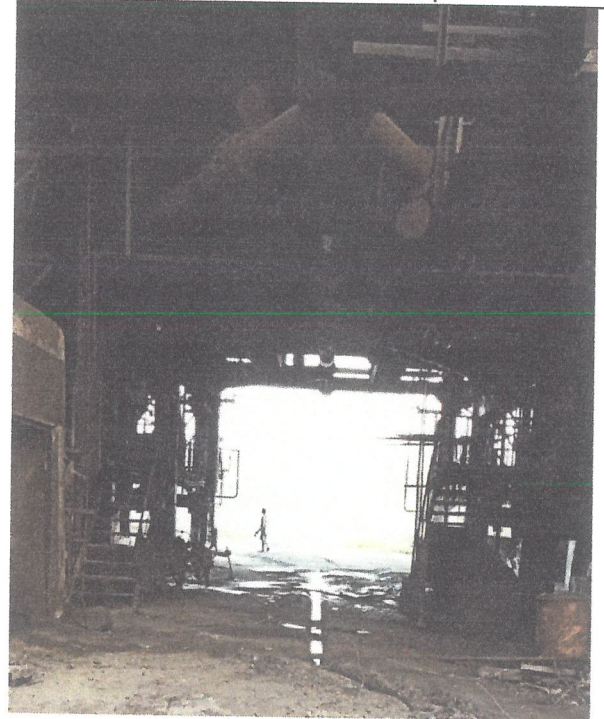
Grid pillar established near Coal heap



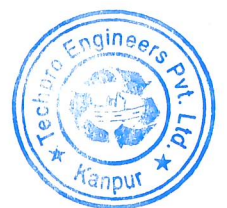
Control building inside the complex area



Internal road at the complex area



Main plan at complex area

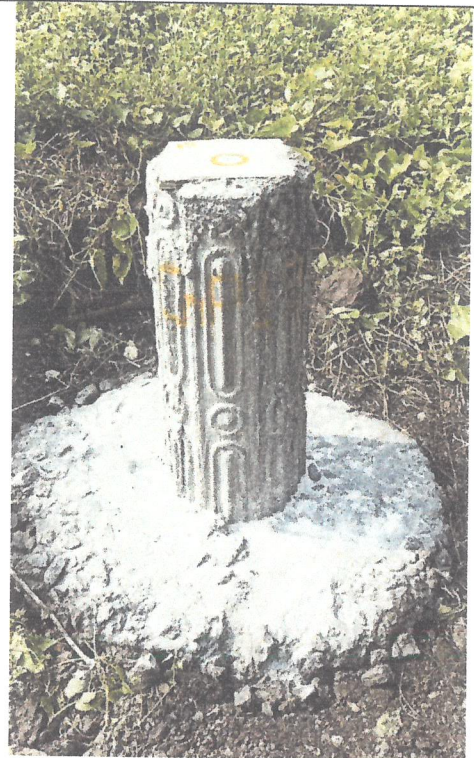




TOPOGRAPHICAL & CONTOUR SURVEY WORKFOR PROPOSED COAL TO METHANOL PROJECT AT
DANKUNI COAL COMPLEX



Permanent bench mark constructed at complex area



Grid pillars constructed at complex area



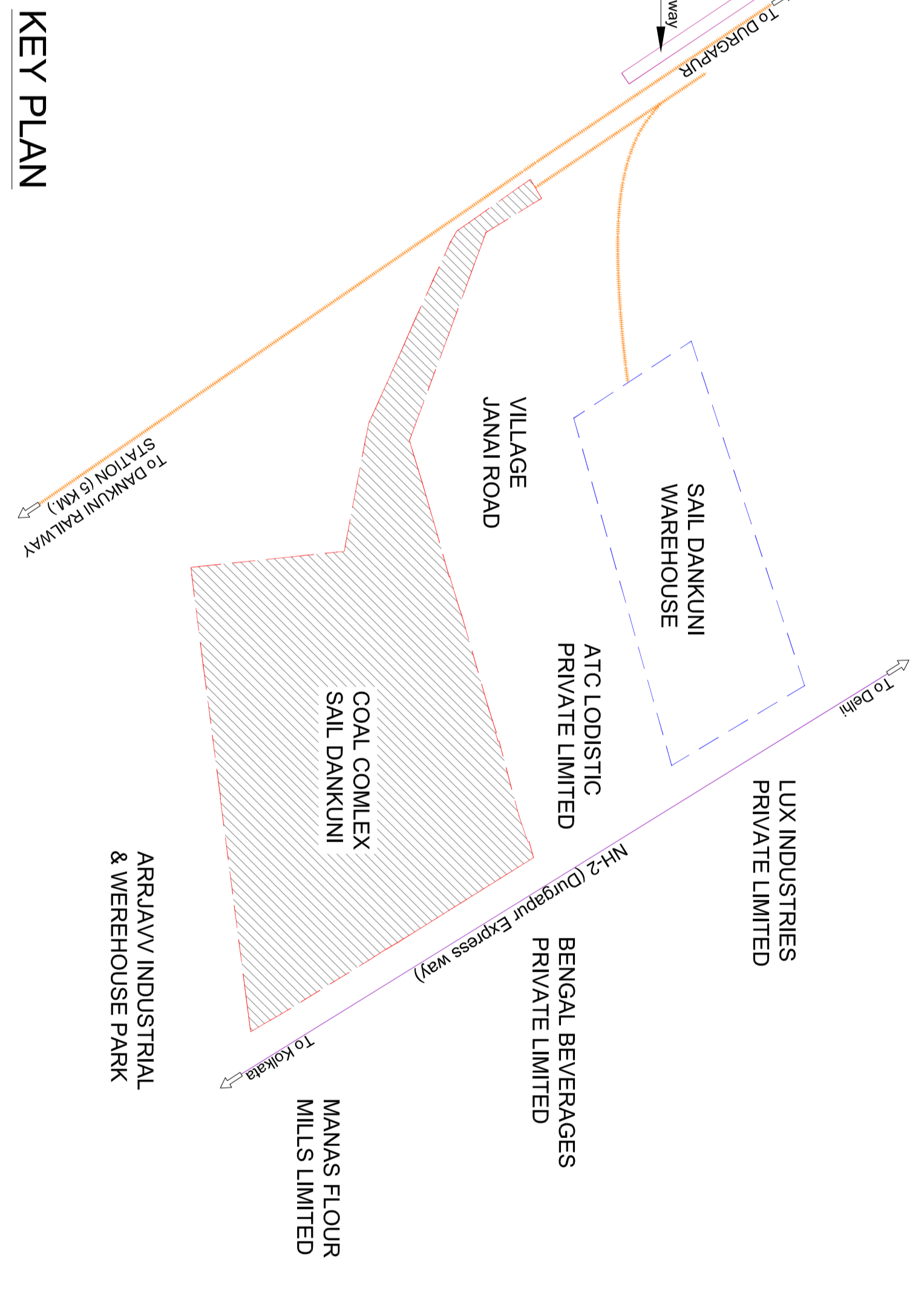
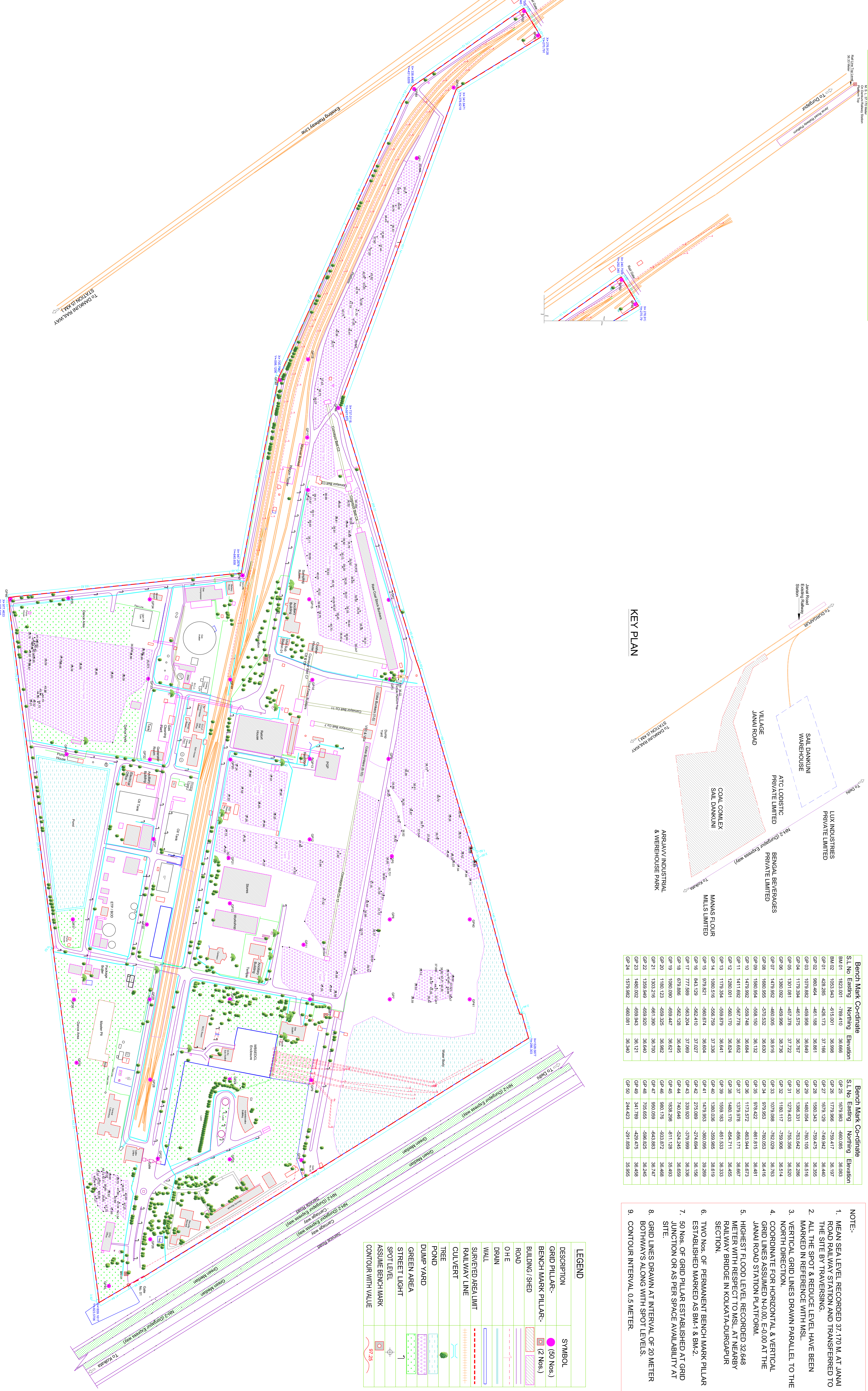
Cooling tower at complex area



Existing vegetation at complex area

END OF DOCUMENT





Bench Mark Co-ordinate		
BM No	Easting	Nothing Elevation
BM 01	1823.001	-789.410
BM 02	1823.343	-613.001
GP 01	428.265	-426.173
GP 02	960.464	-461.188
GP 03	1079.822	-459.958
GP 04	1179.394	-461.575
GP 05	1301.081	-457.378
GP 06	1380.922	-459.986
GP 07	1479.522	-480.005
GP 08	1680.955	-570.532
GP 09	1580.324	-550.150
GP 10	1479.922	-559.748
GP 11	1411.622	-550.778
GP 12	1280.001	-560.170
GP 13	1179.324	-559.879
GP 14	1080.516	-556.279
GP 15	979.821	-560.674
GP 16	843.129	-562.410
GP 17	777.289	-562.204
GP 18	679.268	-562.128
GP 19	1080.090	-459.447
GP 20	1180.123	-459.325
GP 21	1303.218	-461.390
GP 22	1359.949	-459.920
GP 23	1480.002	-459.943
GP 24	1579.982	-460.081

Bench Mark Co-ordinate		
GP No	Easting	Nothing Elevation
GP 25	1879.933	-460.065
GP 26	1779.966	-759.417
GP 27	1679.129	-749.472
GP 28	1680.343	-759.475
GP 29	1480.054	-760.105
GP 30	1386.331	-763.842
GP 31	1279.433	-765.565
GP 32	1180.117	-769.906
GP 33	1079.088	-762.029
GP 34	979.953	-760.653
GP 35	978.422	-461.815
GP 36	1179.972	-463.844
GP 37	1379.978	-464.711
GP 38	1480.170	-464.711
GP 39	1659.183	-461.533
GP 40	1800.038	-369.885
GP 41	1479.953	-369.095
GP 42	275.039	-274.824
GP 43	339.920	-379.899
GP 44	740.046	-524.245
GP 45	1838.298	-411.728
GP 46	900.176	-453.872
GP 47	990.059	-443.883
GP 48	705.655	-458.825
GP 49	341.299	-459.475
GP 50	244.423	-291.859

- NOTE:-
- MEAN SEA LEVEL RECORDED 37.170M AT JANAKI ROAD RAILWAY STATION AND TRANSFERRED TO THE SITE BY TRAVERSING.
 - ALL THE SPOT & REDUCE LEVEL HAVE BEEN MARKED IN REFERENCE WITH MSL.
 - VERTICAL GRID LINES DRAWN PARALLEL TO THE NORTH DIRECTION.
 - COORDINATE FOR HORIZONTAL & VERTICAL GRID LINES ASSUMED N=0.00, E=0.00 AT THE JANAKI ROAD STATION PLATFORM.
 - HIGHEST FLOOD LEVEL RECORDED 32.648 METER WITH RESPECT TO MSL, AT NEARBY RAILWAY BRIDGE IN KOLKATA-DURGAPUR SECTION.
 - TWO NOS. OF PERMANENT BENCH MARK PILLAR ESTABLISHED MARKED AS BM-1 & BM-2.
 - 50 NOS. OF GRID PILLAR ESTABLISHED AT GRID JUNCTION OR AS PER SPACE AVAILABILITY AT SITE.
 - GRID LINES DRAWN AT INTERVAL OF 20 METER BOTHWAYS ALONG WITH SPOT LEVELS.
 - CONTOUR INTERVAL 0.5 METER.

DESCRIPTION	SYMBOL
GRID PILLAR-- (50 Nos.)	●
BENCH MARK PILLAR-- (2 Nos.)	⊕
BUILDING / SHED	▭
ROAD	—
O H E	—
DRAIN	—
WALL	—
SURVEYED AREA LIMIT	—
RAILWAY LINE	—
CULVERT	—
TREE	🌳
POND	—
DUMP YARD	—
GREEN AREA	—
STREET LIGHT	—
SPOT LEVEL	1
ASSUME BENCH MARK CONTOUR WITH VALUE	97.25

DRG. TITLE: TOPOGRAPHICAL SURVEY PLAN OF DANKUNI COAL COMPLEX, W.B.

PROJECT: COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX.

CLIENT: PROJECTS & DEVELOPMENT INDIA LIMITED, NOIDA.

PRINCIPAL EMPLOYER:- Coal India Limited
 A Government of India Undertaking
 Coal India Limited
 A Maharatna Company

PROJECT CONSULTANT:- T E C H P R O ENGINEERS PVT. LIMITED
 103, Ratan Dharm,
 12/483M Roberts Ganj
 KANPUR-208001
 Ph. : 0512-2525759, 9793209918
 www.techproindia.com/info@techproindia.com

REVISIONS:

Rev. No.	REVISION	DATE
R1	CONTOUR & SPOT LEVEL, PERMANENT BENCH MARK & GRID PILLAR ADDED	27/11/19

PROPERTY: SHEET NO: 1 / 2
 SURVEYER: OM PRAKASH PAL
 SCALE: 1:1500
 DGN BY: GAURAV SHUKLA
 AREA: 464296.10 Sq.m.
 DATE: 23/10/2019

APPROVED BY: E:- SUSHIL TRIPATHI
 E:- ARVIND KUMAR GARG (M.TECH.)

**Report on
Geotechnical Investigation Work
for
Proposed Coal to Methanol Project
at
Dankuni Coal Complex, Dankuni (WB)**

**Principal Client
Coal India Limited**

**Client
Projects & Development India Limited
PDIL Bhawan, A-14, Sector-1, Noida – 201 301
Distt: Gautam Budh Nagar, (UP), India**

***Geotechnical Consultant
Centre for Advanced Engineering.
59/2, Bangur Avenue, Block-C, Kolkata-700 055
PH. No. : 033-2574 2130, email: cae.india2@gmail.com***

Report on
Geotechnical Investigation Work
for
Proposed Coal to Methanol Project
at
Dankuni Coal Complex, Dankuni (WB)

Principal Client: Coal India Limited
Client: Projects & Development India Limited

A. ✎ Introduction:

It has been proposed by Coal India Limited, to construct Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB). A detailed geotechnical investigation was needed for this purpose and Coal India Limited has appointed M/s Project & Development India Limited (PDIL), PDIL Bhawan, A-14, Sector-1, Noida – 201 301, Gautam Budh Nagar, UP for consultancy, Design & Engineering and site supervision services. M/s PDIL has entrusted M/s Centre for Advanced Engineering of 59/2, Bangur Avenue, Block-C, Kolkata – 700055, possessing their own **ISO/IEC 17025:2017** accredited laboratory by **NABL** as Geotechnical Consultant for carrying out Geotechnical Investigation and to provide recommendation for foundation system.

Location:

The proposed site is located at **Dankuni Coal Complex, West Bengal.**

B 📖 Scope of Investigation:

B1. Field Investigation:

Scope of field investigation work was indicated by **Projects & Development India Limited** vide P.O. No. : **11/PNMM/P/4804/2019-20/4030000304**, Dated: **20.09.2019**. It consists of sinking of fourteen (14) boreholes, two (2) Plate Load Test, two (2) Cyclic Plate Load Test, eleven (11) Electrical Resistivity Test and three (3) Static Cone Penetration Test.

B2. Laboratory Test:

Scope of laboratory test consists of determination of Natural Moisture Content, Bulk & Dry Density, Specific Gravity & Void Ratio, Liquid Limit & Plastic Limit, Grain Size Analysis (Sieve & Hydrometer), Unconfined Compression Test, Direct Shear Test, Triaxial Shear Test – (UU,

CU,CD), Consolidation Test, Swelling Pressure Test, Shrinkage Limit Test, Modified Proctor Density Test, Chemical Test on Soil Sample and Chemical Test on Water Sample.

B3. Recommendation of Foundation System:

Scope of work consists of analysis of soil characteristics based on result obtained from field exploration and laboratory test, recommendation of suitable foundation system.

C. Description of Subsoil:

The location of boreholes is shown in the enclosed sketch no: **PC176-0000-0201**. The bore-log indicates the sub-soil condition as encountered during field investigation considering laboratory test results on disturbed and undisturbed soil samples as well as soil samples obtained from split spoon of the Standard Penetration Test (SPT) apparatus. The SPT values (N Values) are indicated in the corresponding bore-log.

Sub- soil profile of the site

The entire area is divided into 13 zones as follows:-

1. Zone 1 – Air Separation Unit. (BH-8 & ERT-8)
2. Zone 2 – CMD & Gassifier Unit. (BH-4, BH-9, BH-11, CPLT-1, ERT-7, ERT-9 & SCPT-3)
3. Zone 3 – Gas Cleaning & Purification. (BH-7, CPLT-2, ERT-6 & SCPT-2)
4. Zone 4 – Methanol Synthesis. (BH-10 & ERT-4)
5. Zone 5 – Cooling Tower. (ERT-5)
6. Zone 6 – Boiler Unit. (BH-2, BH-3, SCPT-1, ERT-2)
7. Zone 7 – DM Plant & Storage. (BH-6, PLT-1 & ERT-3)
8. Zone 8 – Coal Storage Area including Crusher. (BH-1 & ERT-1)
9. Zone 9 – Methanol Storage Tank. (BH-5)
10. Zone 10 – ETP. (BH-13 & ERT-11)
11. Zone 11 – Work Shop. (PLT-2)
12. Zone 12 – Ware House. (BH-14)
13. Zone 13 – Canteen. (BH-12 & ERT-10)

D. Field Investigation:

D1. Boring:

The exploratory boreholes were sunk using shell and auger/wash boring method. Casing was used up to a depth of 3.000 metres to protect the sides of boreholes against collapse. The

boring was conducted as per the guidelines and provisions of IS: 1892. Standard Penetration Test was conducted in the boreholes at all the strata encountered. Undisturbed soil samples were collected from the boreholes. Disturbed samples were collected from the split spoon sampler at all the test depths and test location of Standard Penetration Test and from different typical strata.

The termination depth of the borehole and depth of water table as observed in the boreholes are indicated below:

Table 1

Bore Hole No.	Termination Depth below EGL (Mtr)	Depth of Water Table Below EGL (Mtr.) Explored during the period October to December 2019.
BH-1	35.000	2.100
BH-2	35.000	2.340
BH-3	35.000	2.250
BH-4	35.000	5.140
BH-5	35.000	2.150
BH-6	35.000	0.200
BH-7	30.000	3.150
BH-8	39.000	6.280
BH-9	39.000	6.450
BH-10	35.000	0.850
BH-11	30.000	2.340
BH-12	35.000	0.840
BH-13	35.000	1.000
BH-14	30.000	2.450

D.2. Sampling:

D.2.1 Undisturbed Sampling:

The collection of undisturbed soil sample was done, wherever possible depending on existing soil strata, as per the guidelines of IS: 1892 – Code of Practice for site Investigation for Foundation. The sampling system used was an assembly of sampling tube of 100 mm diameter and 450 mm long, connected with a jarring link. The specification of the tube is as per the provision of IS: 2132, Code of practice for thin walled sampling of soils.

After the samples are collected within the tubes, the tubes are taken out of the borehole. Both the ends of the tube were properly sealed with wax, properly labeled depth-wise and borehole-wise, capped and thus made ready for onward transmission for testing the soil samples in the laboratory.

D.2.2 Disturbed Sampling:

Disturbed samples were collected from cutting shoe and split spoon of the SPT sampler. These samples were collected in polythene bags, properly labeled depth-wise and borehole-wise and were used in the preparation of bore log as well as for general identification & classification purpose of soil as per IS: 1498. The same were then packed and sent to the laboratory for further test.

D3. Standard Penetration Test:

Standard Penetration Test was conducted as per the guidelines and provisions of IS: 2131- Method for standard penetration test for soil, in the borehole at regular intervals or at change of strata with the SPT sampler. In this test, the sampler was driven by falling a weight of 63.5 Kg hammer through a height of 750 mm. The sampler was driven through a depth of 450mm. The number of blows for every 150mm. of penetration was recorded. The first 150 mm. was taken as seating drive, the number of blows for subsequent 300 mm. is the **SPT N-value**. The observed N-values are indicated in the corresponding bore log.

D4. Recording of Ground Water Table:

The field exploration was carried out during the month of October and December 2019.

The recorded ground water table is indicated in Table 1 of the report.

Laboratory Testing:

Laboratory tests were conducted on the soil samples collected from the boreholes. The tests were conducted as per provisions and guidelines of Bureau of Indian Standard laid down in their different codes and as per requirements of the client.

All disturbed and undisturbed samples were opened up in the laboratory for further identification & classification of soil samples. Various tests were conducted for ascertaining the following engineering and physical properties of the sub-soil:

 Natural Moisture Content

- ☞ Bulk & Dry Density
- ☞ Specific Gravity & Void Ratio.
- ☞ Liquid Limit & Plastic Limit.
- ☞ Grain Size Analysis (Sieve & Hydrometer)
- ☞ Unconfined Compressive Strength.
- ☞ Direct Shear Test
- ☞ Tri-axial Shear Strength (UU, CU & CD.)
- ☞ Consolidation Properties.
- ☞ Swelling Pressure.
- ☞ Shrinkage Limit.
- ☞ Modified Proctor Density Test.
- ☞ Chemical Test on Soil Sample.
- ☞ Chemical Test of Water Sample.

F. Discussion and Recommendation:-

F1. Foundation system:

In general the top soil is heterogeneous fill with coal dust, sand, silt, clay, brickbats, stone chips etc, thus this layer is not suitable for resting shallow foundation. However, shallow foundation of light to medium pressure intensity is proposed to rest in this layer by sand replacement and the same is recommended in Table – 3. At the location of Zone-2 CMD & Gassifier Unit the shallow foundation is not suggested with sand replacement technique since the thickness of heterogeneous fill is about 5.00Mtr.

F2. Ground Development:

In case any special requirement arises, ground improvement may be resorted to depending on the proposed type of structure/ loading on ground. For foundation imparting medium pressure on the sub-soil, sand replacement has been proposed. Sand replacement may be adopted for subsoil having recorded N-value range of 0 to 4. For this, foundation is proposed at a depth of 1.50Mtr below EGL, and soil underneath the foundation is proposed to be replaced by sand for a thickness of 1.50Mtr below the foundation. The sand shall be

compacted for minimum relative density of 85%. The bearing capacities of improved soil thus obtain is indicated below:

Table-3

Footing Size (m)	Estimated Settlement (mm)	Allowable Bearing Capacity (t/m ²)
<u>Square</u>		
2.00 X 2.00	31.71	12.25
2.50 X 2.50	52.42	10.24
3.00 X 3.00	77.24	9.00
<u>Rectangular</u>		
3.00 X 2.00	38.45	10.50
3.75 X 2.50	65.76	8.96
4.50 X 3.00	90.24	8.00
<u>Strip</u>		
1.50	43.56	6.00
2.00	68.73	5.25
2.50	99.21	4.80

F3. Pile Foundation:

Bored Cast-in-situ Pile foundations have been recommended for structures with heavy load on foundations. Recommended pile capacities have been indicated for different zones in their corresponding chapters.

Chemical tests were performed on a few soil samples and water samples for determining the pH value, Sulphate & Chloride content. It is seen that the values are on a safe side and so no precaution will be required for foundation concrete. Either **Ordinary Portland cement** or **Portland slag cement** or **Portland Pozzolana cement** can be used for the purpose.



S.NO.	REFERENCE Dwg.	DRAWING NO.
1.	LAYOUT PLAN OF DANKUNI COAL COMPLEX SHOWING AREAS AVAILABLE FOR NEW INDUSTRIAL DEVELOPMENT	REGD/1002/11/2017/01

S.NO.	NEW FACILITIES DESCRIPTION	DIMENSION
I	AGE STORAGE UNIT	15M x 6M
II	DM & CRUSHER UNIT	200M x 100M
III	DM CLEANING & PNEUMATION	200M x 60M
IV	METHANOL SYNTHESIS	15M x 60M
V	WATER TOWER	15M x 15M
VI	WATER TOWER	15M x 15M
VII	DM PLANT & STORAGE	10M x 6M
VIII	COAL STORAGE AREA INCLUDING CRUSHER	10M x 70M
IX	METHANOL STORAGE TANK	10M x 70M
X	WORKSHOP	5M x 30M
XI	WARE HOUSE	5M x 30M
XII	ASH/SLAG POND	1000 SQ (APPROX)
XIII	CANTEN	5M x 20M
XIV	WATER TOWER	5M x 20M
XV	WATER RESERVOIR (EXISTING TO BE MODIFIED)	1000 SQ (APPROX)

S.NO.	EXISTING FACILITIES DESCRIPTION	DIMENSION
1	ADMINISTRATION BUILDING	---
2	INDUSTRY BUILDING (L 1 AND B)	---
3	WORKSHOP	---
4	CANTEN	---
5	CENTRAL LABORATORY	---
6	FIRE STATION	---
7	PRODUCER GAS PLANT	---
8	REPORT HOUSE	---
9	GAS CLEANING PLANT	---
10	GAS HOLDER	---
11	LIGHT OIL TANKS	---
12	DM DISTILLATION PLANT	---
13	DM PLANT	---
14	DM WASHING STATION	---
15	DM WASHING STATION	---
16	DM WASHING STATION	---
17	DM WASHING STATION	---
18	DM WASHING STATION	---
19	DM WASHING STATION	---
20	DM WASHING STATION	---
21	DM WASHING STATION	---
22	DM WASHING STATION	---

NOTES:
 1) ALL DIMENSIONS ARE IN MM UNLESS INDICATED OTHERWISE.



PROJECT: M/S COAL INDIA LTD.
 COAL TO METHANOL PROJECT AT DANKUNI COAL COMPLEX
 OVERALL LAYOUT PLAN FOR GEO-TECHNICAL INVESTIGATION WORK AT DANKUNI, WEST BENGAL, INDIA.
 PROJECTS & DEVELOPMENT INDIA LTD. Noida

Sl. No.	Area (Sq. Meters)	Description
A	11,62,000	Area available for development of CL, Coke and Gas
B	2,97,50,000	Area available for development of CL, Coke and Gas
C	14,37,70,000	Area available for development of CL, Coke and Gas
D	1,85,00,000	Area available for development of CL, Coke and Gas
E	1,27,00,000	Area available for development of CL, Coke and Gas
F	36,58,000	Area available for development of CL, Coke and Gas
G	22,22,000	Area available for development of CL, Coke and Gas
H	1,29,71,000	Area available for development of CL, Coke and Gas
I	12,95,000	Area available for development of CL, Coke and Gas
J	2,05,47,000	Area available for development of CL, Coke and Gas
TOTAL	1,85,00,000	

SCHEDULE OF FREE LAND AVAILABLE TO SET UP NEW TECHNOLOGY AFTER EVACUATION OF COAL / COKE PRODUCTS

Sl. No.	Area (Sq. Meters)	Description	Notes (if any)
A	11,62,000	Area available for development of CL, Coke and Gas	
B	2,97,50,000	Area available for development of CL, Coke and Gas	
C	14,37,70,000	Area available for development of CL, Coke and Gas	
D	1,85,00,000	Area available for development of CL, Coke and Gas	
E	1,27,00,000	Area available for development of CL, Coke and Gas	
F	36,58,000	Area available for development of CL, Coke and Gas	
G	22,22,000	Area available for development of CL, Coke and Gas	
H	1,29,71,000	Area available for development of CL, Coke and Gas	
I	12,95,000	Area available for development of CL, Coke and Gas	
J	2,05,47,000	Area available for development of CL, Coke and Gas	
TOTAL	1,85,00,000		

NOTES (if any):
 1) Borehole shall be after disposal of CL, Coke and Gas.
 2) Scepter shall be available as conveyor system, not working after disposal of CL, Coke and Gas.
 3) P-LT shall be available after disposal of CL, Coke and Gas.
 4) CRT shall be available after disposal of CL, Coke and Gas.
 5) ERT shall be available after disposal of CL, Coke and Gas.
 6) Area shall be available after disposal of CL, Coke and Gas.
 7) Area shall be available after disposal of CL, Coke and Gas.
 8) Area shall be available after disposal of CL, Coke and Gas.
 9) Area shall be available after disposal of CL, Coke and Gas.
 10) Area shall be available after disposal of CL, Coke and Gas.
 11) Area shall be available after disposal of CL, Coke and Gas.
 12) Area shall be available after disposal of CL, Coke and Gas.
 13) Area shall be available after disposal of CL, Coke and Gas.
 14) Area shall be available after disposal of CL, Coke and Gas.
 15) Area shall be available after disposal of CL, Coke and Gas.
 16) Area shall be available after disposal of CL, Coke and Gas.
 17) Area shall be available after disposal of CL, Coke and Gas.
 18) Area shall be available after disposal of CL, Coke and Gas.
 19) Area shall be available after disposal of CL, Coke and Gas.
 20) Area shall be available after disposal of CL, Coke and Gas.
 21) Area shall be available after disposal of CL, Coke and Gas.
 22) Area shall be available after disposal of CL, Coke and Gas.
 23) Area shall be available after disposal of CL, Coke and Gas.
 24) Area shall be available after disposal of CL, Coke and Gas.
 25) Area shall be available after disposal of CL, Coke and Gas.
 26) Area shall be available after disposal of CL, Coke and Gas.
 27) Area shall be available after disposal of CL, Coke and Gas.
 28) Area shall be available after disposal of CL, Coke and Gas.
 29) Area shall be available after disposal of CL, Coke and Gas.
 30) Area shall be available after disposal of CL, Coke and Gas.

ZONE-1

**AIR SEPARATION
UNIT**

One (1) borehole was sunk in this area, viz borehole marked BH-8. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with coal dust etc followed by first layer of soft brownish grey silty clay/ clayey silt. The second layer is soft dark grey silty clay/ clayey silt. The third layer is medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt and the fourth layer as encountered up to the explored depth is very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt.

Discussion and Recommendation:

Based on the sub-soil condition, pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-1). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-1).
Recommended Pile Capacity

Sl.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	30.000	2.000	50	46	2.49
2	0.500	30.000	2.000	64	57	2.72
3	0.550	30.000	2.000	72	63	2.82
4	0.600	30.000	2.000	79	69	2.92
5	0.750	30.000	2.000	103	86	3.19
6	1.000	30.000	2.000	144	115	3.59

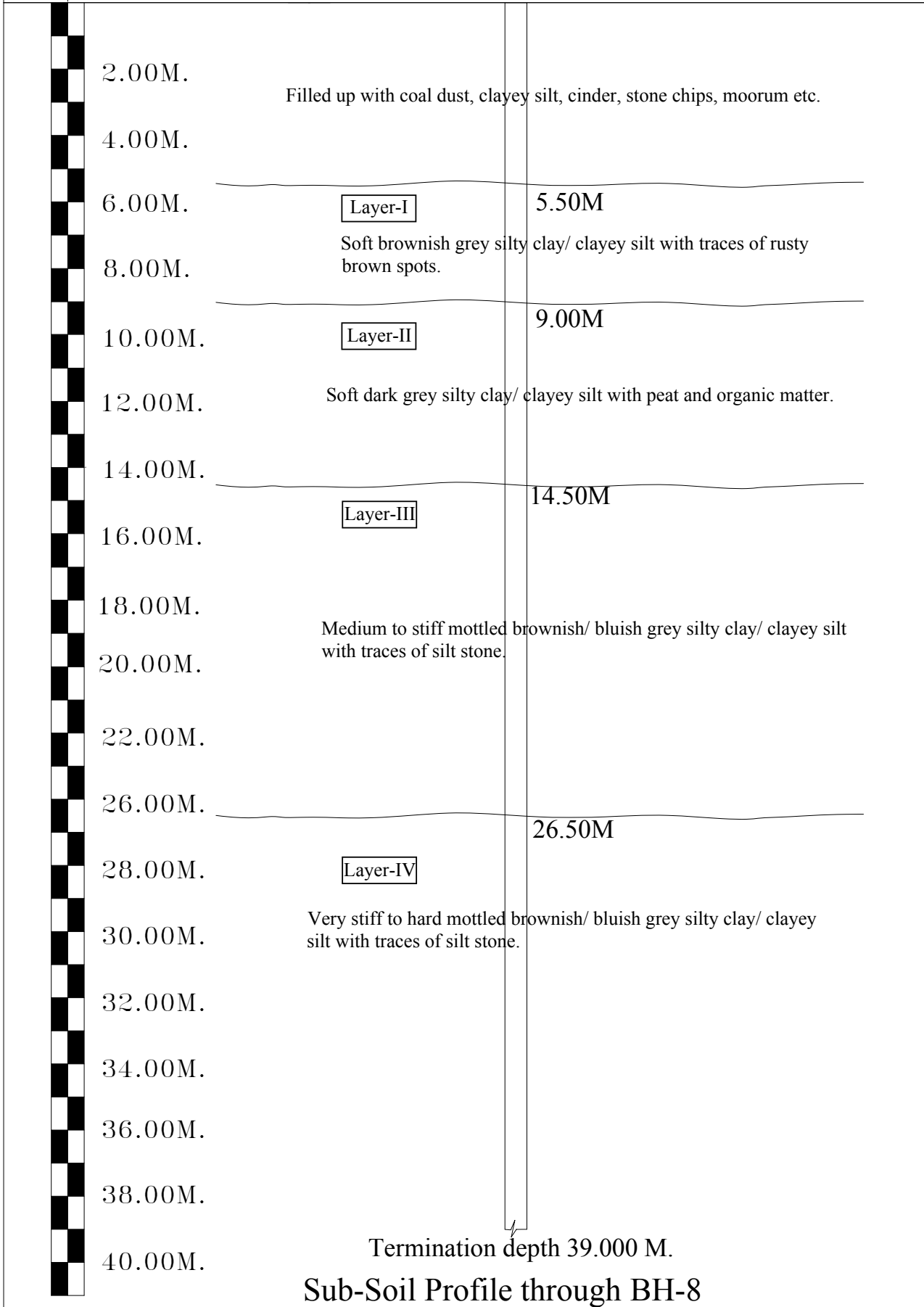
BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-8 (Sheet-1)	
Project: SOIL PDIL DANKUNI AIR SEPARATION UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 34.576		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	39.000 M.	SPT	18	UDS	8	WS	
Type of Drilling		DCPT		DS	20	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 22.11.2019	
						Completed on : 24.11.2019	
						Water Struck At : 6.25 M.	
						Standing Water Table : 6.20 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Filled up with coal dust, clayey silt, cinder, stone chips, moorum etc.		01	N = 9	DS1	0.50 M		
				DS2	1.00 M		
		02		SPT1	1.50-1.95M		
				DS3	1.50-1.95M		
		03	N = 13	SPT2	3.00-3.45M		
				DS4	3.00-3.45M		
		04	N = 12	SPT3	4.50-4.95M		
				DS5	4.50-4.95M		
	Soft brownish grey silty clay/ clayey silt with traces of rusty brown spots.		06	N = 2	SPT4	5.50-5.95M	
					DS6	5.50-5.95M	
			08	N = 2	SPT5	7.50-7.95M	
					DS7	7.50-7.95M	
		UDS1	8.00-8.45M				
Soft dark grey silty clay/ clayey silt with peat and organic matter.		09	N = 2	SPT6	9.00-9.45M		
				DS8	9.00-9.45M		
		11	N = 2	SPT7	10.50-10.95M		
				DS9	10.50-10.95M		
			UDS2	11.00-11.45M			
		13	N = 2	SPT8	12.50-12.95M		
		DS10		12.50-12.95M			
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of silt stone.		14	N = 7	UDS3	14.00-14.45M		
				SPT9	14.50-14.95M		
		15	N = 9	DS11	14.50-14.95M		
				SPT10	16.50-16.95M		
		17	N = 9	DS12	16.50-16.95M		
				UDS4	17.00-17.45M		
		18	N = 9	SPT11	18.50-18.95M		
		DS13		18.50-18.95M			
Contd.....							
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample		WS - Water Sample	
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.		RCS - Rock Core Sample	

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-8 (Sheet-2)	
Project: SOIL PDIL DANKUNI AIR SEPARATION UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 34.576		Unit:		Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	39.000 M.	SPT	18	UDS	8	WS	
Type of Drilling		DCPT		DS	20	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 22.11.2019	
						Completed on : 24.11.2019	
						Water Struck At : 6.25 M.	
						Standing Water Table : 6.20 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of silt stone.		21	N = 12	UDS5	20.00-20.45M		
		22		SPT12	20.50-20.95M		
		23		DS14	20.50-20.95M		
Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of silt stone.		24	N = 14	UDS6	23.00-23.45M		
		25		SPT13	23.50-23.95M		
		26		DS15	23.50-23.95M		
		27	N = 25	UDS7	26.00-26.45M		
		28		SPT14	26.50-26.95M		
		29		DS16	26.50-26.95M		
Termination Depth 39.000 Mtr.		30	N = 27	UDS8	29.00-29.45M		
		31		SPT15	29.50-29.95M		
		32	N = 30	DS17	29.50-29.95M		
		33		SPT16	32.50-32.95M		
		34	N = 34	DS18	32.50-32.95M		
		35		SPT17	35.50-35.95M		
	36	N = 41	DS19	35.50-35.95M			
	37		SPT18	38.55-39.00M			
		38	N = 41	DS20	38.55-39.00M		
		39					

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

RL=34.576

BH-8



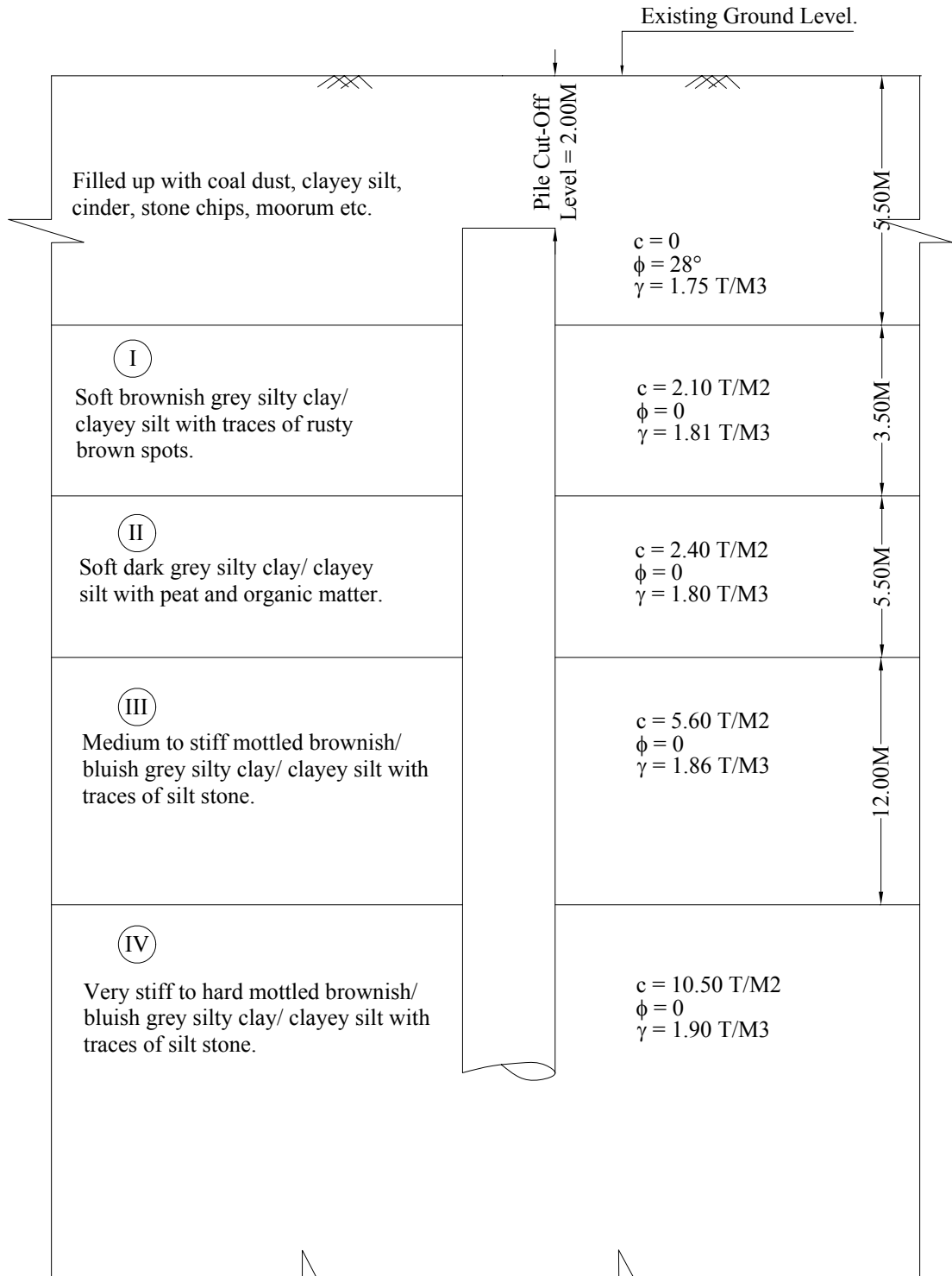
Sub-Soil Profile through BH-8

SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/UC/DS	C	φ								
I	Soft brownish grey silty clay/ clayey silt with traces of rusty brown spots.	8	5.50	DN	2	48	21	11.6			2.67								9.85	0	9	66	25	
		8	8.00	UD	50	20	12.3	1.81	33.64	2.66	1.35	0.38	UU	0.21	0	0.00-0.10	0.0343	0	10.5	0	10	62	28	
																0.10-0.20	0.0383							
													CU	0.06	11	0.20-0.40	0.0452							
																0.40-0.80	0.0261							
CD	0	17	0.80-1.60	0.0184																				
			1.60-3.20	0.0149																				
II	Soft dark grey silty clay/ clayey silt with peat and organic matter.	8	10.50	DN	2	58	22	16.5			2.58								13.4	0	11	69	20	
		8	11.00	UD	55	21	15.7	1.80	37.49	2.61	1.31	0.46	UU	0.24	0	0.00-0.10	0.0334	0	12.78	0	9	61	30	
																0.10-0.20	0.0392							
													CU	0.04	12	0.20-0.40	0.0463							
																0.40-0.80	0.0277							
CD	0	18	0.80-1.60	0.0191																				
			1.60-3.20	0.0167																				
III	Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of silt stone.	8	16.50	DN	9	49	20	10.8			2.67								14.4	2	12	59	27	
		8	17.00	UD	51	21	12.6	1.86	31.19	2.66	1.42	1.09	UU	0.56	0	0.00-0.10	0.0328	0	16.6	3	11	58	28	
																0.10-0.20	0.0357							
													CU	0.11	19	0.20-0.40	0.0409							
																0.40-0.80	0.0238							
CD	0	26	0.80-1.60	0.0172																				
			1.60-3.20	0.0138																				
IV	Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of silt stone.	8	26.50	DN	25	53	20	14.1			2.67								20.2	1	10	60	29	
		8	32.50	DN	30	50	20	13.8			2.66								18.3	3	14	57	26	



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/	AIR SEPARATION UNIT	1638	03
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Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Layer No: Fill

Soil Description : Filled up with coal dust, clayey silt, cinder, stone chips, moorum etc.

Sl.No	Pile Dia, D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	30.000	2.000	5.500	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	4.125	2.501	1.705	4.398	-7.499
2	0.500	30.000	2.000	5.500	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	4.125	2.501	1.705	5.498	-9.373
3	0.550	30.000	2.000	5.500	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	4.125	2.501	1.705	6.048	-10.311
4	0.600	30.000	2.000	5.500	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	4.125	2.501	1.705	6.597	-11.248
5	0.750	30.000	2.000	5.500	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	4.125	2.501	1.705	8.247	-14.060
6	1.000	30.000	2.000	5.500	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	4.125	2.501	1.705	10.996	-18.747

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft brownish grey silty clay/ clayey silt with traces of rusty brown spots.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = α*C*A_s
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	5.500	9.000	1	2.1	4.398	9.236
2	0.500	30.000	5.500	9.000	1	2.1	5.498	11.545
3	0.550	30.000	5.500	9.000	1	2.1	6.048	12.700
4	0.600	30.000	5.500	9.000	1	2.1	6.597	13.854
5	0.750	30.000	5.500	9.000	1	2.1	8.247	17.318
6	1.000	30.000	5.500	9.000	1	2.1	10.996	23.091

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description Soft dark grey silty clay/ clayey silt with peat and organic matter.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	9.000	14.500	1	2.4	6.912	16.588
2	0.500	30.000	9.000	14.500	1	2.4	8.639	20.735
3	0.550	30.000	9.000	14.500	1	2.4	9.503	22.808
4	0.600	30.000	9.000	14.500	1	2.4	10.367	24.881
5	0.750	30.000	9.000	14.500	1	2.4	12.959	31.102
6	1.000	30.000	9.000	14.500	1	2.4	17.279	41.469

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	14.500	26.500	0.9	5.6	15.080	76.001
2	0.500	30.000	14.500	26.500	0.9	5.6	18.850	95.002
3	0.550	30.000	14.500	26.500	0.9	5.6	20.735	104.502
4	0.600	30.000	14.500	26.500	0.9	5.6	22.619	114.002
5	0.750	30.000	14.500	26.500	0.9	5.6	28.274	142.503
6	1.000	30.000	14.500	26.500	0.9	5.6	37.699	190.004

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	26.500	30.000	0.45	10.5	4.398	20.782
2	0.500	30.000	26.500	30.000	0.45	10.5	5.498	25.977
3	0.550	30.000	26.500	30.000	0.45	10.5	6.048	28.575
4	0.600	30.000	26.500	30.000	0.45	10.5	6.597	31.172
5	0.750	30.000	26.500	30.000	0.45	10.5	8.247	38.966
6	1.000	30.000	26.500	30.000	0.45	10.5	10.996	51.954

Ultimate End Bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Average Cohesion at the pile tip, C_P	Cross sectional area of the pile tip, A_P	Bearing capacity factor, N_C	UltimateEnd bearing capacityat pile tip, Q_{Bu} = A_P*N_C*C_P
	Mtr	Mtr.	Mtr	Mtr.	T/M ²	M ²		T
1	0.400	30.000	26.500	30.000	10.5	0.126	9.000	11.875
2	0.500	30.000	26.500	30.000	10.5	0.196	9.000	18.555
3	0.550	30.000	26.500	30.000	10.5	0.238	9.000	22.452
4	0.600	30.000	26.500	30.000	10.5	0.283	9.000	26.719
5	0.750	30.000	26.500	30.000	10.5	0.442	9.000	41.749
6	1.000	30.000	26.500	30.000	10.5	0.785	9.000	74.220

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.21 Kg/cm ²	
	=	20.601 Kn/M ²	
L (Length of Pile)	=	30.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.153 MN/M ³	
T (Stiffness Factor)	=	1.938 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	28.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.264 Mtr.	
Therefore,	Lf	=	4.264 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	24.39 Kn	
Horizontal Shear Capacity = H_{design}	=	2.49 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Air Separation unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Fill	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T	T
1	0.400	30.000	-7.499	9.236	16.588	76.001	20.782	11.875	126.983	2.5	50.793	50	46	2.49
2	0.500	30.000	-9.373	11.545	20.735	95.002	25.977	18.555	162.440	2.5	64.976	64	57	2.72
3	0.550	30.000	-10.311	12.700	22.808	104.502	28.575	22.452	180.725	2.5	72.290	72	63	2.82
4	0.600	30.000	-11.248	13.854	24.881	114.002	31.172	26.719	199.382	2.5	79.753	79	69	2.92
5	0.750	30.000	-14.060	17.318	31.102	142.503	38.966	41.749	257.577	2.5	103.031	103	86	3.19
6	1.000	30.000	-18.747	23.091	41.469	190.004	51.954	74.220	361.991	2.5	144.796	144	115	3.59

ZONE-2

CMD & GASSIFIER

Total three (3) boreholes were sunk in this area, viz borehole marked BH-4, BH-9 and BH-2. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with coal dust, clayey silt etc followed by first layer of soft to medium brownish grey silty clay/ clayey silt. The second layer is soft to medium bluish grey silty clay/ clayey silt. The third layer is stiff mottled brownish/ bluish grey silty clay/ clayey silt. The fourth layer is very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt and the fifth layer as encountered up to the explored depth is dense brownish grey silty sand.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Cyclic Plate Load Test:

One (1) cyclic plate load test has been carried out at this zone marked as CPLT-1.

2. Static Cone Penetration Test:

One (1) static cone penetration test has been carried out at this zone marked as SCPT-3.

3. Electrical Resistivity Test:

Two (2) electrical resistivity tests have been carried out at this zone marked as ERT-7 and ERT-9.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-2). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-2).
Recommended Pile Capacity

SI.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	30.000	2.000	52	47	2.41
2	0.500	30.000	2.000	71	60	2.64
3	0.550	30.000	2.000	81	67	2.74
4	0.600	30.000	2.000	92	74	2.84
5	0.750	30.000	2.000	131	96	3.10
6	1.000	30.000	2.000	217	136	3.48

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-4 (Sheet-1)	
Project: SOIL PDIL DANKUNI CMD & GASSIFIER UNIT								Job No.: Soil - 1638	
Co-ord:		E.G.L.: 37.709		Unit:				Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 14.11.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	9	WS		Completed on : 18.11.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 5.20 M.	
Depth of Drilling		VST		SCPT				Standing Water Table : 5.14 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with coal dust, stone chips etc.		01	N = 2	DS1	0.50 M				
				DS2	1.00 M				
				SPT1	1.50-1.95M				
				DS3	1.50-1.95M				
				SPT2	3.00-3.45M				
				DS4	3.00-3.45M				
Medium brownish grey silty clay/ clayey silt with traces of sand and rusty brown spots.		05	N = 4	SPT3	4.50-4.95M				
				DS5	4.50-4.95M				
				UDS1	5.00-5.45M				
				SPT4	6.00-6.45M				
Medium dark grey silty clay/ clayey silt with peat.		08	N = 6	DS7	7.50-7.95M				
				UDS2	8.00-8.45M				
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		10	N = 4	SPT6	9.00-9.45M				
				DS8	9.00-9.45M				
				N = 4	SPT7	10.50-10.95M			
					DS9	10.50-10.95M			
					UDS3	11.00-11.45M			
				N = 9	SPT8	12.50-12.95M			
DS10	12.50-12.95M								
Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		15	N = 14	SPT9	14.50-14.95M				
				DS11	14.50-14.95M				
				N = 15	SPT10	16.50-16.95M			
					DS12	16.50-16.95M			
UDS5	17.00-17.45M								
Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		19	N = 18	SPT11	18.50-18.95M				
				DS13	18.50-18.95M				
Contd.....									
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample		WS - Water Sample			
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.		RCS - Rock Core Sample			

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-4 (Sheet-2)	
Project:SOIL PDIL DANKUNI CMD & GASSIFIER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 37.709		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	9	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 14.11.2019	
						Completed on : 18.11.2019	
						Water Struck At :5.20 M.	
						Standing Water Table : 5.14 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		21	N = 19	UDS6 SPT12 DS14	20.00-20.45M 20.50-20.95M 20.50-20.95M		
		23	N = 21	UDS7 SPT13 DS15	23.00-23.45M 23.50-23.95M 23.50-23.95M		
		26	N = 24	UDS8 SPT14 DS16	26.00-26.45M 26.50-26.95M 26.50-26.95M		
		29	N = 27	UDS9 SPT15 DS17	29.00-29.45M 29.50-29.95M 29.50-29.95M		
		32	N = 30	SPT16 DS18	32.50-32.95M 32.50-32.95M		
		34	N = 36	SPT17 DS19	34.55-35.00M 34.55-35.00M		
	Termination Depth 35.000 Mtr.		35				
			36				
			37				
			38				
			39				

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-9 (Sheet-1)	
Project: SOIL PDIL DANKUNI CMD & GASSIFIER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.378		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	39.000 M.	SPT	18	UDS	9	WS	
Type of Drilling		DCPT		DS	20	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 19.11.2019	
						Completed on : 22.11.2019	
						Water Struck At : 6.50 M.	
						Standing Water Table : 6.45 M.	

DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E	
				NO.	DEPTH
Filled up with coal dust, stone chips etc.		01	N = 10	DS1	0.50 M
				DS2	1.00 M
				SPT1	1.50-1.95M
		02	N = 11	DS3	1.50-1.95M
				SPT2	3.00-3.45M
				DS4	3.00-3.45M
		03	N = 25	SPT3	4.50-4.95M
				DS5	4.50-4.95M
				UDS1	5.00-5.45M
Soft to medium brownish grey silty clay/ clayey silt.		04	N = 4	SPT4	6.00-6.45M
				DS6	6.00-6.45M
				SPT5	7.50-7.95M
		05	N = 2	DS7	7.50-7.95M
				UDS2	8.00-8.45M
				SPT6	9.00-9.45M
Soft to medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.		06	N = 3	DS8	9.00-9.45M
				SPT7	10.50-10.95M
				DS9	10.50-10.95M
		07	N = 4	UDS3	11.00-11.45M
				SPT8	12.50-12.95M
				DS10	12.50-12.95M
		08	N = 5	UDS4	14.00-14.45M
				SPT9	14.50-14.95M
				DS11	14.50-14.95M
Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.		09	N = 8	SPT10	16.50-16.95M
				DS12	16.50-16.95M
				UDS5	17.00-17.45M
		10	N = 12	SPT11	18.50-18.95M
				DS13	18.50-18.95M
		11	N = 13		
		12			
		13			
		14			
		15			
		16			
		17			
		18			
		19			
Contd.....					

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-9 (Sheet-2)	
Project:SOIL PDIL DANKUNI CMD & GASSIFIER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.378		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	39.000 M.	SPT	18	UDS	9	WS	
Type of Drilling		DCPT		DS	20	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 19.11.2019	
						Completed on : 22.11.2019	
						Water Struck At : 6.50 M.	
						Standing Water Table : 6.45 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.		21	N = 15	UDS6	20.00-20.45M		
				SPT12	20.50-20.95M		
				DS14	20.50-20.95M		
		23	N = 15	UDS7	23.00-23.45M		
				SPT13	23.50-23.95M		
				DS15	23.50-23.95M		
Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.		26	N = 36	UDS8	26.00-26.45M		
				SPT14	26.50-26.95M		
				DS16	26.50-26.95M		
		29	N = 30	UDS9	29.00-29.45M		
				SPT15	29.50-29.95M		
				DS17	29.50-29.95M		
Dense brownish grey silty sand with clay binders and sand stone.		33	N = 32	SPT16	32.50-32.95M		
				DS18	32.50-32.95M		
		36	N = 30	SPT17	35.50-35.95M		
				DS19	35.50-35.95M		
Termination Depth 39.000 Mtr.		39	N = 37	SPT18	38.55-39.00M		
				DS20	38.55-39.00M		

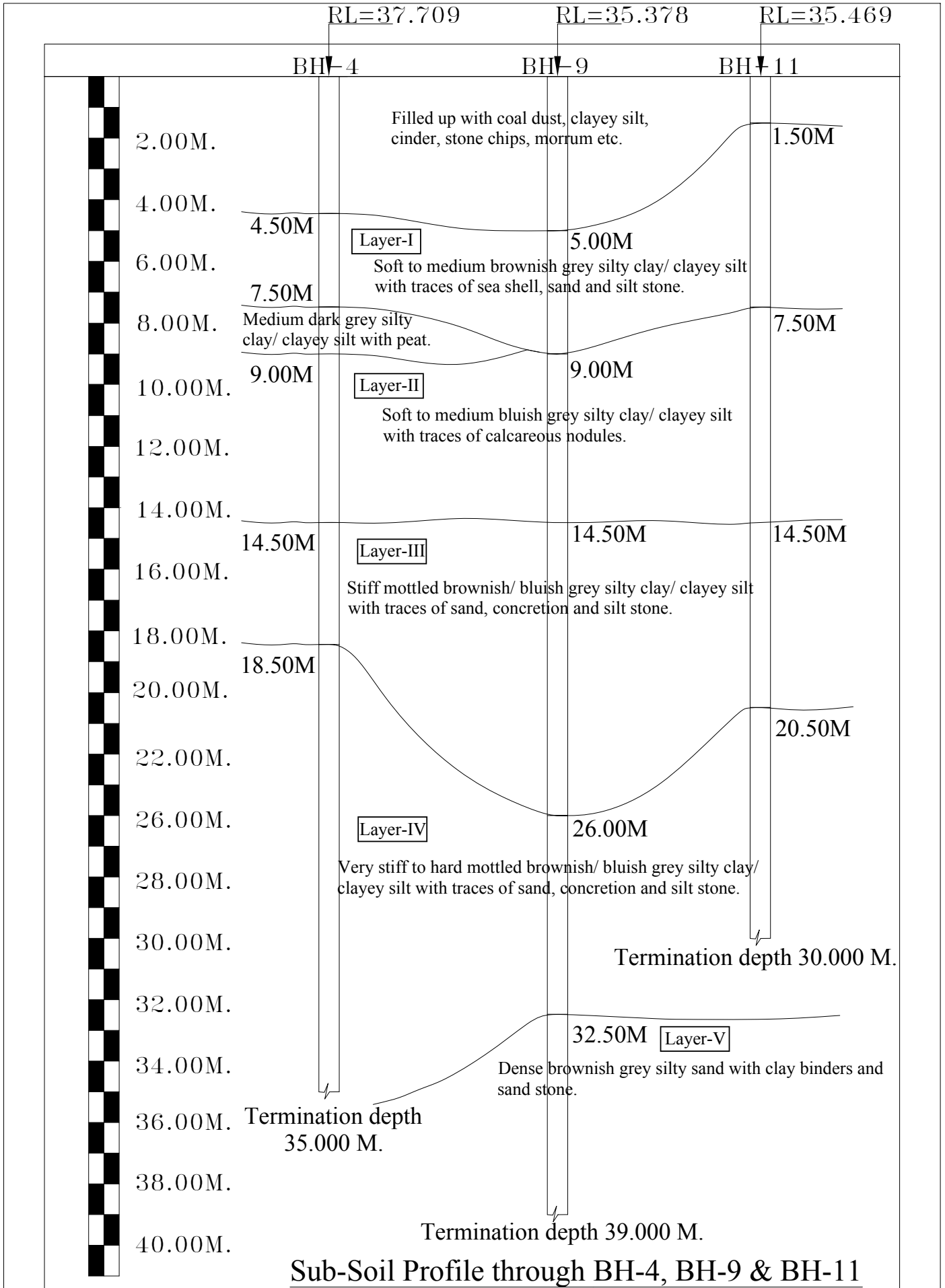
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-11 (Sheet-1)	
Project: SOIL PDIL DANKUNI CMD & GASSIFIER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.469		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	30.000 M.	SPT	15	UDS	10	WS	
Type of Drilling		DCPT		DS	17	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 25.11.2019	
						Completed on : 26.11.2019	
						Water Struck At : 2.40 M.	
						Standing Water Table : 2.34 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Filled up with coal dust, clayey silt, cinder, stone chips, morrum etc.		01		DS1	0.50 M		
				DS2	1.00 M		
Soft to medium brownish grey silty clay/ clayey silt with traces of sea shell, sand and silt stone.		02	N = 2	SPT1	1.50-1.95M		
				DS3	1.50-1.95M		
		03	N = 3	UDS1	2.00-2.45M		
				SPT2	3.00-3.45M		
		04		DS4	3.00-3.45M		
		05	N = 2	SPT3	4.50-4.95M		
				DS5	4.50-4.95M		
				UDS2	5.00-5.45M		
		06	N = 4	SPT4	6.00-6.45M		
				DS6	6.00-6.45M		
		07					
Soft to medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.		08	N = 3	SPT5	7.50-7.95M		
				DS7	7.50-7.95M		
				UDS3	8.00-8.45M		
		09	N = 4	SPT6	9.00-9.45M		
				DS8	9.00-9.45M		
		10	N = 4	SPT7	10.50-10.95M		
				DS9	10.50-10.95M		
				UDS4	11.00-11.45M		
		11					
		12					
13	N = 5	SPT8	12.50-12.95M				
		DS10	12.50-12.95M				
14		UDS5	14.00-14.45M				
Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		15	N = 25	SPT9	14.50-14.95M		
				DS11	14.50-14.95M		
		16					
		17	N = 9	SPT10	16.50-16.95M		
				DS12	16.50-16.95M		
		18		UDS6	17.00-17.45M		
		19	N = 10	SPT11	18.50-18.95M		
				DS13	18.50-18.95M		
		20					
Contd.....							
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample		WS - Water Sample	
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.		RCS - Rock Core Sample	

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-11 (Sheet-2)	
Project: SOIL PDIL DANKUNI CMD & GASSIFIER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.469		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	30.000 M.	SPT	15	UDS	10	WS	
Type of Drilling		DCPT		DS	17	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 25.11.2019	
						Completed on : 26.11.2019	
						Water Struck At : 2.40 M.	
						Standing Water Table : 2.34 M.	

DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E	
				NO.	DEPTH
Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		21	N = 17	UDS7	20.00-20.45M
				SPT12	20.50-20.95M
				DS14	20.50-20.95M
Very stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		22	N = 25	UDS8	23.00-23.45M
				SPT13	23.50-23.95M
				DS15	23.50-23.95M
		23	N = 26	UDS9	26.00-26.45M
				SPT14	26.50-26.95M
				DS16	26.50-26.95M
		24	N = 29	UDS10	29.00-29.45M
				SPT15	29.55-30.00M
				DS17	29.55-30.00M
Termination Depth 30.000 Mtr.		25			
		26			
		27			
		28			
		29			
		30			
		31			
		32			
		33			
		34			
		35			
		36			
		37			
		38			
		39			

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample



SUMMARY OF LABORATORY TEST RESULTS

Table-3

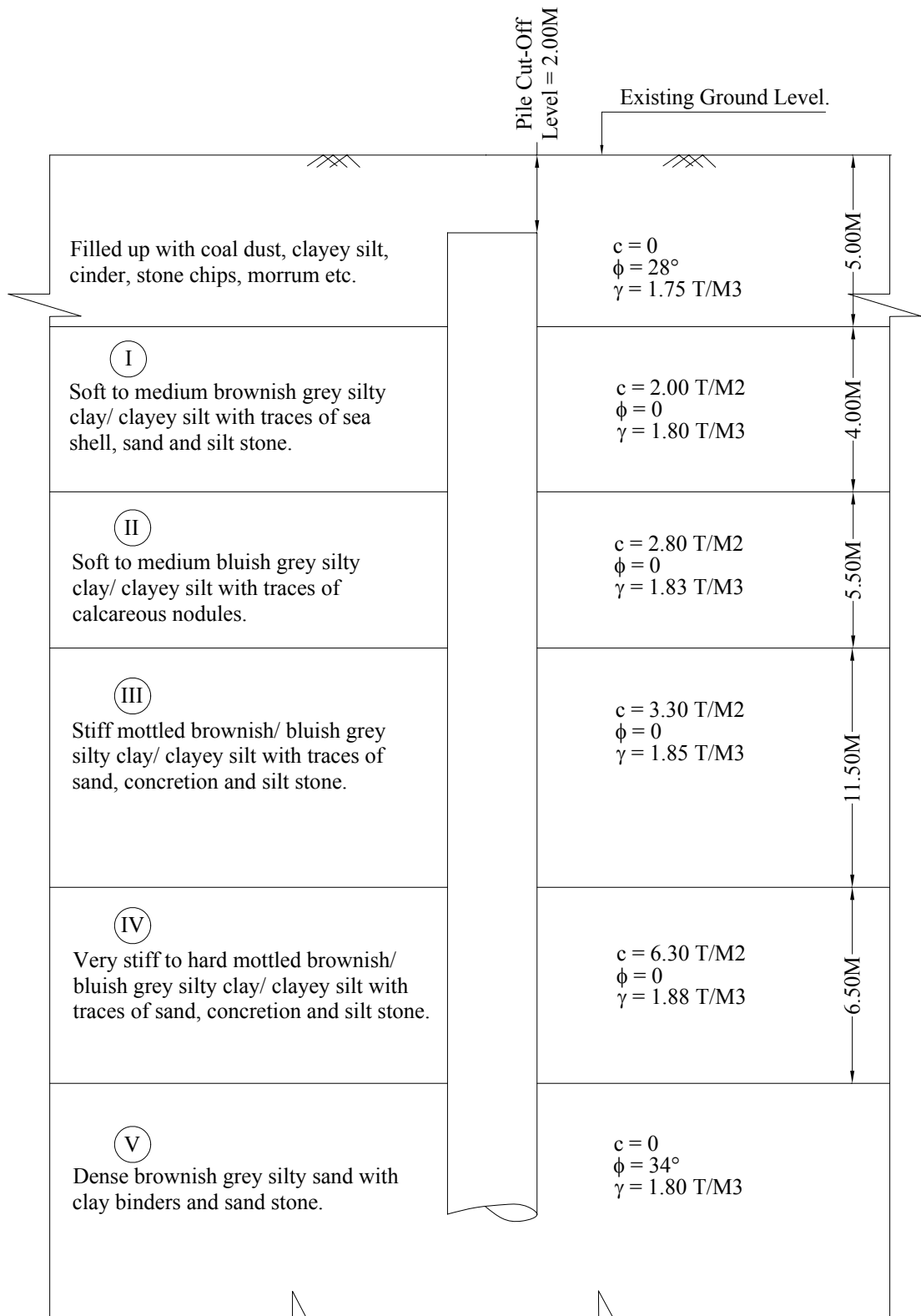
Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc γ_b	Water Content in % m	Specific Gravity G	Dry Density in gm/cc γ_d	Unconfined Test in Kg/sqcm q_u	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading										
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm C	Friction angle in degree ϕ					UU/cu/CD /DS	Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %						
						%	%	%																							
I	Medium brownish grey silty clay/ clayey silt with traces of sand and rusty brown spots.	4	4.50	DN	4	43	19	11.6			2.67								14.6	0	11	67	22								
		4	5.00	UD		47	20	12.2	1.84	35.4	2.66	1.36	0.41	UU	0.22	0	0.00-0.10	0.0167	0	20.4	0	9	66	25							
															CU	0.09	12	0.20-0.40							0.0448						
															CD	0	17	0.40-0.80							0.0563						
																0.80-1.60	0.0443														
																	1.60-3.20	0.0239													
II	Medium dark grey silty clay/ clayey silt with peat.	4	7.50	DN	6	59	23	14.7			2.56								14.8	0	7	71	22								
III	Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretin.	4	10.50	DN	4	65	22	13.2			2.67									18.4	0	6	55	39							
		4	11.00	UD		58	21	13.1	1.85	30.66	2.66	1.42	0.61	UU	0.33	0	0.00-0.10	0.0073	0	16.3	0	8	57	35							
															CU	0.09	15	0.20-0.40							0.0254						
															CD	0	20	0.40-0.80							0.0349						
																0.80-1.60	0.0298														
																	1.60-3.20	0.0213													
IV	Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretin.	4	14.50	DN	14	49	21	13.8			2.71									0	0	9	64	27							
		4	17.00	UD		48	20	14.2	1.88	28.64	2.68	1.46	1.21	UU	0.63	0	0.00-0.10	0.0061	0	0	0	11	63	26							
															CU	0.12	15	0.20-0.40							0.0234						
															CD	0	28	0.40-0.80							0.0331						
																0.80-1.60	0.0272														
																	1.60-3.20	0.0183													
V	Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretin.	4	20.00	UD		48	19	12.2	1.92	25.31	2.67	1.53	2.14	UU	1.09	0	0.00-0.10	0.0058	0	8.69	0	12	61	27							
															CU	0.17	22	0.20-0.40							0.0228						
															CD	0	30	0.40-0.80							0.0324						
																		0.80-1.60							0.0249						
																	1.60-3.20	0.0159													
		4	23.50	DN	21	47	20	13.3			2.66									4.6	0	14	61	25							
		4	29.50	DN	27	54	22	15.1			2.68									8.37	0	11	59	30							

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading						
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					UU/CU/CD /DS	C	φ	Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						γ _b	m	G								γ _d	q _u	%	%
I	Soft to medium brownish grey silty clay/ clayey silt.	9	5.00	UD	48	19	14.2	1.80	33.18	2.66	1.35	0.45	UU	0.24	0	0.00-0.10	0.0101	0	0	0	7	55	38				
																0.10-0.20	0.0169										
													CU	0.07	12	0.20-0.40	0.0403										
																0.40-0.80	0.0348										
													CD	0	16	0.80-1.60	0.0272										
			1.60-3.20	0.0191																							
		9	6.00	DN	4	50	22	15.4			2.67							0	0	6	52	42					
II	Soft to medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.	9	10.50	DN	4	55	20	14.2		2.66			UU	0.31	0	0.00-0.10	0.0132	0	8.63	0	6	72	22				
																0.10-0.20	0.0177										
													CU	0.12	14	0.20-0.40	0.0298										
																0.40-0.80	0.0238										
													CD	0	20	0.80-1.60	0.0189										
			1.60-3.20	0.0131																							
		9	12.50	DN	5	39	18	12.7		2.67							7.92	0	10	72	18						
III	Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.	9	16.50	DN	12	52	24	16.2		2.69			UU	0.66	0	0.00-0.10	0.0065	0	4.97	0	8	61	31				
																0.10-0.20	0.0139										
													CU	0.14	22	0.20-0.40	0.0293										
																0.40-0.80	0.0243										
													CD	0	28	0.80-1.60	0.0199										
			1.60-3.20	0.0148																							
		9	20.50	DN	15	66	25	16.3		2.66							9.69	0	5	58	37						
IV	Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.	9	26.50	UD	48	21	14.6	1.94	24.73	2.67	1.56	2.12	UU	1.09	0	0.00-0.10	0.0059	0	5.67	0	11	65	24				
																0.10-0.20	0.0131										
													CU	0.21	26	0.20-0.40	0.0268										
																0.40-0.80	0.0241										
													CD	0	31	0.80-1.60	0.0184										
			1.60-3.20	0.0127																							
		9	29.50	DN	30	53	22	16.1		2.66							0	0	9	62	29						
V	Dense brownish grey silty sand with clay binders and sand stone.	9	32.50	DN	32	NP		1.80		2.66			DS	0.08	34				0	35	64	1	0				
																DS	0.05	32				0	0	98	2	0	

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading						
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					UU/CU/CD /DS	C	φ	Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						γ _b	m	G					γ _d	q _u					
I	Soft to medium brownish grey silty clay/ clayey silt with traces of sea shell, sand and silt stone.	11	1.50	DN	2	50	21	14.6			2.69								15	0	8	54	38				
		11	2.00	UD		49	20	13.4	1.80	36.62	2.67	1.32	0.38	UU	0.20	0	0.00-0.10 0.10-0.20	0.0251 0.0329	0	13.7	0	6	68	26			
														CU	0.07	14	0.20-0.40 0.40-0.80	0.0438 0.0366									
														CD	0	17	0.80-1.60 1.60-3.20	0.0259 0.0191									
11	6.00	DN	4	47	23	16.5			2.65									14.6	0	7	69	24					
II	Soft to medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.	11	8.00	UD		52	23	16.8	1.83	31.17	2.67	1.40	0.54	UU	0.28	0	0.00-0.10 0.10-0.20	0.0249 0.0321	0	0	0	10	62	28			
														CU	0.11	15	0.20-0.40 0.40-0.80	0.0429 0.0351									
														CD	0	20	0.80-1.60 1.60-3.20	0.0249 0.0179									
		11	9.00	DN	4	50	24	17.2			2.66									0	0	8	67	25			
11	12.50	DN	5	55	22	15.7			2.66									0	0	6	63	31					
III	Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.	11	17.00	UD		49	19	13.7	1.87	28.64	2.67	1.45	1.20	UU	0.62	0	0.00-0.10 0.10-0.20	0.0165 0.0259	0	0	0	8	63	29			
														CU	0.13	20	0.20-0.40 0.40-0.80	0.0409 0.0349									
														CD	0	27	0.80-1.60 1.60-3.20	0.0281 0.0176									
		11	18.50	DN	10	54	24	16.9			2.66									0	0	10	63	27			
IV	Very stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.	11	26.50	DN	26	45	18	12.7			2.68								0	0	15	59	26				
		11	29.55	DN	29	46	19	11.9			2.67								0	0	13	62	25				

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ CMD & GASSIFIER UNIT 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: Fill

Soil Description : Filled up with coal dust, clayey silt, cinder, stone chips, morrum etc.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	35.000	2.000	5.000	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	3.75	2.273	1.591	3.770	-5.999
2	0.500	35.000	2.000	5.000	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	3.75	2.273	1.591	4.712	-7.499
3	0.550	35.000	2.000	5.000	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	3.75	2.273	1.591	5.184	-8.249
4	0.600	35.000	2.000	5.000	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	3.75	2.273	1.591	5.655	-8.998
5	0.750	35.000	2.000	5.000	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	3.75	2.273	1.591	7.069	-11.248
6	1.000	35.000	2.000	5.000	1.000	28	25	20.72	10.66	10.88	1.75	0.75	1.3	15	1.5	0.44	0.909	3.75	2.273	1.591	9.425	-14.997

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description: Soft to medium brownish grey silty clay/ clayey silt with traces of sea shell, sand and silt stone.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	35.000	5.000	9.000	1	2	5.027	10.053
2	0.500	35.000	5.000	9.000	1	2	6.283	12.566
3	0.550	35.000	5.000	9.000	1	2	6.912	13.823
4	0.600	35.000	5.000	9.000	1	2	7.540	15.080
5	0.750	35.000	5.000	9.000	1	2	9.425	18.850
6	1.000	35.000	5.000	9.000	1	2	12.566	25.133

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Soft to medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	35.000	9.000	14.500	1	2.8	6.912	19.352
2	0.500	35.000	9.000	14.500	1	2.8	8.639	24.190
3	0.550	35.000	9.000	14.500	1	2.8	9.503	26.609
4	0.600	35.000	9.000	14.500	1	2.8	10.367	29.028
5	0.750	35.000	9.000	14.500	1	2.8	12.959	36.285
6	1.000	35.000	9.000	14.500	1	2.8	17.279	48.381

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description: Stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	35.000	14.500	26.000	1	3.3	14.451	47.689
2	0.500	35.000	14.500	26.000	1	3.3	18.064	59.612
3	0.550	35.000	14.500	26.000	1	3.3	19.871	65.573
4	0.600	35.000	14.500	26.000	1	3.3	21.677	71.534
5	0.750	35.000	14.500	26.000	1	3.3	27.096	89.418
6	1.000	35.000	14.500	26.000	1	3.3	36.128	119.223

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description: Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with traces of sand, concretion and silt stone.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{SU} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	35.000	26.000	32.500	0.7	6.3	8.168	36.022
2	0.500	35.000	26.000	32.500	0.7	6.3	10.210	45.027
3	0.550	35.000	26.000	32.500	0.7	6.3	11.231	49.530
4	0.600	35.000	26.000	32.500	0.7	6.3	12.252	54.032
5	0.750	35.000	26.000	32.500	0.7	6.3	15.315	67.540
6	1.000	35.000	26.000	32.500	0.7	6.3	20.420	90.054

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description : Dense brownish grey silty sand with clay binders and sand stone.

Sl.No	Pile Dia, D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	35.000	32.500	35.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	4.8	0.54	3.749	4.8	3.749	3.749	3.142	11.779
2	0.500	35.000	32.500	35.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	6	0.54	4.687	6	4.687	4.687	3.927	18.405
3	0.550	35.000	32.500	35.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	6.6	0.54	5.155	6.6	5.155	5.155	4.320	22.270
4	0.600	35.000	32.500	35.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	7.2	0.54	5.624	7.2	5.624	5.624	4.712	26.503
5	0.750	35.000	32.500	35.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	9	0.54	7.030	9	7.030	7.030	5.890	41.411
6	1.000	35.000	32.500	35.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	12	0.54	9.373	12	9.373	9.373	7.854	73.619

Ultimate end bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description : Dense brownish grey silty sand with clay binders and sand stone.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $=(\phi -3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Dl} at pile tip	A_p	End Bearing
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			M ²	T
1	0.400	35.000	32.500	35.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	4.8	0.126	12.967
2	0.500	35.000	32.500	35.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	6	0.196	25.326
3	0.550	35.000	32.500	35.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	6.6	0.238	33.709
4	0.600	35.000	32.500	35.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	7.2	0.283	43.763
5	0.750	35.000	32.500	35.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	9	0.442	85.475
6	1.000	35.000	32.500	35.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	12	0.785	202.607

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.2 Kg/cm ²	
	=	19.62 Kn/M ²	
L (Length of Pile)	=	35.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n _h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.097 MN/M ³	
T (Stiffness Factor)	=	1.957 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	33.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.305 Mtr.	
Therefore,	Lf	=	4.305 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	23.68 Kn	
Horizontal Shear Capacity = H_{design}	=	2.41 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: CMD & Gassifier unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Fill	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	Skin friction from layer 5	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T	T	T
1	0.400	30.000	-5.999	10.053	19.352	47.689	36.022	11.779	12.967	131.863	2.5	52.745	52	47	2.41
2	0.500	30.000	-7.499	12.566	24.190	59.612	45.027	18.405	25.326	177.627	2.5	71.051	71	60	2.64
3	0.550	30.000	-8.249	13.823	26.609	65.573	49.530	22.270	33.709	203.265	2.5	81.306	81	67	2.74
4	0.600	30.000	-8.998	15.080	29.028	71.534	54.032	26.503	43.763	230.942	2.5	92.377	92	74	2.84
5	0.750	30.000	-11.248	18.850	36.285	89.418	67.540	41.411	85.475	327.730	2.5	131.092	131	96	3.10
6	1.000	30.000	-14.997	25.133	48.381	119.223	90.054	73.619	202.607	544.019	2.5	217.607	217	136	3.48

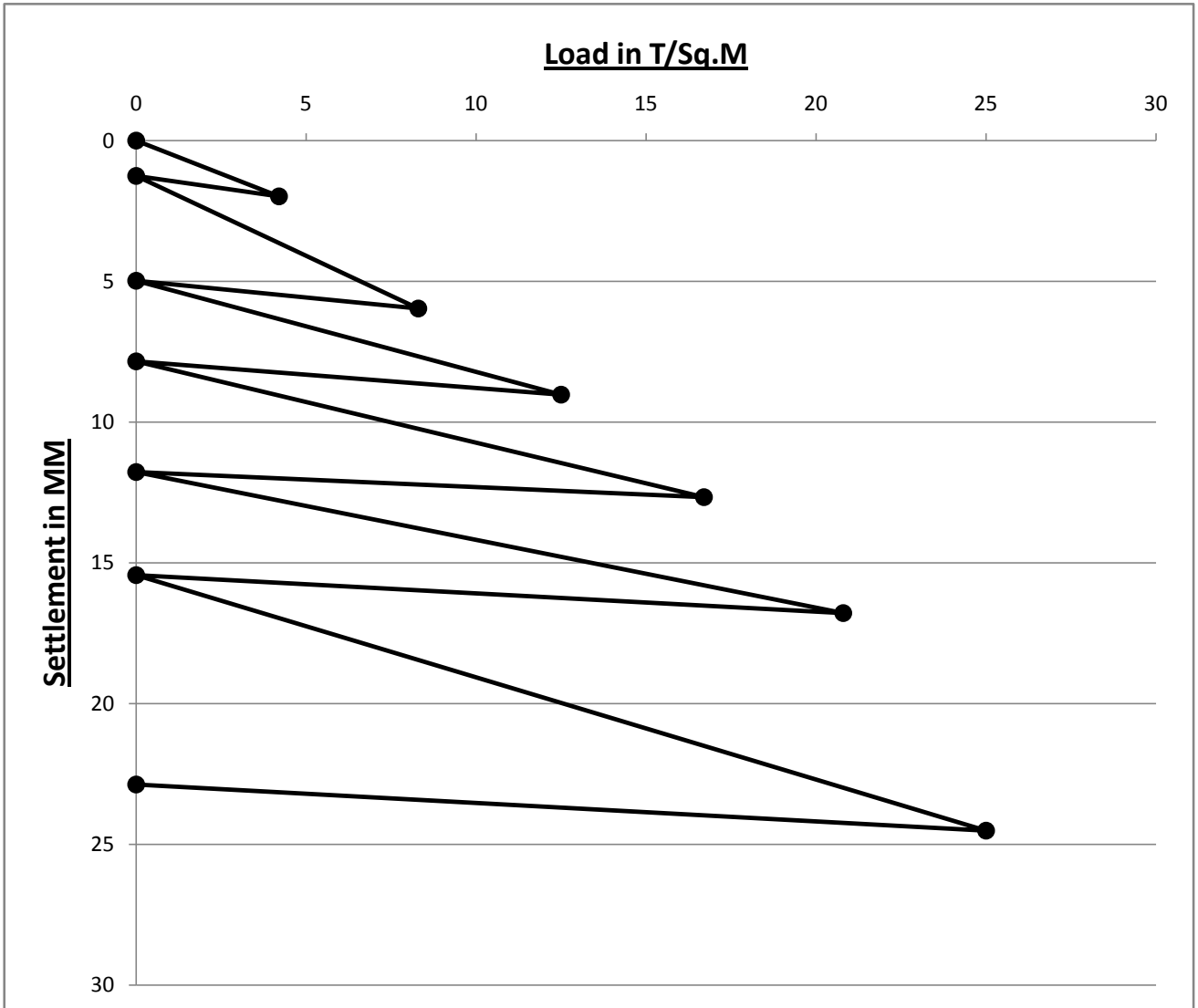
CYCLIC PLATE LOAD TEST

CYCLIC PLATE LOAD TEST SITE DATA SHEET

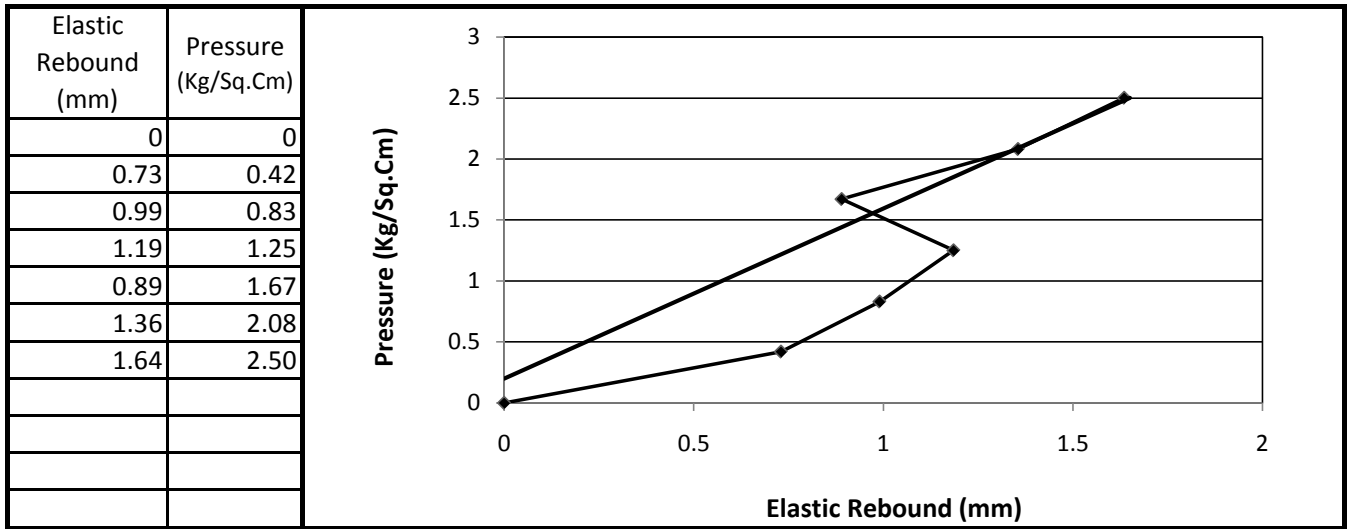
Client : Projects & Development India Limited
 Location : Beside the existing road way bridge.
 Test Number : CPLT-1
 Plate Size : 60 X 60 = 3600 Sqcm
 Pit Size : 3.00M X 3.00M X 2.50M
 Ground Water Table : Not Encountered
 L.C. of Dial Guage : 0.01 mm
 Jack Ram Dia : 10.5 cm
 Jack Ram Area : 86.59 Sqcm

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
12-12-2019	10:30:00	0.00	0	2500	2500	0.00	0.00	0.00	
	10:30:00	1500	0.42	2500	2500	0.00	0.00	0.00	
	10:31:00			2454	2457	0.46	0.43	0.45	
	10:32:15			2391	2399	1.09	1.01	1.05	
	10:34:00			2357	2364	1.43	1.36	1.40	
	10:36:15			2329	2337	1.71	1.63	1.67	
	10:39:00			2315	2322	1.85	1.78	1.82	
	10:46:00			2307	2310	1.93	1.90	1.92	
	10:55:00			2304	2306	1.96	1.94	1.95	
	11:30:00			2303	2300	1.97	2.00	1.99	
	11:30:00	0	0	2303	2300	1.97	2.00	1.99	
	12:30:00			2368	2381	1.32	1.19	1.26	
	12:30:00	3000	0.83	2368	2381	1.32	1.19	1.26	
	12:31:00			2251	2247	2.49	2.53	2.51	
	12:32:15			2183	2178	3.17	3.22	3.20	
	12:34:00			2084	2092	4.16	4.08	4.12	
	12:36:15			2011	2030	4.89	4.70	4.80	
	12:39:00			1937	1943	5.63	5.57	5.60	
	12:46:00			1914	1924	5.86	5.76	5.81	
	12:55:00			1903	1914	5.97	5.86	5.92	
	13:30:00			1899	1908	6.01	5.92	5.97	
	13:30:00	0	0	1899	1908	6.01	5.92	5.97	
	14:30:00			1979	2026	5.21	4.74	4.98	
	14:30:00	4500	1.25	1979	2026	5.21	4.74	4.98	
	14:31:00			1892	1910	6.08	5.90	5.99	
	14:32:15			1811	1830	6.89	6.70	6.80	
	14:34:00			1768	1772	7.32	7.28	7.30	
	14:36:15			1706	1713	7.94	7.87	7.91	
	14:39:00			1676	1683	8.24	8.17	8.21	
	14:46:00			1632	1642	8.68	8.58	8.63	
	14:55:00			1611	1596	8.89	9.04	8.97	

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
	15:30:00			1607	1588	8.93	9.12	9.03	
	15:30:00	0	0	1607	1588	8.93	9.12	9.03	
	16:30:00			1733	1699	7.67	8.01	7.84	
	16:30:00	6000	1.67	1733	1699	7.67	8.01	7.84	
	16:31:00			1673	1633	8.27	8.67	8.47	
	16:32:15			1608	1588	8.92	9.12	9.02	
	16:34:00			1557	1539	9.43	9.61	9.52	
	16:36:15			1481	1469	10.19	10.31	10.25	
	16:39:00			1403	1353	10.97	11.47	11.22	
	16:46:00			1308	1269	11.92	12.31	12.12	
	16:55:00			1237	1247	12.63	12.53	12.58	
	17:30:00			1229	1238	12.71	12.62	12.67	
	17:30:00	0	0	1229	1238	12.71	12.62	12.67	
	18:30:00			1326	1319	11.74	11.81	11.78	
	18:30:00	7500	2.08	1326	1319	11.74	11.81	11.78	
	18:31:00			1288	1282	12.12	12.18	12.15	
	18:32:15			1207	1203	12.93	12.97	12.95	
	18:34:00			1137	1129	13.63	13.71	13.67	
	18:36:15			1088	1079	14.12	14.21	14.17	
	18:39:00			1027	1022	14.73	14.78	14.76	
	18:46:00			951	959	15.49	15.41	15.45	
	18:55:00			831	824	16.69	16.76	16.73	
	19:30:00			824	819	16.76	16.81	16.79	
	19:30:00	0	0	824	819	16.76	16.81	16.79	
	20:30:00			951	963	15.49	15.37	15.43	
	20:30:00	9000	2.50	951	963	15.49	15.37	15.43	
	20:31:00			783	791	17.17	17.09	17.13	
	20:32:15			689	696	18.11	18.04	18.08	
	20:34:00			602	613	18.98	18.87	18.93	
	20:36:15			509	522	19.91	19.78	19.85	
	20:39:00			403	411	20.97	20.89	20.93	
	20:46:00			221	224	22.79	22.76	22.78	
	20:55:00			114	106	23.86	23.94	23.90	
	21:30:00			45	53	24.55	24.47	24.51	
	21:30:00	0	0.00	45	53	24.55	24.47	24.51	
	22:30:00			206	219	22.94	22.81	22.88	



Evaluation of Dynamic Properties of Soil



<u>Computed dynamic properties of soil</u>	
Coefficient of elastic uniform compression (C_u) kg/cm ³	15.291
Coefficient of elastic uniform shear (C_τ) kg/cm ³	7.646
Coefficient of elastic non-uniform compression (C_ϕ) kg/cm ³	26.455
Coefficient of elastic non-uniform shear (C_ψ) kg/cm ³	11.469

STATIC CONE PENETRATION TEST

Table -1

Project: Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Client.: Project & Development India Limited

Side ID :

Correction A	
1. Mass of Cone (m)	1.34 Kg
2. Mass of each sounding rod (m1)	1.55 Kg
3. Cone area at Base (b)	10 Sqcm
4. Plunger Area (b')	20 Sqcm
5. Correction factor to be added to gauge reading C1 = (m+nm1)/10	0.289 Kg
6. No of Rod Used (n)	6

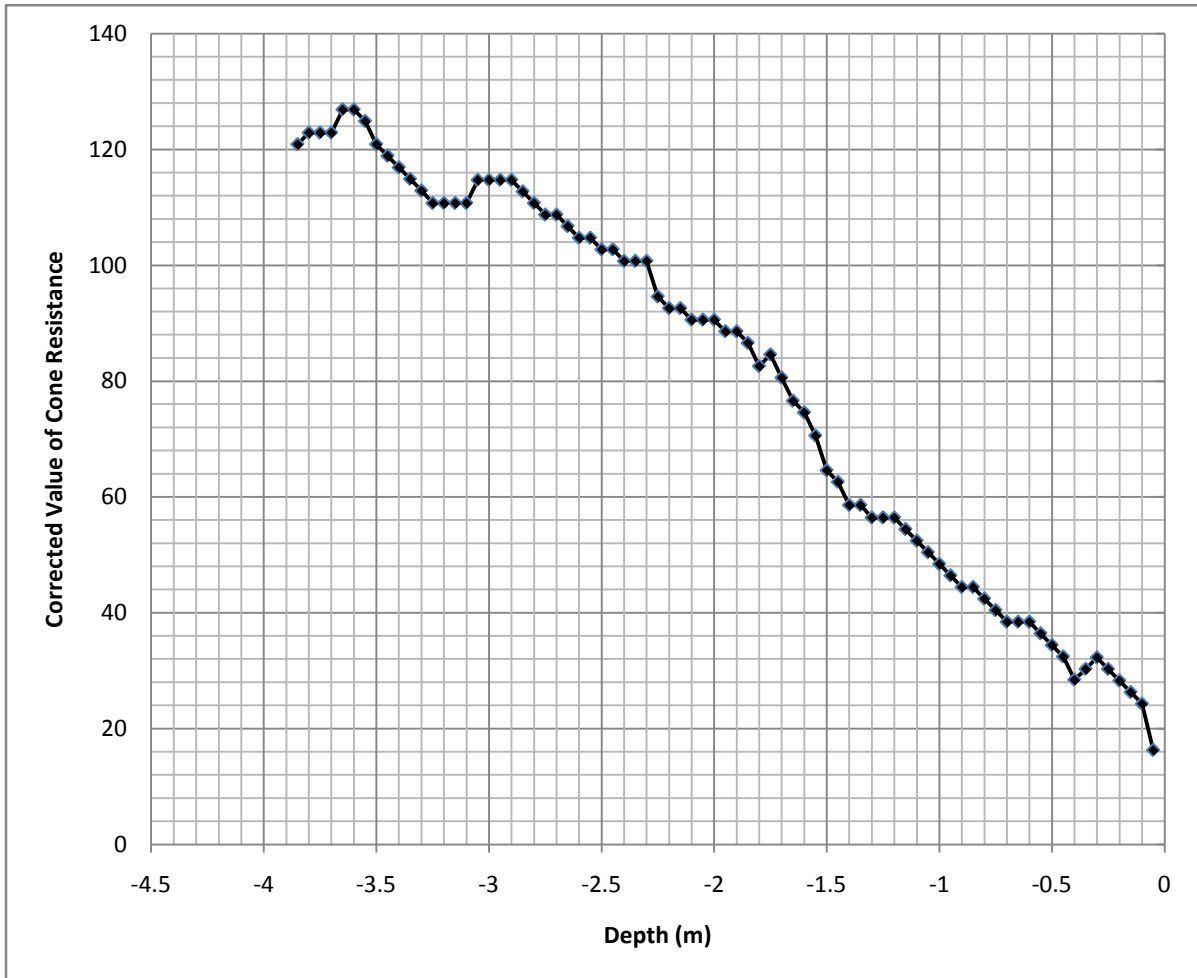
Correction B	
1. Mass of friction Jacket (m _f)	1.345 Kg
2. Outer dia, of Friction Jacket (d)	3.6 cm
3. Length of Friction Jacket (h)	13 Sqcm
4. Surface area of friction jacket (a) = π dh	147 Sqcm
5. Correction factor to be added to gauge reading C2 = (m _f /a)	0.01 Kg/ Sqcm
Test Number	SCPT-3

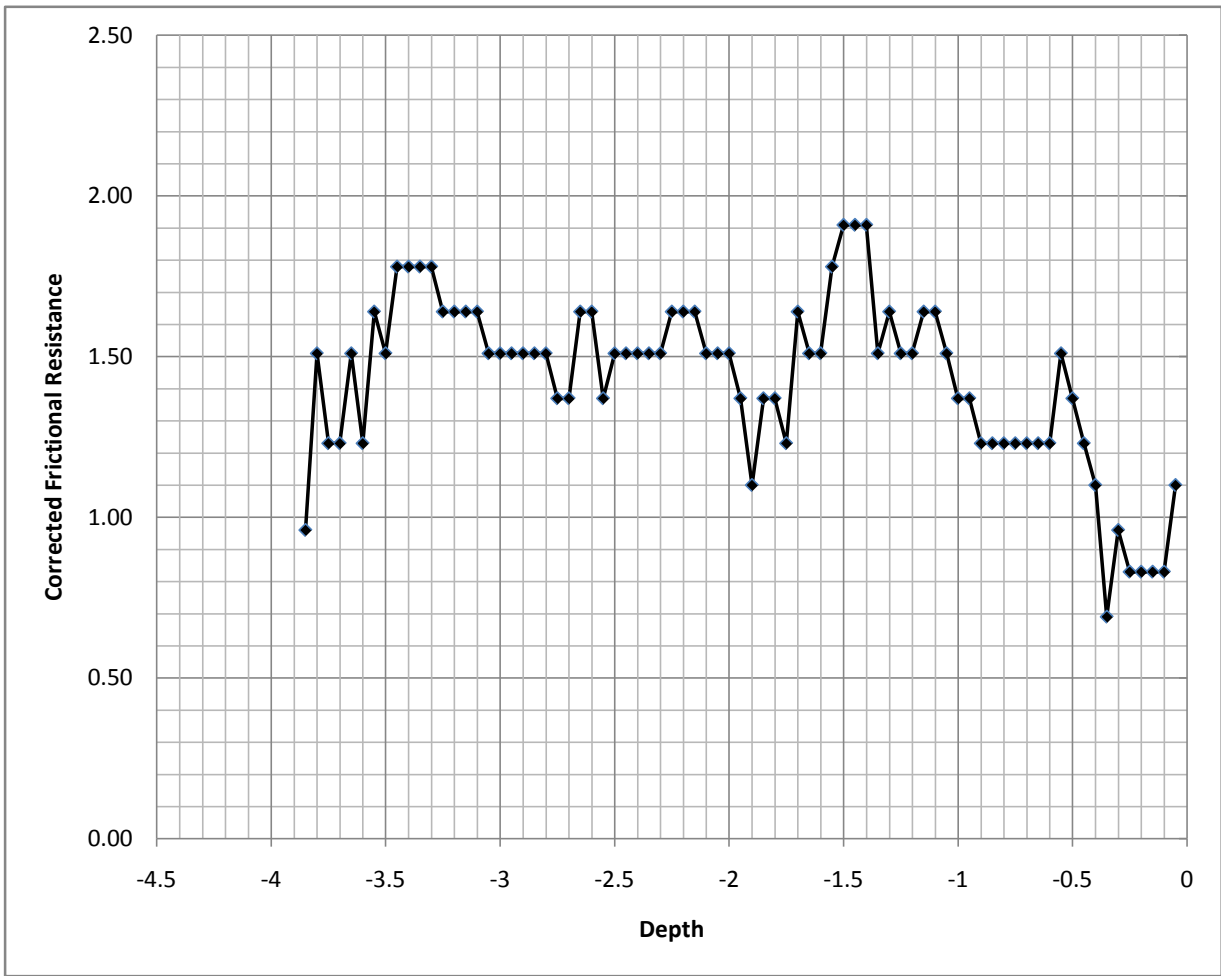
Depth	Number of Rod in Use	CONE				JACKET				
		Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	y=Y*(b'/b)	C1	R _c =y+C1	X	x=X*(b'/b)	x-y	Z=(x-y)*(b/a)	Rf= Z+(mf/a)
-0.05	1	8	16	0.29	16.29	16	32	16	1.09	1.10
-0.10	1	12	24	0.29	24.29	18	36	12	0.82	0.83
-0.15	1	13	26	0.29	26.29	19	38	12	0.82	0.83
-0.20	1	14	28	0.29	28.29	20	40	12	0.82	0.83
-0.25	1	15	30	0.29	30.29	21	42	12	0.82	0.83
-0.30	1	16	32	0.29	32.29	23	46	14	0.95	0.96
-0.35	1	15	30	0.29	30.29	20	40	10	0.68	0.69
-0.40	2	14	28	0.44	28.44	22	44	16	1.09	1.10
-0.45	2	16	32	0.44	32.44	25	50	18	1.22	1.23
-0.50	2	17	34	0.44	34.44	27	54	20	1.36	1.37
-0.55	2	18	36	0.44	36.44	29	58	22	1.5	1.51
-0.60	2	19	38	0.44	38.44	28	56	18	1.22	1.23
-0.65	2	19	38	0.44	38.44	28	56	18	1.22	1.23
-0.70	2	19	38	0.44	38.44	28	56	18	1.22	1.23

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-0.75	2	20	40	0.44	40.44	29	58	18	1.22	1.23
-0.80	2	21	42	0.44	42.44	30	60	18	1.22	1.23
-0.85	2	22	44	0.44	44.44	31	62	18	1.22	1.23
-0.90	2	22	44	0.44	44.44	31	62	18	1.22	1.23
-0.95	2	23	46	0.44	46.44	33	66	20	1.36	1.37
-1.00	2	24	48	0.44	48.44	34	68	20	1.36	1.37
-1.05	2	25	50	0.44	50.44	36	72	22	1.5	1.51
-1.10	2	26	52	0.44	52.44	38	76	24	1.63	1.64
-1.15	2	27	54	0.44	54.44	39	78	24	1.63	1.64
-1.20	2	28	56	0.44	56.44	39	78	22	1.5	1.51
-1.25	2	28	56	0.44	56.44	39	78	22	1.5	1.51
-1.30	2	28	56	0.44	56.44	40	80	24	1.63	1.64
-1.35	3	29	58	0.6	58.6	40	80	22	1.5	1.51
-1.40	3	29	58	0.6	58.6	43	86	28	1.9	1.91
-1.45	3	31	62	0.6	62.6	45	90	28	1.9	1.91
-1.50	3	32	64	0.6	64.6	46	92	28	1.9	1.91
-1.55	3	35	70	0.6	70.6	48	96	26	1.77	1.78
-1.60	3	37	74	0.6	74.6	48	96	22	1.5	1.51
-1.65	3	38	76	0.6	76.6	49	98	22	1.5	1.51
-1.70	3	40	80	0.6	80.6	52	104	24	1.63	1.64
-1.75	3	42	84	0.6	84.6	51	102	18	1.22	1.23
-1.80	3	41	82	0.6	82.6	51	102	20	1.36	1.37
-1.85	3	43	86	0.6	86.6	53	106	20	1.36	1.37
-1.90	3	44	88	0.6	88.6	52	104	16	1.09	1.1
-1.95	3	44	88	0.6	88.6	54	108	20	1.36	1.37
-2.00	3	45	90	0.6	90.6	56	112	22	1.5	1.51
-2.05	3	45	90	0.6	90.6	56	112	22	1.5	1.51
-2.10	3	45	90	0.6	90.6	56	112	22	1.5	1.51
-2.15	3	46	92	0.6	92.6	58	116	24	1.63	1.64

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-2.20	3	46	92	0.6	92.6	58	116	24	1.63	1.64
-2.25	3	47	94	0.6	94.6	59	118	24	1.63	1.64
-2.30	4	50	100	0.75	100.75	61	122	22	1.5	1.51
-2.35	4	50	100	0.75	100.75	61	122	22	1.5	1.51
-2.40	4	50	100	0.75	100.75	61	122	22	1.5	1.51
-2.45	4	51	102	0.75	102.75	62	124	22	1.5	1.51
-2.50	4	51	102	0.75	102.75	62	124	22	1.5	1.51
-2.55	4	52	104	0.75	104.75	62	124	20	1.36	1.37
-2.60	4	52	104	0.75	104.75	64	128	24	1.63	1.64
-2.65	4	53	106	0.75	106.75	65	130	24	1.63	1.64
-2.70	4	54	108	0.75	108.75	64	128	20	1.36	1.37
-2.75	4	54	108	0.75	108.75	64	128	20	1.36	1.37
-2.80	4	55	110	0.75	110.75	66	132	22	1.5	1.51
-2.85	4	56	112	0.75	112.75	67	134	22	1.5	1.51
-2.90	4	57	114	0.75	114.75	68	136	22	1.5	1.51
-2.95	4	57	114	0.75	114.75	68	136	22	1.5	1.51
-3.00	4	57	114	0.75	114.75	68	136	22	1.5	1.51
-3.05	4	57	114	0.75	114.75	68	136	22	1.5	1.51
-3.10	4	55	110	0.75	110.75	67	134	24	1.63	1.64
-3.15	4	55	110	0.75	110.75	67	134	24	1.63	1.64
-3.20	4	55	110	0.75	110.75	67	134	24	1.63	1.64
-3.25	4	55	110	0.75	110.75	67	134	24	1.63	1.64
-3.30	5	56	112	0.91	112.91	69	138	26	1.77	1.78
-3.35	5	57	114	0.91	114.91	70	140	26	1.77	1.78
-3.40	5	58	116	0.91	116.91	71	142	26	1.77	1.78
-3.45	5	59	118	0.91	118.91	72	144	26	1.77	1.78
-3.50	5	60	120	0.91	120.91	71	142	22	1.5	1.51
-3.55	5	62	124	0.91	124.91	74	148	24	1.63	1.64
-3.60	5	63	126	0.91	126.91	72	144	18	1.22	1.23

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-3.65	5	63	126	0.91	126.91	74	148	22	1.5	1.51
-3.70	5	61	122	0.91	122.91	70	140	18	1.22	1.23
-3.75	5	61	122	0.91	122.91	70	140	18	1.22	1.23
-3.80	5	61	122	0.91	122.91	72	144	22	1.5	1.51
-3.85	5	60	120	0.91	120.91	67	134	14	0.95	0.96





ELECTRICAL RESISTIVITY TEST

Table ERT - 7

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 12-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

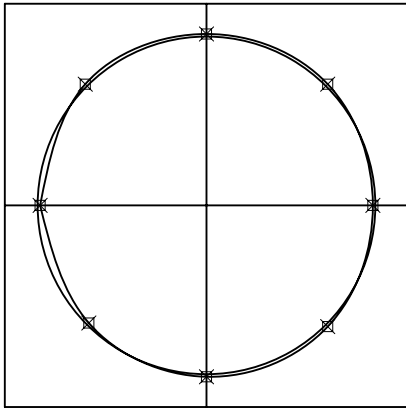
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	34	34	33	34	34	33	33	34	213.63	213.63	207.35	213.63	213.63	207.35	207.35	213.63
2	2.0	33	33	34	33	33	34	34	33	414.69	414.69	427.26	414.69	414.69	427.26	427.26	414.69
3	5.0	34	34	33	34	34	33	33	34	1,068.14	1,068.14	1,036.73	1,068.14	1,068.14	1,036.73	1,036.73	1,068.14
4	10.0	Space Not Available															
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Table ERT - 9

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 09-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

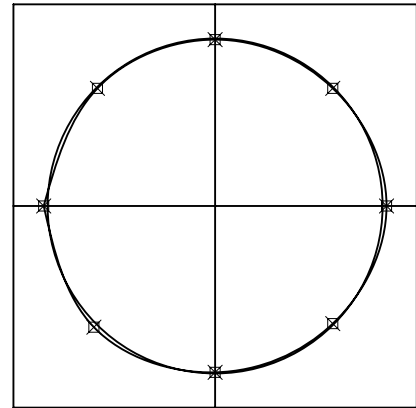
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	50	49	49	49	49	49	49	50	314.16	307.88	307.88	307.88	307.88	307.88	307.88	314.16
2	2.0	51	51	51	51	51	51	51	51	640.88	640.88	640.88	640.88	640.88	640.88	640.88	640.88
3	5.0	52	52	52	52	52	52	52	52	1,633.63	1,633.63	1,633.63	1,633.63	1,633.63	1,633.63	1,633.63	1,633.63
4	10.0	53	53	53	53	53	53	53	53	3,330.09	3,330.09	3,330.09	3,330.09	3,330.09	3,330.09	3,330.09	3,330.09
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Location - ERT-7



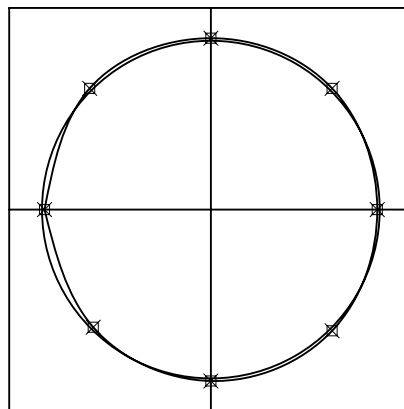
Electrode Spacing - 1.00M
R = 33.49 ohm, Resistivity = 210.32 Ohm-m

Location - ERT-7



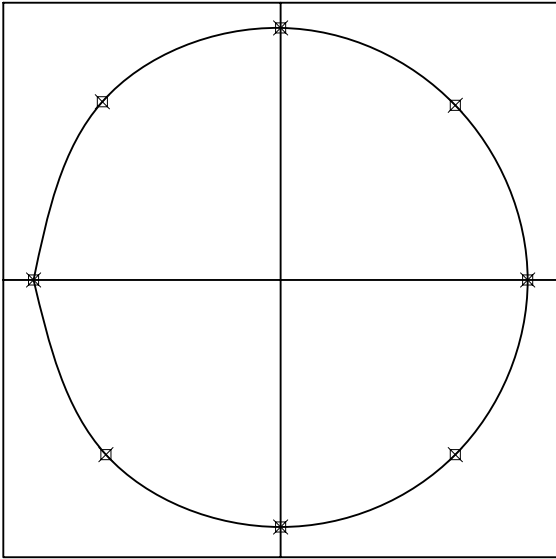
Electrode Spacing - 2.00M
R = 33.22 ohm, Resistivity = 417.24 Ohm-m

Location - ERT-7



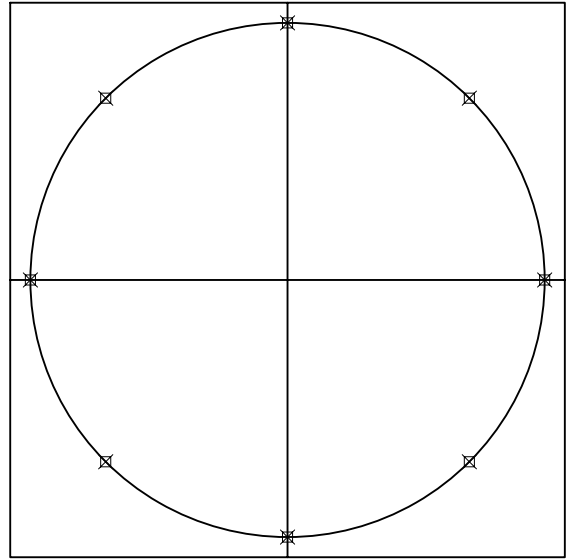
Electrode Spacing - 5.00M
R = 33.49 ohm, Resistivity = 1051.57 Ohm-m

Location - ERT-9



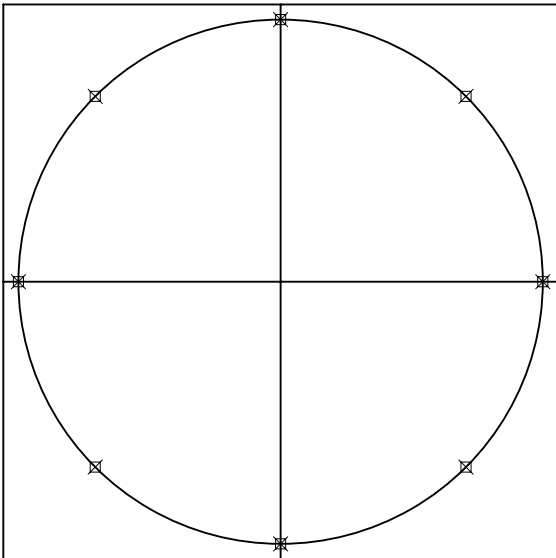
Electrode Spacing - 1.00M
R = 49.05 ohm, Resistivity = 308.03 Ohm-m

Location - ERT-9



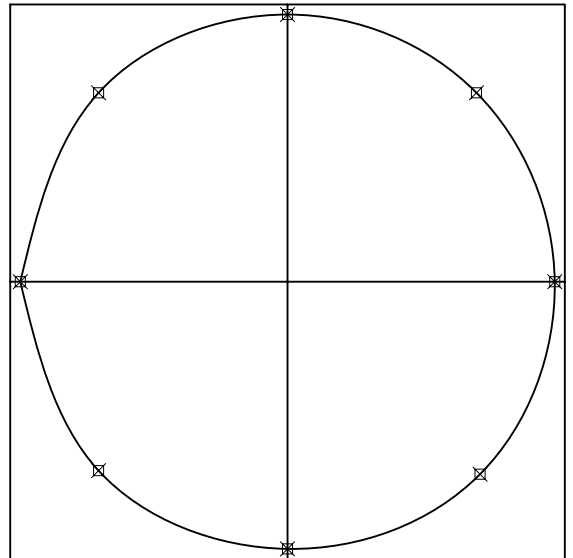
Electrode Spacing - 2.00M
R = 51.00 ohm, Resistivity = 640.88 Ohm-m

Location - ERT-9



Electrode Spacing - 5.00M
R = 52.00 ohm, Resistivity = 1633.63 Ohm-m

Location - ERT-9



Electrode Spacing - 10.00M
R = 52.89 ohm, Resistivity = 3321.49 Ohm-m

ZONE-3

**GAS CLEANING &
PURIFICATION**

Total one (1) borehole was sunk in this area, viz borehole marked BH-7. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with coal dust, clayey silt etc followed by first layer of soft brownish grey silty clay/ clayey silt. The second layer is medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt and the third layer as encountered up to the explored depth is very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Cyclic Plate Load Test:

One (1) cyclic plate load test has been carried out at this zone marked as CPLT-2.

2. Static Cone Penetration Test:

One (1) static cone penetration test has been carried out at this zone marked as SCPT-2.

3. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-6.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-3). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-3).
Recommended Pile Capacity

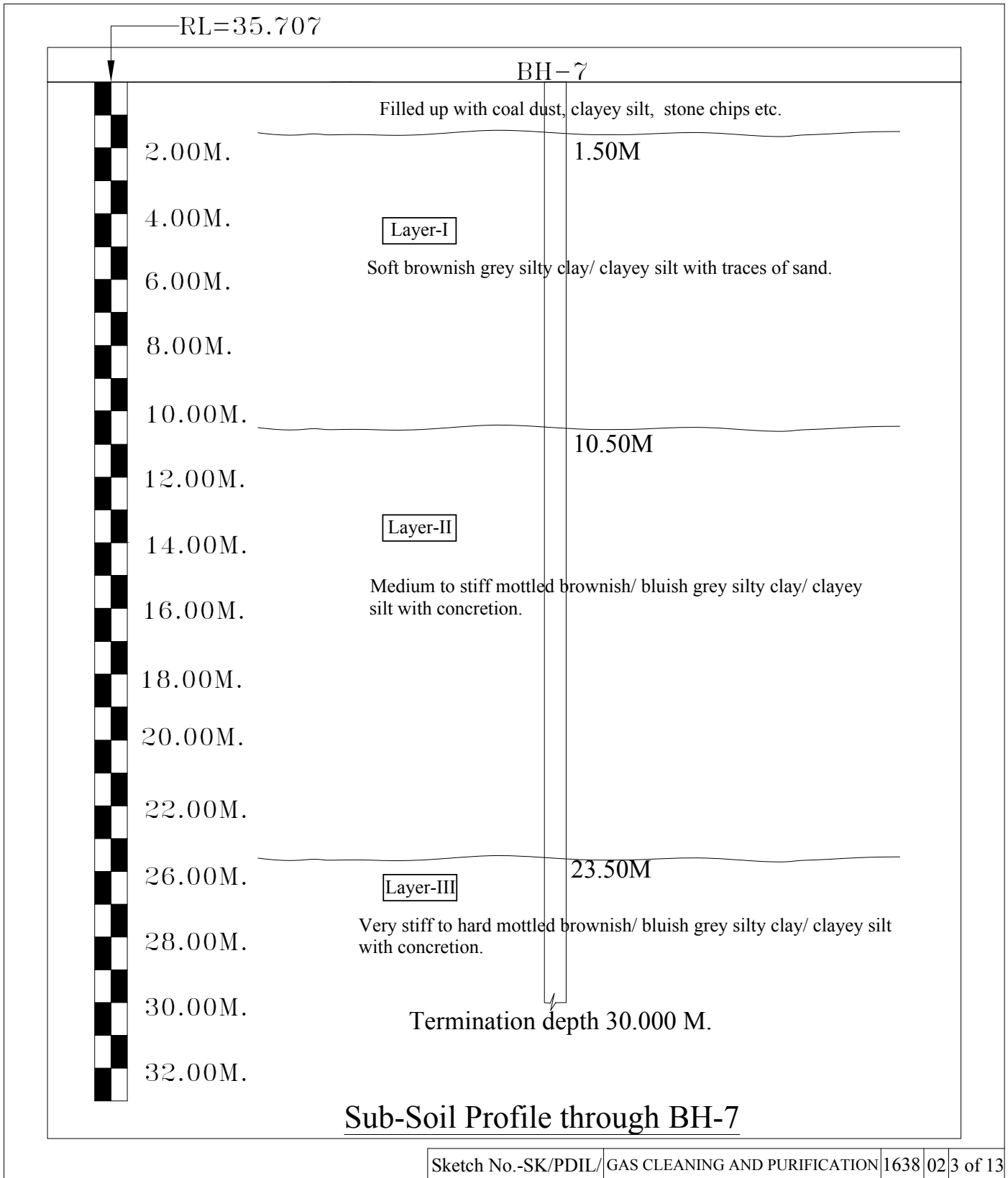
SI.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	28.000	2.000	44	39	2.73
2	0.500	28.000	2.000	56	49	2.99
3	0.550	28.000	2.000	63	54	3.10
4	0.600	28.000	2.000	69	58	3.21
5	0.750	28.000	2.000	90	73	3.51
6	1.000	28.000	2.000	128	98	3.94

BORE LOG SHEET		Centre for Advanced Engineering					Bore Hole No.:BH-7 (Sheet-1)	
Project: SOIL PDIL DANKUNI GAS CLEANING AND PURIFICATION								Job No.: Soil - 1638
Co-ord:		E.G.L.: 35.707		Unit:		Bore Hole Dia. :150 MM.		
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 27.11.2019
Depth of Boring	30.000 M.	SPT	15	UDS	10	WS		Completed on : 29.11.2019
Type of Drilling		DCPT		DS	17	RCS		Water Struck At : 3.20 M.
Depth of Drilling		VST		SCPT				Standing Water Table : 3.15 M.
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E				
				NO.	DEPTH			
Filled up with coal dust, clayey silt, stone chips etc.		01		DS1	0.50 M			
				DS2	1.00 M			
Soft brownish grey silty clay/ clayey silt with traces of sand.		02	N = 3	SPT1	1.50-1.95M			
				DS3	1.50-1.95M			
				UDS1	2.00-2.45M			
		03	N = 2	SPT2	3.00-3.45M			
				DS4	3.00-3.45M			
		04	N = 2	SPT3	4.50-4.95M			
				DS5	4.50-4.95M			
				UDS2	5.00-5.45M			
		05	N = 2	SPT4	6.00-6.45M			
				DS6	6.00-6.45M			
06	N = 3	SPT5	7.50-7.95M					
		DS7	7.50-7.95M					
		UDS3	8.00-8.45M					
07	N = 2	SPT6	9.00-9.45M					
		DS8	9.00-9.45M					
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with concretions.		11	N = 4	SPT7	10.50-10.95M			
				DS9	10.50-10.95M			
				UDS4	11.00-11.45M			
		12	N = 7	SPT8	12.50-12.95M			
				DS10	12.50-12.95M			
		13	N = 7	UDS5	14.00-14.45M			
				SPT9	14.50-14.95M			
				DS11	14.50-14.95M			
		14	N = 7	SPT10	16.50-16.95M			
DS12	16.50-16.95M							
15	N = 7	UDS6	17.00-17.45M					
16	N = 8	SPT11	18.50-18.95M					
		DS13	18.50-18.95M					
17	N = 8							
18	N = 8							
19	N = 8							
Contd.....								
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample		WS - Water Sample		
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.		RCS - Rock Core Sample		

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-7 (Sheet-2)	
Project:SOIL PDIL DANKUNI		GAS CLEANING AND PURIFICATION				Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.707		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	30.000 M.	SPT	15	UDS	10	WS	
Type of Drilling		DCPT		DS	17	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 27.11.2019	
						Completed on : 29.11.2019	
						Water Struck At : 3.20 M.	
						Standing Water Table : 3.15 M.	

D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E	
				NO.	DEPTH
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with concretion.		21	N = 9	UDS7	20.00-20.45M
				SPT12	20.50-20.95M
				DS14	20.50-20.95M
Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with concretion.		23	N = 23	UDS8	23.00-23.45M
				SPT13	23.50-23.95M
				DS15	23.50-23.95M
		26	N = 29	UDS9	26.00-26.45M
				SPT14	26.50-26.95M
				DS16	26.50-26.95M
Termination Depth 30.000 Mtr.		29	N = 33	UDS10	29.00-29.45M
				SPT15	29.55-30.00M
				DS17	29.55-30.00M
		31			
		32			
		33			
		34			
		35			
		36			
		37			
		38			
		39			

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample



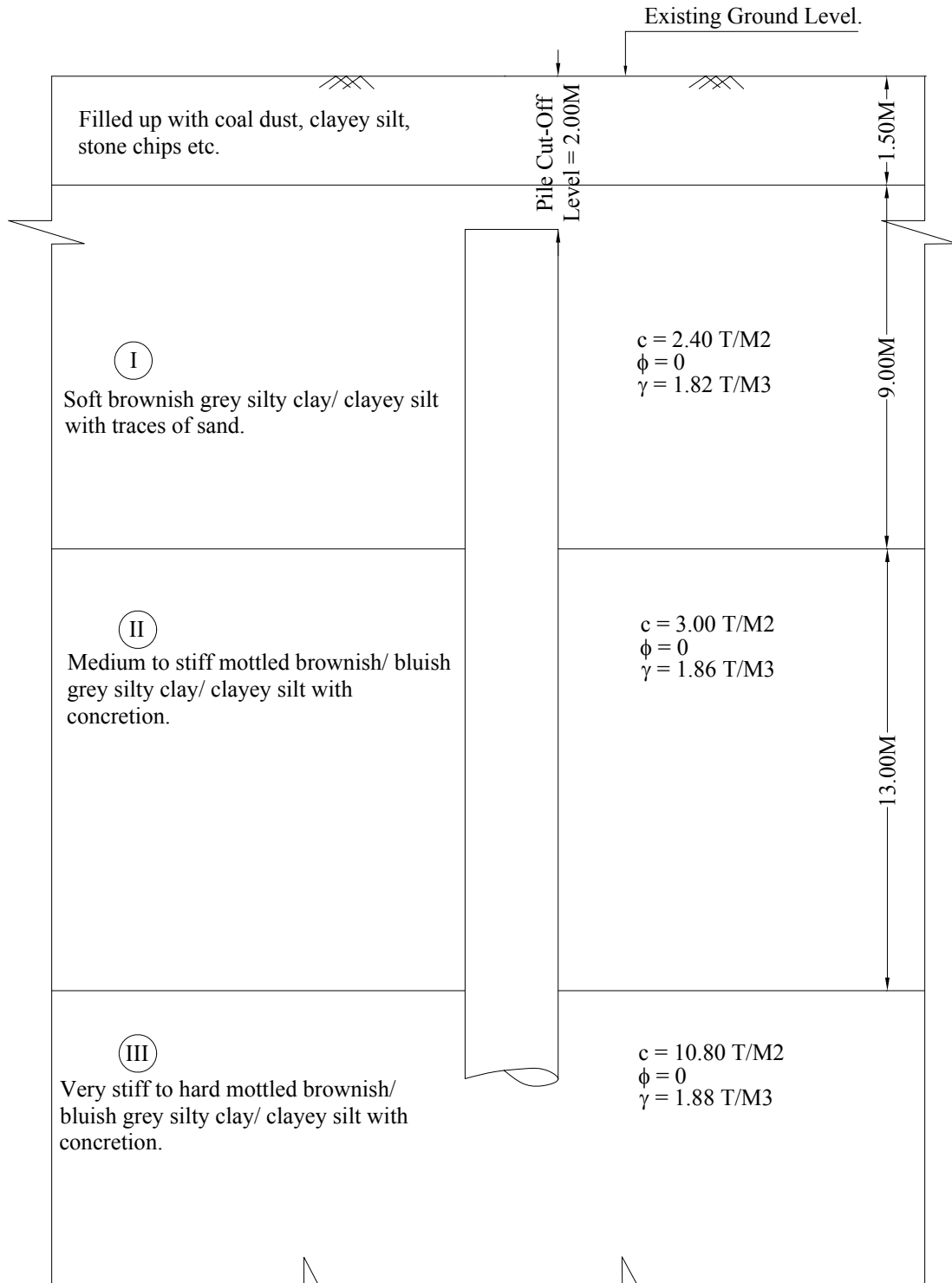
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/CU/CD /DS	C	φ								
I	Soft brownish grey silty clay/ clayey silt with traces of sand.	7	3.00	DN	2	52	20	13.4			2.66								8.29	0	9	61	30	
		7	5.00	UD		49	21	15.1	1.82	31.15	2.67	1.39	0.45	UU	0.24	0	0.00-0.10	0.0238	6.64	0	10	64	26	
																	0.10-0.20	0.0289						
														CU	0.08	11	0.20-0.40	0.0463						
		CD	0	18	0.40-0.80	0.0388																		
0.80-1.60	0.0299																							
			1.60-3.20	0.0193																				
7	7.50	DN	2	56	23	14.6			2.67									7.69	0	6	63	31		
II	Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with concretion.	7	11.00	UD		48	20	13.2	1.86	28.99	2.66	1.44	0.57	UU	0.30	0	0.00-0.10	0.0251	15.83	0	7	67	26	
																	0.10-0.20	0.0296						
														CU	0.11	13	0.20-0.40	0.0457						
																	0.40-0.80	0.0379						
														CD	0	20	0.80-1.60	0.0284						
		1.60-3.20	0.0173																					
		7	10.50	DN	4	49	21	14.2			2.68									18.93	0	9	66	25
7	14.50	DN	7	47	20	13.3			2.67										25.69	0	12	60	28	
7	20.50	DN	9	50	19	12.9			2.66										14.68	0	11	59	30	
III	Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with concretion.	7	26.00	UD		50	20	13.1	1.88	23.38	2.68	1.52	2.10	UU	1.08	0	0.00-0.10	0.0128	0	0	10	62	28	
																	0.10-0.20	0.0198						
														CU	0.22	22	0.20-0.40	0.0338						
																	0.40-0.80	0.0218						
		CD	0	30	0.80-1.60	0.0165																		
1.60-3.20	0.0119																							
7	26.50	DN	29	52	21	14.6			2.67									0	0	8	63	29		

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ GAS CLEANING AND PURIFICATION 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Gas Cleaning & Purification unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft brownish grey silty clay/ clayey silt with traces of sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	2.000	10.500	1	2.4	10.681	25.635
2	0.500	28.000	2.000	10.500	1	2.4	13.352	32.044
3	0.550	28.000	2.000	10.500	1	2.4	14.687	35.249
4	0.600	28.000	2.000	10.500	1	2.4	16.022	38.453
5	0.750	28.000	2.000	10.500	1	2.4	20.028	48.066
6	1.000	28.000	2.000	10.500	1	2.4	26.704	64.088

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Gas Cleaning & Purification unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with concretion.

Sl.No	Pile Dia, D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	10.500	23.300	1	3.0	16.085	48.255
2	0.500	28.000	10.500	23.300	1	3.0	20.106	60.319
3	0.550	28.000	10.500	23.300	1	3.0	22.117	66.350
4	0.600	28.000	10.500	23.300	1	3.0	24.127	72.382
5	0.750	28.000	10.500	23.300	1	3.0	30.159	90.478
6	1.000	28.000	10.500	23.300	1	3.0	40.212	120.637

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Gas Cleaning & Purification unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with concretion.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	23.500	28.000	0.4	10.8	5.655	24.429
2	0.500	28.000	23.500	28.000	0.4	10.8	7.069	30.536
3	0.550	28.000	23.500	28.000	0.4	10.8	7.775	33.590
4	0.600	28.000	23.500	28.000	0.4	10.8	8.482	36.644
5	0.750	28.000	23.500	28.000	0.4	10.8	10.603	45.804
6	1.000	28.000	23.500	28.000	0.4	10.8	14.137	61.073

Ultimate End Bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Gas Cleaning & Purification unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description: Very stiff to hard mottled brownish/ bluish grey silty clay/ clayey silt with concretion.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Average Cohesion at the pile tip, C_P	Cross sectional area of the pile tip, A_P	Bearing capacity factor, N_C	UltimateEnd bearing capacityat pile tip, Q_{Bu} = A_P*N_C*C_P
	Mtr	Mtr.	Mtr	Mtr.	T/M ²	M ²		T
1	0.400	28.000	23.500	28.000	10.8	0.126	9.000	12.215
2	0.500	28.000	23.500	28.000	10.8	0.196	9.000	19.085
3	0.550	28.000	23.500	28.000	10.8	0.238	9.000	23.093
4	0.600	28.000	23.500	28.000	10.8	0.283	9.000	27.483
5	0.750	28.000	23.500	28.000	10.8	0.442	9.000	42.942
6	1.000	28.000	23.500	28.000	10.8	0.785	9.000	76.341

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.24 Kg/cm ²	
	=	23.544 Kn/M ²	
L (Length of Pile)	=	28.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
f_{ck}	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.350 MN/M ³	
T (Stiffness Factor)	=	1.878 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	26.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.132 Mtr.	
Therefore,	Lf	=	4.132 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	26.80 Kn	
Horizontal Shear Capacity = H_{design}	=	2.73 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Gas Cleaning & Purification unit, Dankuni Coal Complex, West Bengal

SI.No	Pile Dia, D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T
1	0.400	28.000	25.635	48.255	24.429	12.215	110.534	2.5	44.214	44	39	2.73
2	0.500	28.000	32.044	60.319	30.536	19.085	141.984	2.5	56.794	56	49	2.99
3	0.550	28.000	35.249	66.350	33.590	23.093	158.282	2.5	63.313	63	54	3.10
4	0.600	28.000	38.453	72.382	36.644	27.483	174.962	2.5	69.985	69	58	3.21
5	0.750	28.000	48.066	90.478	45.804	42.942	227.290	2.5	90.916	90	73	3.51
6	1.000	28.000	64.088	120.637	61.073	76.341	322.139	2.5	128.856	128	98	3.94

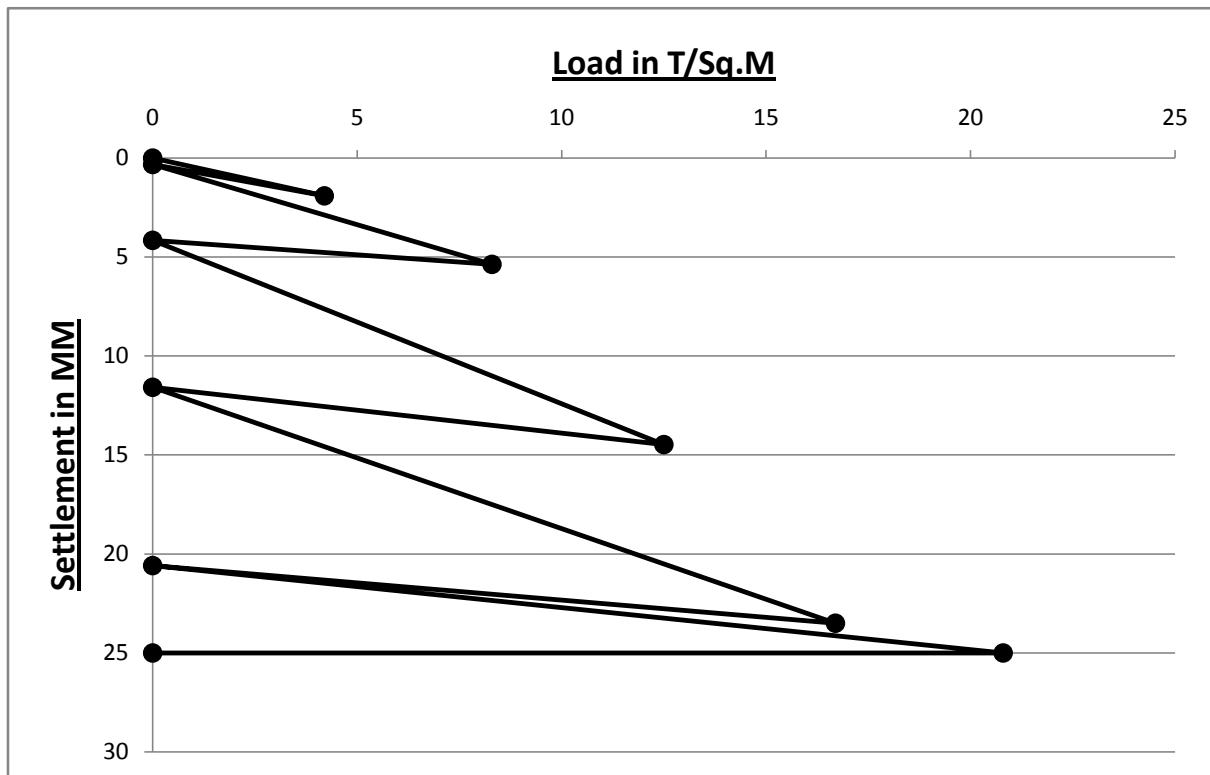
CYCLIC PLATE LOAD TEST

CYCLIC PLATE LOAD TEST SITE DATA SHEET

Client : Projects & Development India Limited
 Location : In front of Ex. Mechanical Building
 Test Number : CPLT-2
 Plate Size : 60 X 60 = 3600 Sqcm
 Pit Size : 3.00M X 3.00M X 2.50M
 Ground Water Table : Not Encountered
 L.C. of Dial Guage : 0.01 mm
 Jack Ram Dia : 10.5 cm
 Jack Ram Area : 86.59 Sqcm

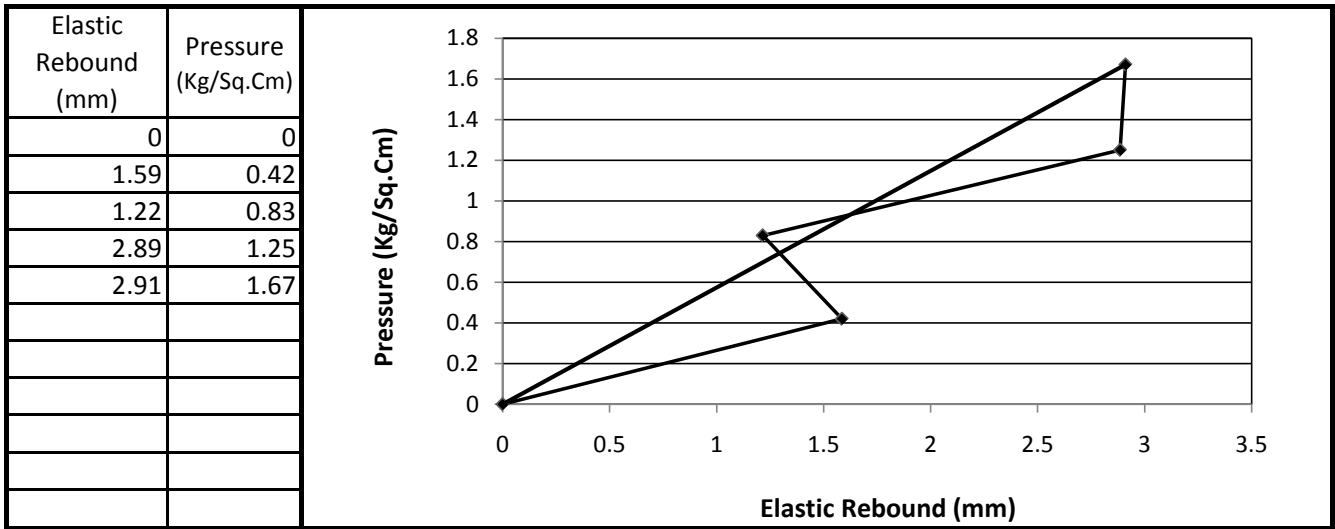
DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
28-11-2019	10:45:00	0.00	0	2500	2500	0.00	0.00	0.00	
	10:45:00	1500	0.42	2500	2500	0.00	0.00	0.00	
	10:46:00			2439	2477	0.61	0.23	0.42	
	10:47:15			2417	2456	0.83	0.44	0.64	
	10:49:00			2391	2438	1.09	0.62	0.86	
	10:51:15			2375	2407	1.25	0.93	1.09	
	10:54:00			2331	2390	1.69	1.10	1.40	
	11:01:00			2322	2368	1.78	1.32	1.55	
	11:10:00			2312	2326	1.88	1.74	1.81	
	11:46:00			2302	2316	1.98	1.84	1.91	
	11:46:00	0	0	2302	2316	1.98	1.84	1.91	
	12:46:00			2490	2445	0.10	0.55	0.33	
	12:46:00	3000	0.83	2490	2445	0.10	0.55	0.33	
	12:47:00			2110	2120	3.90	3.80	3.85	
	12:48:15			2100	2111	4.00	3.89	3.95	
	12:50:00			2090	2102	4.10	3.98	4.04	
	12:52:15			2082	2088	4.18	4.12	4.15	
	12:55:00			2079	2080	4.21	4.20	4.21	
	13:02:00			2030	2010	4.70	4.90	4.80	
	13:11:00			1990	2003	5.10	4.97	5.04	
	13:46:00			1940	1986	5.60	5.14	5.37	
	13:46:00	0	0	1940	1986	5.60	5.14	5.37	
	14:46:00			2136	2033	3.64	4.67	4.16	
	14:46:00	4500	1.25	2136	2033	3.64	4.67	4.16	
	14:47:00			1570	1645	9.30	8.55	8.93	
	14:48:15			1552	1532	9.48	9.68	9.58	
	14:50:00			1441	1420	10.59	10.80	10.70	
	14:52:15			1318	1394	11.82	11.06	11.44	
	14:55:00			1200	1279	13.00	12.21	12.61	
	15:02:00			1116	1195	13.84	13.05	13.45	
	15:11:00			1045	1107	14.55	13.93	14.24	
	15:46:00			1012	1095	14.88	14.05	14.47	
	15:46:00	0	0	1012	1095	14.88	14.05	14.47	

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
	16:46:00			1327	1357	11.73	11.43	11.58	
	16:46:00	6000	1.67	1327	1357	11.73	11.43	11.58	
	16:47:00			158	232	23.42	22.68	23.05	
	16:48:15			130	214	23.70	22.86	23.28	
	16:50:00			115	201	23.85	22.99	23.42	
	16:52:15			112	198	23.88	23.02	23.45	
	16:55:00			112	198	23.88	23.02	23.45	
	17:02:00			112	198	23.88	23.02	23.45	
	17:11:00			110	196	23.90	23.04	23.47	
	17:46:00			108	193	23.92	23.07	23.50	
	17:46:00	0	0	108	193	23.92	23.07	23.50	
	18:46:00			421	462	20.79	20.38	20.59	
	18:46:00	7500	2.08	421	462	20.79	20.38	20.59	
	18:47:00			0	0	25.00	25.00	25.00	
	18:48:15			0	0	25.00	25.00	25.00	
	18:50:00			0	0	25.00	25.00	25.00	
	18:52:15			0	0	25.00	25.00	25.00	
	18:55:00			0	0	25.00	25.00	25.00	
	19:02:00			0	0	25.00	25.00	25.00	
	19:11:00			0	0	25.00	25.00	25.00	
	19:46:00			0	0	25.00	25.00	25.00	
	19:46:00	0	0	0	0	25.00	25.00	25.00	
	20:46:00			0	0	25.00	25.00	25.00	



Load Vs Settlement Curve for CPLT-2

Evaluation of Dynamic Properties of Soil



<u>Computed dynamic properties of soil</u>	
Coefficient of elastic uniform compression (C_u) kg/cm ³	5.739
Coefficient of elastic uniform shear (C_t) kg/cm ³	2.87
Coefficient of elastic non-uniform compression (C_ϕ) kg/cm ³	9.93
Coefficient of elastic non-uniform shear (C_ψ) kg/cm ³	4.305

STATIC CONE PENETRATION TEST

Table -1

Project: Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Client.: Project & Development India Limited

Side ID :

Correction A	
1. Mass of Cone (m)	1.34 Kg
2. Mass of each sounding rod (m1)	1.55 Kg
3. Cone area at Base (b)	10 Sqcm
4. Plunger Area (b')	20 Sqcm
5. Correction factor to be added to gauge reading C1 = (m+nm1)/10	0.289 Kg
6. No of Rod Used (n)	6

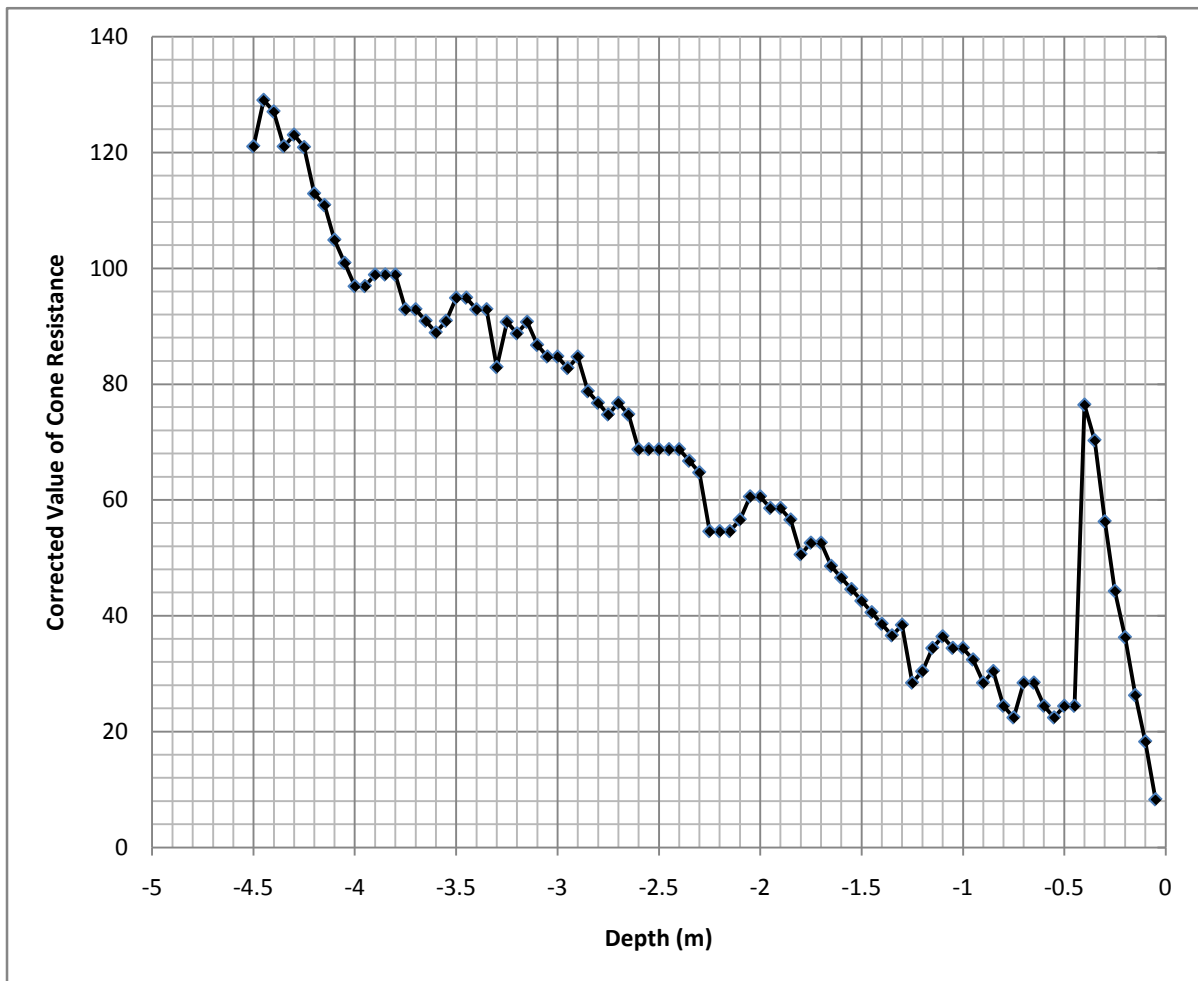
Correction B	
1. Mass of friction Jacket (m _f)	1.345 Kg
2. Outer dia, of Friction Jacket (d)	3.6 cm
3. Length of Friction Jacket (h)	13 Sqcm
4. Surface area of friction jacket (a) = π dh	147 Sqcm
5. Correction factor to be added to gauge reading C2 = (m _f /a)	0.01 Kg/ Sqcm
Test Number	SCPT-2

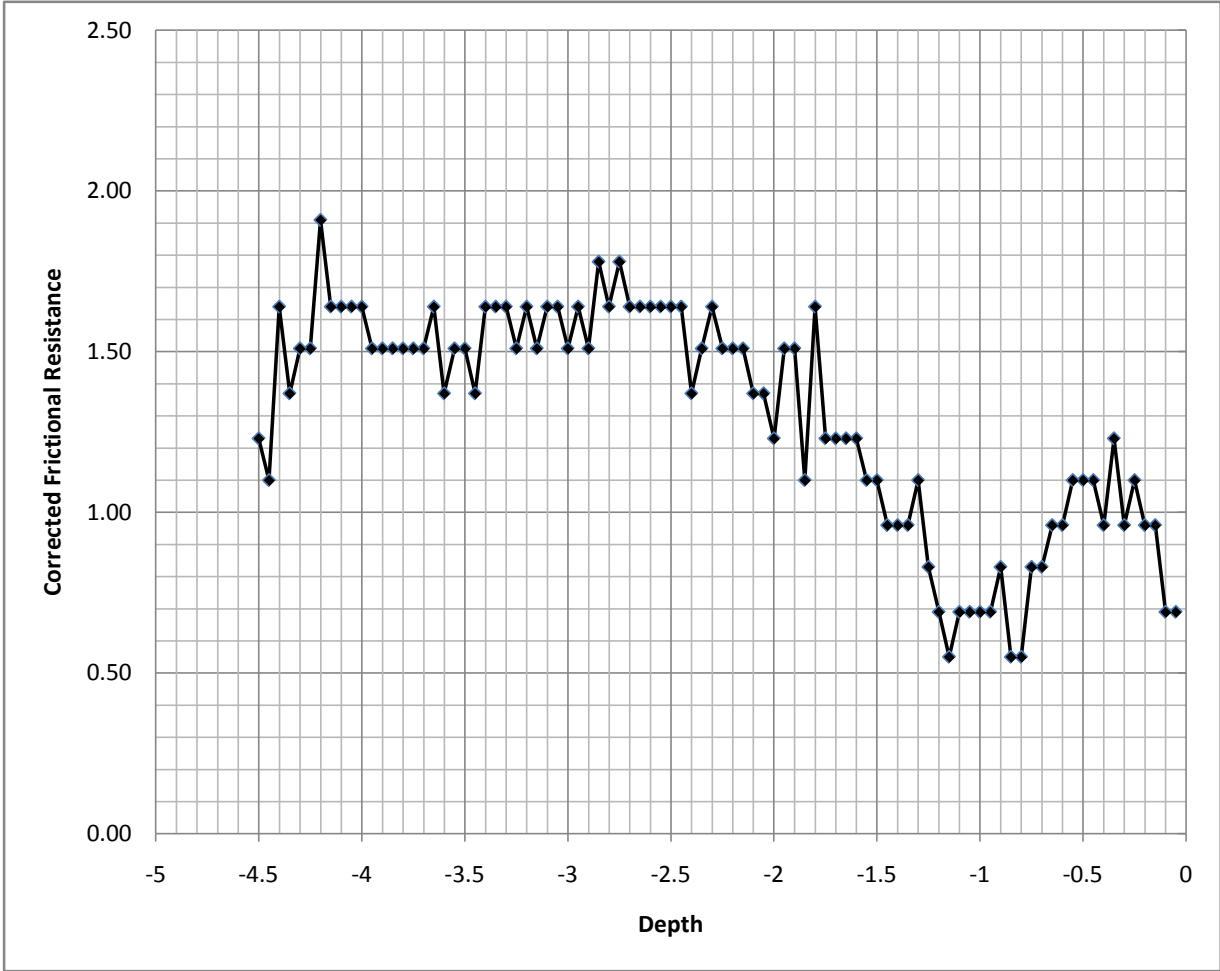
Depth	Number of Rod in Use	CONE				JACKET				
		Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	y=Y*(b'/b)	C1	R _c =y+C1	X	x=X*(b'/b)	x-y	Z=(x-y)*(b/a)	Rf= Z+(mf/a)
-0.05	1	4	8	0.29	8.29	9	18	10	0.68	0.69
-0.10	1	9	18	0.29	18.29	14	28	10	0.68	0.69
-0.15	1	13	26	0.29	26.29	20	40	14	0.95	0.96
-0.20	1	18	36	0.29	36.29	25	50	14	0.95	0.96
-0.25	1	22	44	0.29	44.29	30	60	16	1.09	1.10
-0.30	1	28	56	0.29	56.29	35	70	14	0.95	0.96
-0.35	1	35	70	0.29	70.29	44	88	18	1.22	1.23
-0.40	2	38	76	0.44	76.44	45	90	14	0.95	0.96
-0.45	2	12	24	0.44	24.44	20	40	16	1.09	1.10
-0.50	2	12	24	0.44	24.44	20	40	16	1.09	1.10
-0.55	2	11	22	0.44	22.44	19	38	16	1.09	1.10
-0.60	2	12	24	0.44	24.44	19	38	14	0.95	0.96
-0.65	2	14	28	0.44	28.44	21	42	14	0.95	0.96
-0.70	2	14	28	0.44	28.44	20	40	12	0.82	0.83

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-0.75	2	11	22	0.44	22.44	17	34	12	0.82	0.83
-0.80	2	12	24	0.44	24.44	16	32	8	0.54	0.55
-0.85	2	15	30	0.44	30.44	19	38	8	0.54	0.55
-0.90	2	14	28	0.44	28.44	20	40	12	0.82	0.83
-0.95	2	16	32	0.44	32.44	21	42	10	0.68	0.69
-1.00	2	17	34	0.44	34.44	22	44	10	0.68	0.69
-1.05	2	17	34	0.44	34.44	22	44	10	0.68	0.69
-1.10	2	18	36	0.44	36.44	23	46	10	0.68	0.69
-1.15	2	17	34	0.44	34.44	21	42	8	0.54	0.55
-1.20	2	15	30	0.44	30.44	20	40	10	0.68	0.69
-1.25	2	14	28	0.44	28.44	20	40	12	0.82	0.83
-1.30	2	19	38	0.44	38.44	27	54	16	1.09	1.10
-1.35	3	18	36	0.6	36.6	25	50	14	0.95	0.96
-1.40	3	19	38	0.6	38.6	26	52	14	0.95	0.96
-1.45	3	20	40	0.6	40.6	27	54	14	0.95	0.96
-1.50	3	21	42	0.6	42.6	29	58	16	1.09	1.10
-1.55	3	22	44	0.6	44.6	30	60	16	1.09	1.10
-1.60	3	23	46	0.6	46.6	32	64	18	1.22	1.23
-1.65	3	24	48	0.6	48.6	33	66	18	1.22	1.23
-1.70	3	26	52	0.6	52.6	35	70	18	1.22	1.23
-1.75	3	26	52	0.6	52.6	35	70	18	1.22	1.23
-1.80	3	25	50	0.6	50.6	37	74	24	1.63	1.64
-1.85	3	28	56	0.6	56.6	36	72	16	1.09	1.1
-1.90	3	29	58	0.6	58.6	40	80	22	1.5	1.51
-1.95	3	29	58	0.6	58.6	40	80	22	1.5	1.51
-2.00	3	30	60	0.6	60.6	39	78	18	1.22	1.23
-2.05	3	30	60	0.6	60.6	40	80	20	1.36	1.37
-2.10	3	28	56	0.6	56.6	38	76	20	1.36	1.37
-2.15	3	27	54	0.6	54.6	38	76	22	1.5	1.51

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-2.20	3	27	54	0.6	54.6	38	76	22	1.5	1.51
-2.25	3	27	54	0.6	54.6	38	76	22	1.5	1.51
-2.30	4	32	64	0.75	64.75	44	88	24	1.63	1.64
-2.35	4	33	66	0.75	66.75	44	88	22	1.5	1.51
-2.40	4	34	68	0.75	68.75	44	88	20	1.36	1.37
-2.45	4	34	68	0.75	68.75	46	92	24	1.63	1.64
-2.50	4	34	68	0.75	68.75	46	92	24	1.63	1.64
-2.55	4	34	68	0.75	68.75	46	92	24	1.63	1.64
-2.60	4	34	68	0.75	68.75	46	92	24	1.63	1.64
-2.65	4	37	74	0.75	74.75	49	98	24	1.63	1.64
-2.70	4	38	76	0.75	76.75	50	100	24	1.63	1.64
-2.75	4	37	74	0.75	74.75	50	100	26	1.77	1.78
-2.80	4	38	76	0.75	76.75	50	100	24	1.63	1.64
-2.85	4	39	78	0.75	78.75	52	104	26	1.77	1.78
-2.90	4	42	84	0.75	84.75	53	106	22	1.5	1.51
-2.95	4	41	82	0.75	82.75	53	106	24	1.63	1.64
-3.00	4	42	84	0.75	84.75	53	106	22	1.5	1.51
-3.05	4	42	84	0.75	84.75	54	108	24	1.63	1.64
-3.10	4	43	86	0.75	86.75	55	110	24	1.63	1.64
-3.15	4	45	90	0.75	90.75	56	112	22	1.5	1.51
-3.20	4	44	88	0.75	88.75	56	112	24	1.63	1.64
-3.25	4	45	90	0.75	90.75	56	112	22	1.5	1.51
-3.30	5	41	82	0.91	82.91	53	106	24	1.63	1.64
-3.35	5	46	92	0.91	92.91	58	116	24	1.63	1.64
-3.40	5	46	92	0.91	92.91	58	116	24	1.63	1.64
-3.45	5	47	94	0.91	94.91	57	114	20	1.36	1.37
-3.50	5	47	94	0.91	94.91	58	116	22	1.5	1.51
-3.55	5	45	90	0.91	90.91	56	112	22	1.5	1.51
-3.60	5	44	88	0.91	88.91	54	108	20	1.36	1.37

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-3.65	5	45	90	0.91	90.91	57	114	24	1.63	1.64
-3.70	5	46	92	0.91	92.91	57	114	22	1.5	1.51
-3.75	5	46	92	0.91	92.91	57	114	22	1.5	1.51
-3.80	5	49	98	0.91	98.91	60	120	22	1.5	1.51
-3.85	5	49	98	0.91	98.91	60	120	22	1.5	1.51
-3.90	5	49	98	0.91	98.91	60	120	22	1.5	1.51
-3.95	5	48	96	0.91	96.91	59	118	22	1.5	1.51
-4.00	5	48	96	0.91	96.91	60	120	24	1.63	1.64
-4.05	5	50	100	0.91	100.91	62	124	24	1.63	1.64
-4.10	5	52	104	0.91	104.91	64	128	24	1.63	1.64
-4.15	5	55	110	0.91	110.91	67	134	24	1.63	1.64
-4.20	5	56	112	0.91	112.91	70	140	28	1.9	1.91
-4.25	5	60	120	0.91	120.91	71	142	22	1.5	1.51
-4.30	6	61	122	1.06	123.06	72	144	22	1.5	1.51
-4.35	6	60	120	1.06	121.06	70	140	20	1.36	1.37
-4.40	6	63	126	1.06	127.06	75	150	24	1.63	1.64
-4.45	6	64	128	1.06	129.06	72	144	16	1.09	1.1
-4.50	6	60	120	1.06	121.06	69	138	18	1.22	1.23





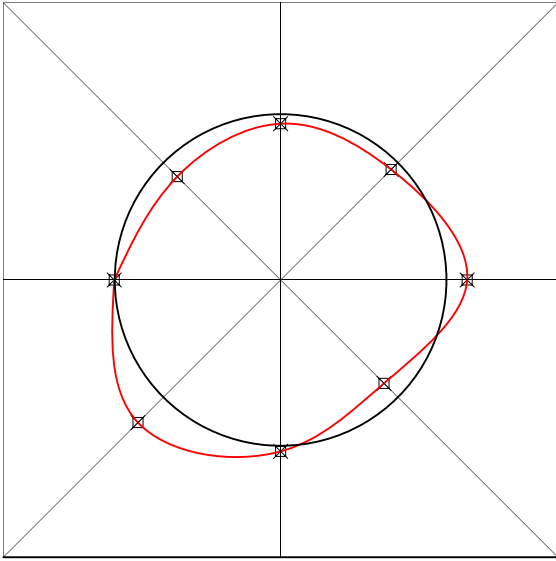
ELECTRICAL RESISTIVITY TEST

Table ERT - 6

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 21-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

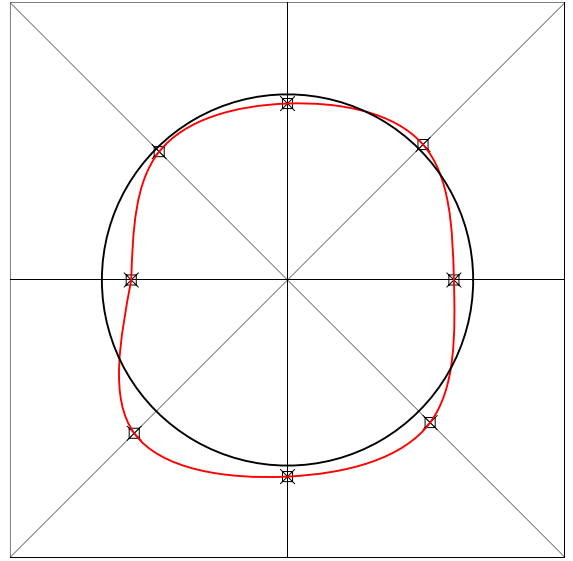
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	31	31	37	29	34	40	33	29	194.78	194.78	232.48	182.21	213.63	251.33	207.35	182.21
2	2.0	35	38	33	40	39	43	31	36	439.82	477.52	414.69	502.65	490.09	540.35	389.56	452.39
3	5.0	48	41	44	47	52	49	50	46	1,507.96	1,288.05	1,382.30	1,476.55	1,633.63	1,539.38	1,570.80	1,445.13
4	10.0	53	50	43	49	51	46	48	42	3,330.09	3,141.59	2,701.77	3,078.76	3,204.42	2,890.27	3,015.93	2,638.94
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Location - ERT-6



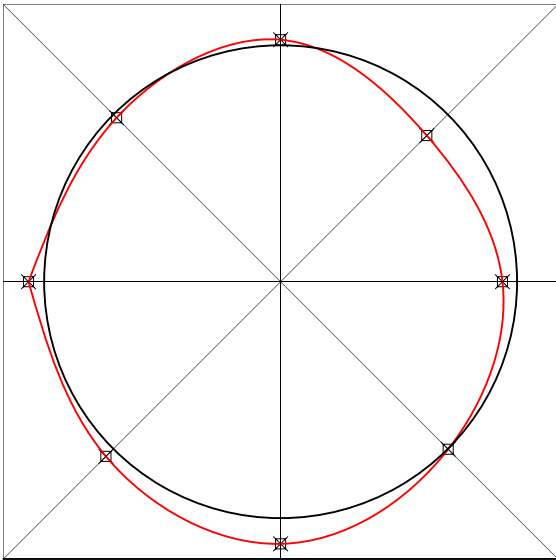
Electrode Spacing - 1.00M
R = 32.89 ohm, Resistivity = 206.55 Ohm-m

Location - ERT-6



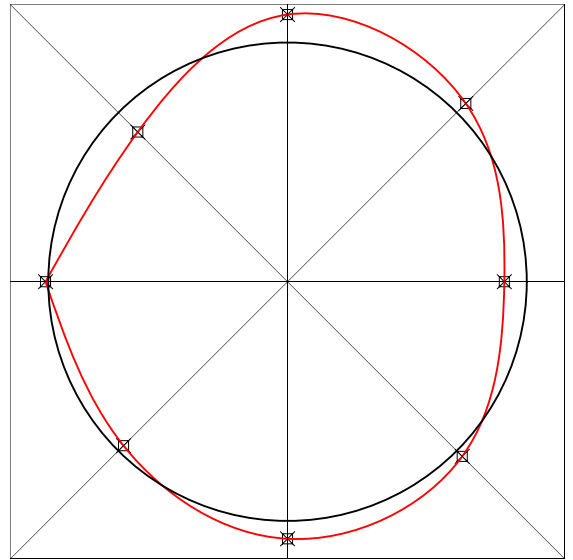
Electrode Spacing - 2.00M
R = 36.82 ohm, Resistivity = 462.46 Ohm-m

Location - ERT-6



Electrode Spacing - 5.00M
R = 46.90 ohm, Resistivity = 1472.66 Ohm-m

Location - ERT-6



Electrode Spacing - 10.00M
R = 47.45 ohm, Resistivity = 2979.86 Ohm-m

ZONE-4

**METHANOL
SYNTHESIS**

Total one (1) borehole was sunk in this area, viz borehole marked BH-10. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with fly ash etc followed by first layer of soft light grey silty clay/ clayey silt. The second layer is soft dark grey silty clay/ clayey silt. The third layer is soft bluish grey silty clay/ clayey silt. The fourth layer is medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt. The fifth layer is medium to dense brownish grey silty sand and the sixth layer as encountered up to the explored depth is hard brownish grey silty clay/ clayey silt.

In addition the following field test has been carried out at this zone and results are being indicated in this chapter.

1. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-4.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-4). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-4).
Recommended Pile Capacity

Sl.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	27.000	2.000	48	43	2.14
2	0.500	27.000	2.000	65	56	2.34
3	0.550	27.000	2.000	74	62	2.43
4	0.600	27.000	2.000	84	69	2.52
5	0.750	27.000	2.000	120	90	2.75
6	1.000	27.000	2.000	201	129	3.09

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-10 (Sheet-1)	
Project: SOIL PDIL DANKUNI METHANOL SYSTHESIS						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.744		Unit:		Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 16.10.2019	
						Completed on : 19.10.2019	
						Water Struck At : 1.00 M.	
						Standing Water Table : 0.85 M.	
DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Filled up with Fly Ash.				DS1	0.50 M		
Soft light grey silty clay/ clayey silt with traces of kankar.		01	N = 2	DS2	1.00 M		
				SPT1	1.50-1.95M		
				DS3	1.50-1.95M		
				UDS1	2.00-2.45M		
Soft dark grey silty clay/ clayey silt with peat.		03	N = 3	SPT2	3.00-3.45M		
				DS4	3.00-3.45M		
				SPT3	4.50-4.95M		
				DS5	4.50-4.95M		
Soft dark grey silty clay/ clayey silt with peat.		06	N = 2	UDS2	5.00-5.45M		
				SPT4	6.00-6.45M		
				DS6	6.00-6.45M		
				SPT5	7.50-7.95M		
Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.		08	N = 2	DS7	7.50-7.95M		
				UDS3	8.00-8.45M		
				SPT6	9.00-9.45M		
				DS8	9.00-9.45M		
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		11	N = 3	SPT7	10.50-10.95M		
				DS9	10.50-10.95M		
				UDS4	11.00-11.45M		
		13	N = 5	SPT8	12.50-12.95M		
				DS10	12.50-12.95M		
		15	N = 10	UDS5	14.00-14.45M		
				SPT9	14.50-14.95M		
				DS11	14.50-14.95M		
		17	N = 16	SPT10	16.50-16.95M		
				DS12	16.50-16.95M		
UDS6	17.00-17.45M						
19	N = 10	SPT11	18.50-18.95M				
		DS13	18.50-18.95M				
Contd.....							
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample			WS - Water Sample		
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.			RCS - Rock Core Sample		

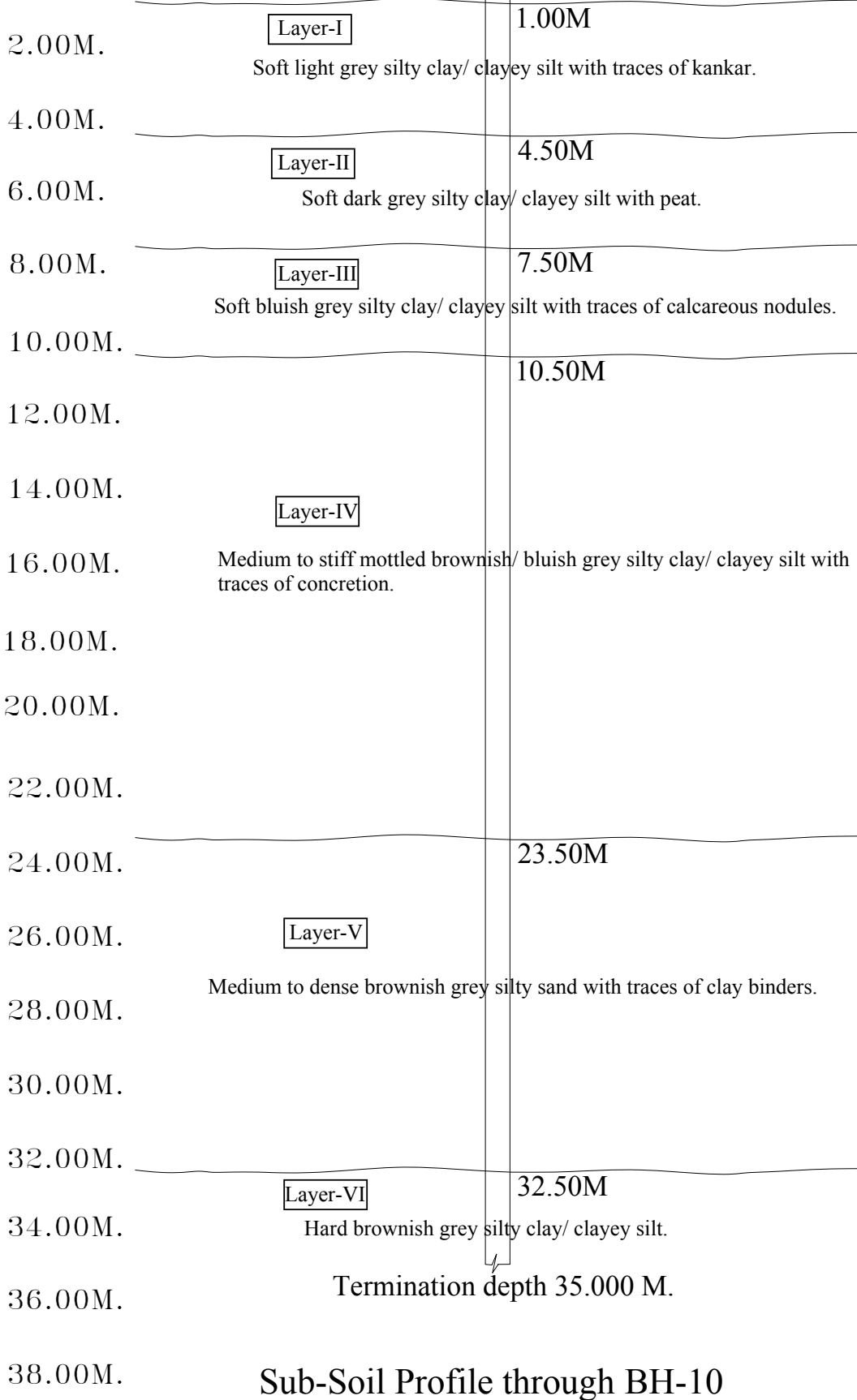
BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-10 (Sheet-2)	
Project:SOIL PDIL DANKUNI METHANOL SYSTHESIS						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.744		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 16.10.2019	
						Completed on : 19.10.2019	
						Water Struck At :1.00 M.	
						Standing Water Table : 0.85 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.		21	N = 14	UDS7	20.00-20.45M		
				SPT12	20.50-20.95M		
				DS14	20.50-20.95M		
Medium to dense brownish grey silty sand with traces of clay binders.		23	N = 29	UDS8	23.00-23.45M		
		24		SPT13	23.50-23.95M		
				DS15	23.50-23.95M		
		26	N = 43	UDS9	26.00-26.45M		
		27		SPT14	26.50-26.95M		
				DS16	26.50-26.95M		
		29	N = 45	UDS10	29.00-29.45M		
		30		SPT15	29.50-29.95M		
				DS17	29.50-29.95M		
Hard brownish grey silty clay/ clayey silt.		33	N = 49	SPT16	32.50-32.95M		
				DS18	32.50-32.95M		
Termination Depth 35.000 Mtr.		34	N = 50	SPT17	34.55-35.00M		
				DS19	34.55-35.00M		
		35					
		36					
		37					
		38					
		39					

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

RL-35.744

BH-10

Filled up with Fly Ash.



Sub-Soil Profile through BH-10

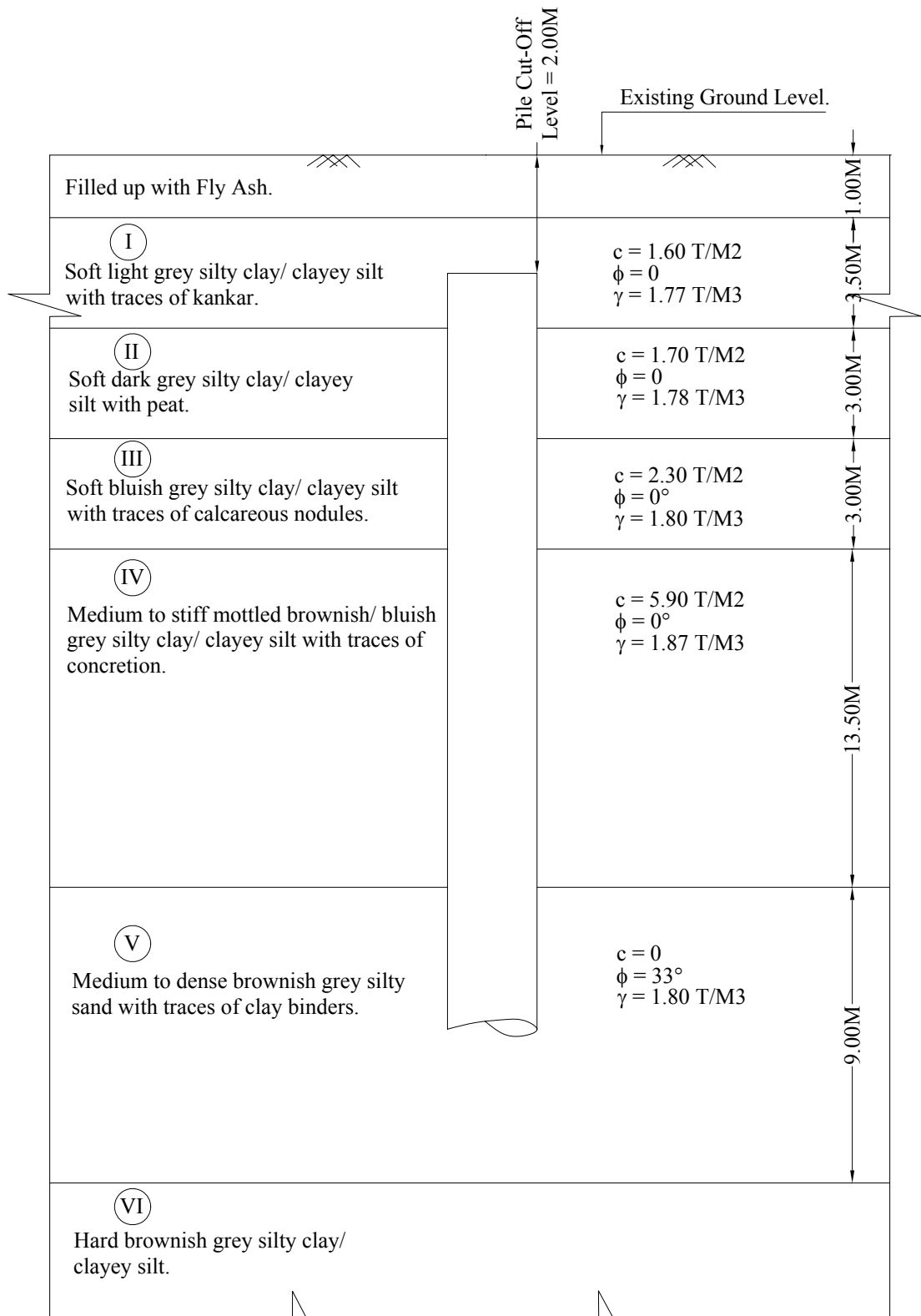
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						γ_b	m	G					γ_d	q_u	UU/CU/CD /DS	C
I	Soft light grey silty clay/ clayey silt with traces of kankar.	10	2.00	UD	54	21	14.2	1.77	40	2.68	1.26	0.30	UU	0.16	0	0.00-0.10	0.0331	0	21.00	0	10	60	30	
																0.10-0.20	0.0370							
													CU	0.06	10	0.20-0.40	0.0440							
					0.40-0.80	0.0246																		
		CD	0	14	0.80-1.60	0.0170																		
					1.60-3.20	0.0145																		
10	3.00	DN	3	55	19	12.3											18.00	0	8	44	48			
II	Soft dark grey silty clay/ clayey silt with peat.	10	5.00	UD	54	22	16.3	1.78	43.6	2.62	1.24	0.29	UU	0.17	0	0.00-0.10	0.0342	0	11.00	0	8	63	29	
																0.10-0.20	0.0378							
													CU	0.04	9	0.20-0.40	0.0451							
					0.40-0.80	0.0256																		
		CD	0	12	0.80-1.60	0.0181																		
					1.60-3.20	0.0152																		
10	7.50	DN	2	56	19	11.8											15.2	0	7	58	35			
III	Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.	10	8.00	UD	53	21	13.5	1.80	35.66	2.67	1.33	0.41	UU	0.23	0	0.00-0.10	0.0334	0	14.4	0	8	62	30	
																0.10-0.20	0.0369							
													CU	0.07	13	0.20-0.40	0.0443							
					0.40-0.80	0.0267																		
		CD	0	17	0.80-1.60	0.0194																		
					1.60-3.20	0.0169																		
10	10.50	DN	3	57	18	12.6											16.6	13	11	39	37			
IV	Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.	10	14.00	UD	53	20	13.8	1.87	28.27	2.68	1.46	1.14	UU	0.59	0	0.00-0.10	0.0235	0	12.2	16	15	38	31	
																0.10-0.20	0.0292							
													CU	0.13	17	0.20-0.40	0.0385							
					0.40-0.80	0.0257																		
		CD	0	22	0.80-1.60	0.0188																		
					1.60-3.20	0.0132																		
10	18.50	DN	10	50	21	14.4											10.1	12	16	46	26			
V	Medium to dense brownish grey silty sand with traces of clay binders.	10	23.50	DN	29	33	18	10.8	1.78	2.65				DS	0.11	32				0	0	59	27	14
		10	29.50	DN	45	30	17	11.2	1.80	2.66				DS	0.09	33				0	0	66	24	10
VI	Hard brownish grey silty clay/ clayey silt.	10	32.50	DN	49	51	20	13.3		2.69									6.27	0	9	67	24	

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/METHANOL SYSTHESIS 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft light grey silty clay/ clayey silt with traces of kankar.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	27.000	2.000	4.500	1	1.6	3.142	5.027
2	0.500	27.000	2.000	4.500	1	1.6	3.927	6.283
3	0.550	27.000	2.000	4.500	1	1.6	4.320	6.912
4	0.600	27.000	2.000	4.500	1	1.6	4.712	7.540
5	0.750	27.000	2.000	4.500	1	1.6	5.890	9.425
6	1.000	27.000	2.000	4.500	1	1.6	7.854	12.566

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description Soft dark grey silty clay/ clayey silt with peat.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{SU} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	27.000	4.500	7.500	1	1.7	3.770	6.409
2	0.500	27.000	4.500	7.500	1	1.7	4.712	8.011
3	0.550	27.000	4.500	7.500	1	1.7	5.184	8.812
4	0.600	27.000	4.500	7.500	1	1.7	5.655	9.613
5	0.750	27.000	4.500	7.500	1	1.7	7.069	12.017
6	1.000	27.000	4.500	7.500	1	1.7	9.425	16.022

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	27.000	7.500	10.500	1	2.3	3.770	8.671
2	0.500	27.000	7.500	10.500	1	2.3	4.712	10.838
3	0.550	27.000	7.500	10.500	1	2.3	5.184	11.922
4	0.600	27.000	7.500	10.500	1	2.3	5.655	13.006
5	0.750	27.000	7.500	10.500	1	2.3	7.069	16.258
6	1.000	27.000	7.500	10.500	1	2.3	9.425	21.677

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{SU} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	27.000	10.500	24.000	0.75	5.9	16.965	75.068
2	0.500	27.000	10.500	24.000	0.75	5.9	21.206	93.835
3	0.550	27.000	10.500	24.000	0.75	5.9	23.326	103.219
4	0.600	27.000	10.500	24.000	0.75	5.9	25.447	112.603
5	0.750	27.000	10.500	24.000	0.75	5.9	31.809	140.753
6	1.000	27.000	10.500	24.000	0.75	5.9	42.412	187.671

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description : Medium to dense brownish grey silty sand with traces of clay binders.

Sl.No	Pile Dia, D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K * P_{Di} * \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K * P_{Di} * \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	27.000	24.000	27.000	1.000	33	30	30.14	18.40	22.40	1.80	0.8	1.3	15	4.8	0.52	3.603	4.8	3.603	3.603	3.770	13.582
2	0.500	27.000	24.000	27.000	1.000	33	30	30.14	18.40	22.40	1.80	0.8	1.3	15	6	0.52	4.503	6	4.503	4.503	4.712	21.221
3	0.550	27.000	24.000	27.000	1.000	33	30	30.14	18.40	22.40	1.80	0.8	1.3	15	6.6	0.52	4.954	6.6	4.954	4.954	5.184	25.678
4	0.600	27.000	24.000	27.000	1.000	33	30	30.14	18.40	22.40	1.80	0.8	1.3	15	7.2	0.52	5.404	7.2	5.404	5.404	5.655	30.559
5	0.750	27.000	24.000	27.000	1.000	33	30	30.14	18.40	22.40	1.80	0.8	1.3	15	9	0.52	6.755	9	6.755	6.755	7.069	47.748
6	1.000	27.000	24.000	27.000	1.000	33	30	30.14	18.40	22.40	1.80	0.8	1.3	15	12	0.52	9.007	12	9.007	9.007	9.425	84.886

Ultimate end bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description : Medium to dense brownish grey silty sand with traces of clay binders.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $=(\phi -3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Dl} at pile tip	A_p	End Bearing
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			M ²	T
1	0.400	27.000	24.000	27.000	0.000	33	30	30.14	18.40	22.40	1.8	0.8	15	4.8	0.126	11.550
2	0.500	27.000	24.000	27.000	0.000	33	30	30.14	18.40	22.40	1.8	0.8	15	6	0.196	22.558
3	0.550	27.000	24.000	27.000	0.000	33	30	30.14	18.40	22.40	1.8	0.8	15	6.6	0.238	30.025
4	0.600	27.000	24.000	27.000	0.000	33	30	30.14	18.40	22.40	1.8	0.8	15	7.2	0.283	38.980
5	0.750	27.000	24.000	27.000	0.000	33	30	30.14	18.40	22.40	1.8	0.8	15	9	0.442	76.133
6	1.000	27.000	24.000	27.000	0.000	33	30	30.14	18.40	22.40	1.8	0.8	15	12	0.785	180.464

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.16 Kg/cm ²	
	=	15.696 Kn/M ²	
L (Length of Pile)	=	27.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	0.900 MN/M ³	
T (Stiffness Factor)	=	2.036 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	25.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.479 Mtr.	
Therefore,	Lf	=	4.479 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	21.03 Kn	
Horizontal Shear Capacity = H_{design}	=	2.14 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Synthesis unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	Skin friction from layer 5	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T	T
1	0.400	27.000	5.027	6.409	8.671	75.068	13.582	11.550	120.306	2.5	48.122	48	43	2.14
2	0.500	27.000	6.283	8.011	10.838	93.835	21.221	22.558	162.748	2.5	65.099	65	56	2.34
3	0.550	27.000	6.912	8.812	11.922	103.219	25.678	30.025	186.568	2.5	74.627	74	62	2.43
4	0.600	27.000	7.540	9.613	13.006	112.603	30.559	38.980	212.301	2.5	84.920	84	69	2.52
5	0.750	27.000	9.425	12.017	16.258	140.753	47.748	76.133	302.334	2.5	120.934	120	90	2.75
6	1.000	27.000	12.566	16.022	21.677	187.671	84.886	180.464	503.287	2.5	201.315	201	129	3.09

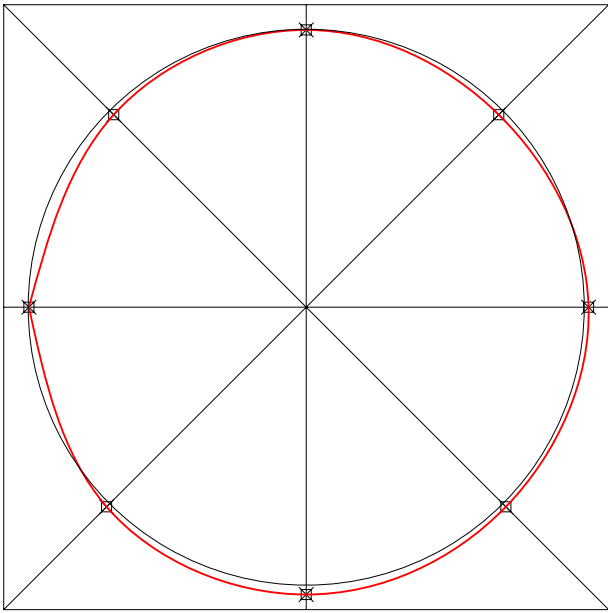
ELECTRICAL RESISTIVITY TEST

Table ERT - 4

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 12-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

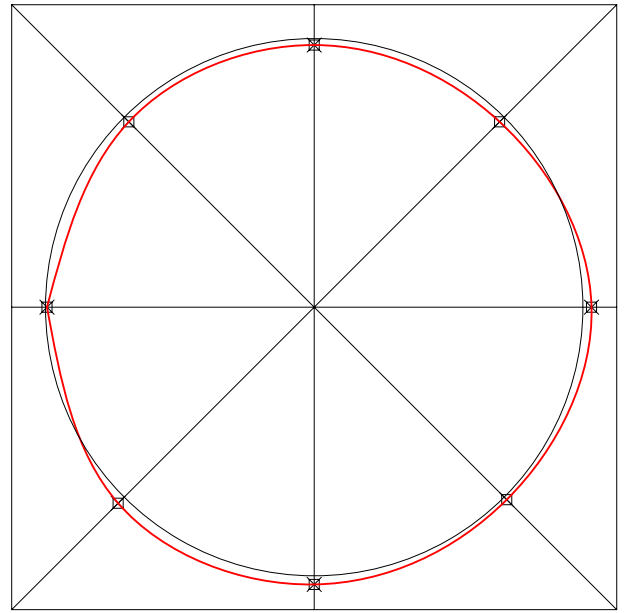
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	55	54	56	56	57	56	55	54	345.58	339.29	351.86	351.86	358.14	351.86	345.58	339.29
2	2.0	52	52	55	54	55	55	53	52	653.45	653.45	691.15	678.58	691.15	691.15	666.02	653.45
3	5.0	51	50	53	52	53	54	51	50	1,602.21	1,570.80	1,665.04	1,633.63	1,665.04	1,696.46	1,602.21	1,570.80
4	10.0	48	48	49	50	49	51	48	47	3,015.93	3,015.93	3,078.76	3,141.59	3,078.76	3,204.42	3,015.93	2,953.10
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Location - ERT-4



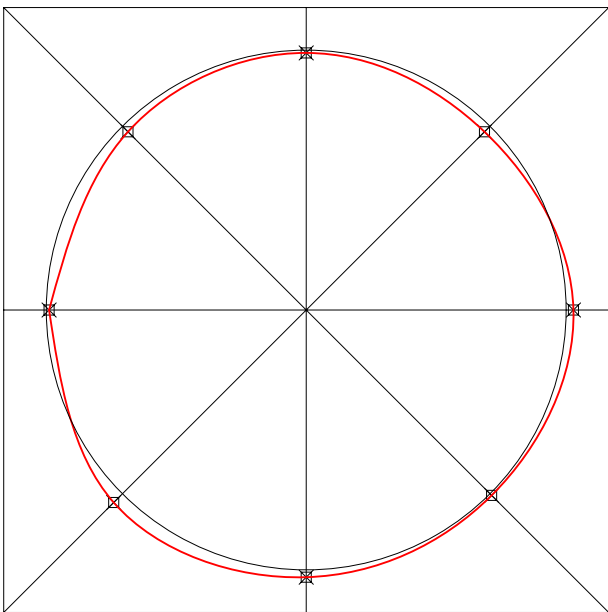
Electrode Spacing - 1.00M
R = 55.14 ohm, Resistivity = 346.28 Ohm-m

Location - ERT-4



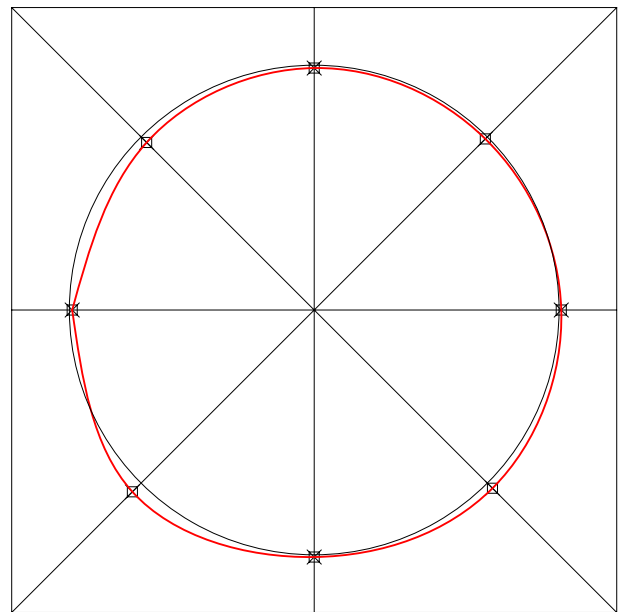
Electrode Spacing - 2.00M
R = 53.29 ohm, Resistivity = 669.32 Ohm-m

Location - ERT-4



Electrode Spacing - 5.00M
R = 51.55 ohm, Resistivity = 1618.67 Ohm-m

Location - ERT-4



Electrode Spacing - 10.00M
R = 48.56 ohm, Resistivity = 3049.57 Ohm-m

ZONE-5

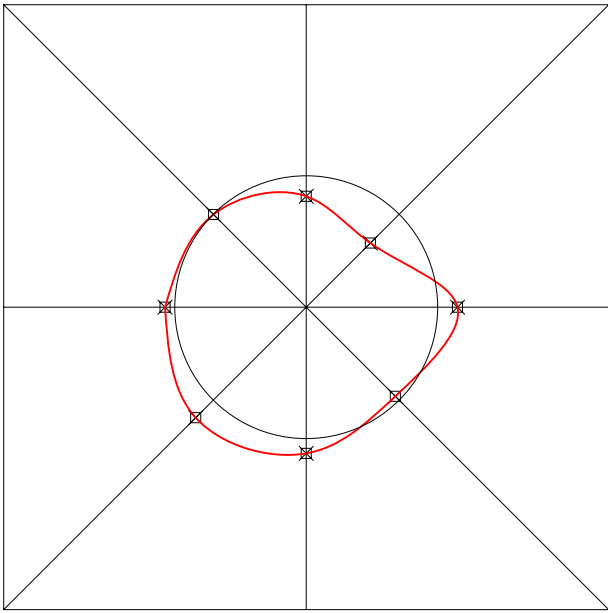
COOLING TOWER

Table ERT - 5

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 21-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

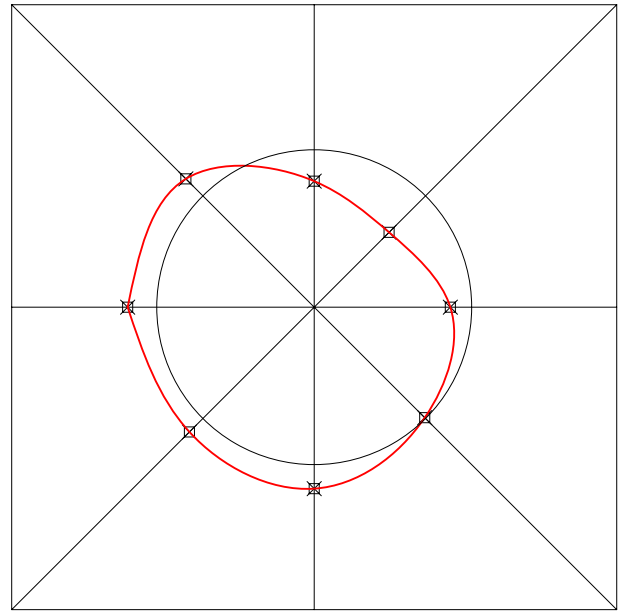
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	22	18	30	25	29	31	28	26	138.23	113.10	188.50	157.08	182.21	194.78	175.93	163.36
2	2.0	25	21	27	31	36	35	37	36	314.16	263.89	339.29	389.56	452.39	439.82	464.96	452.39
3	5.0	33	31	42	32	38	40	46	50	1,036.73	973.89	1,319.47	1,005.31	1,193.81	1,256.64	1,445.13	1,570.80
4	10.0	45	55	50	53	52	53	47	47	2,827.43	3,455.75	3,141.59	3,330.09	3,267.26	3,330.09	2,953.10	2,953.10
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Location - ERT-5



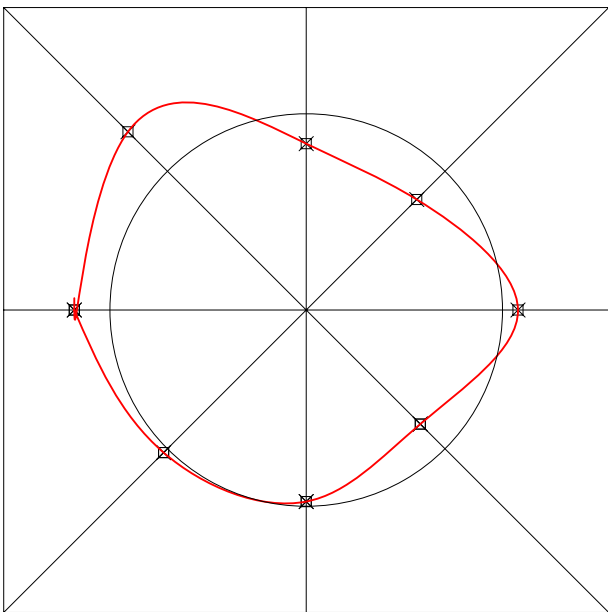
Electrode Spacing - 1.00M
R = 26.07 ohm, Resistivity = 163.72 Ohm-m

Location - ERT-5



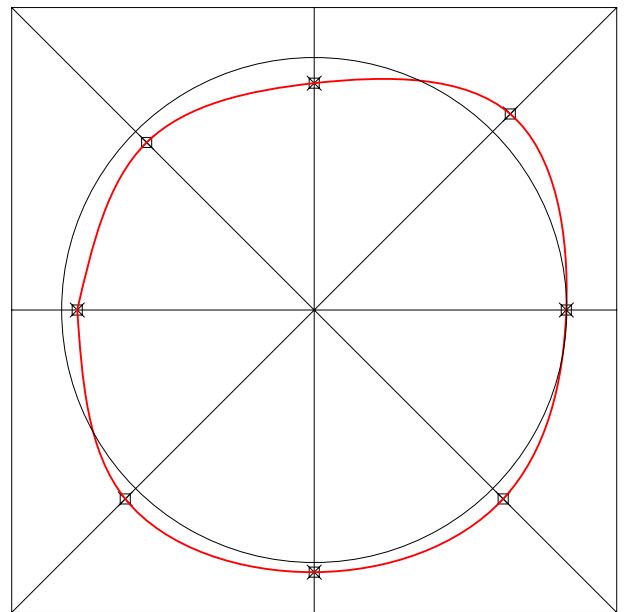
Electrode Spacing - 2.00M
R = 31.23 ohm, Resistivity = 392.25 Ohm-m

Location - ERT-5



Electrode Spacing - 5.00M
R = 38.93 ohm, Resistivity = 1222.40 Ohm-m

Location - ERT-5



Electrode Spacing - 10.00M
R = 50.09 ohm, Resistivity = 3145.65 Ohm-m

ZONE-6

BOILER UNIT

Total two (2) boreholes were sunk in this area, viz borehole marked BH-2 and BH-3. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with coal dust, clayey silt etc followed by first layer of soft light/ dark grey silty clay/ clayey silt. The second layer is soft to medium bluish grey silty clay/ clayey silt. The third layer consists of stiff light/ yellowish grey silty clay/ clayey silt and the fourth layer as encountered up to the explored depth is very stiff to hard brownish grey silty clay/ clayey silt.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Static Cone Penetration Test:

One (1) static cone penetration test has been carried out at this zone marked as SCPT-1.

2. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-2.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-6). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-6).
Recommended Pile Capacity

SI.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	28.000	2.000	54	49	2.52
2	0.500	28.000	2.000	69	62	2.76
3	0.550	28.000	2.000	77	68	2.86
4	0.600	28.000	2.000	85	74	2.96
5	0.750	28.000	2.000	110	93	3.24
6	1.000	28.000	2.000	154	124	3.64

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-2 (Sheet-1)	
Project: SOIL PDIL DANKUNI BOILER UNIT								Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.782		Unit:		Bore Hole Dia. :150 MM.			
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 03.11.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 05.11.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 2.40 M.	
Depth of Drilling		VST		SCPT				Standing Water Table : 2.34 M.	
DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with coal, brickbats, sand etc.		01		DS1	0.50 M				
Soft light grey silty clay/ clayey silt with traces of sand.		02	N = 3	DS2	1.00 M				
				SPT1	1.50-1.95M				
				DS3	1.50-1.95M				
				UDS1	2.00-2.45M				
		03	N = 4	SPT2	3.00-3.45M				
				DS4	3.00-3.45M				
		04							
		05	N = 3	SPT3	4.50-4.95M				
				DS5	4.50-4.95M				
				UDS2	5.00-5.45M				
		06	N = 2	SPT4	6.00-6.45M				
				DS6	6.00-6.45M				
	07								
	08	N = 3	SPT5	7.50-7.95M					
			DS7	7.50-7.95M					
			UDS3	8.00-8.45M					
	09	N = 3	SPT6	9.00-9.45M					
Soft to medium bluish grey silty clay/ clayey silt with traces of sand.				DS8	9.00-9.45M				
		10							
		11	N = 3	SPT7	10.50-10.95M				
				DS9	10.50-10.95M				
				UDS4	11.00-11.45M				
	12								
	13	N = 7	SPT8	12.50-12.95M					
			DS10	12.50-12.95M					
	14			UDS5	14.00-14.45M				
Medium light grey fine silty sand with mica.		15	N = 20	SPT9	14.50-14.95M				
				DS11	14.50-14.95M				
		16							
		17	N = 20	SPT10	16.50-16.95M				
				DS12	16.50-16.95M				
			UDS6	17.00-17.45M					
	18								
	19	N = 27	SPT11	18.50-18.95M					
			DS13	18.50-18.95M					
Contd.....									
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample			WS - Water Sample				
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.			RCS - Rock Core Sample				

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-2 (Sheet-2)	
Project:SOIL PDIL DANKUNI BOILER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.782		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 03.11.2019	
						Completed on : 05.11.2019	
						Water Struck At :2.40 M.	
						Standing Water Table : 2.34 M.	

D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E		
				NO.	DEPTH	
Very stiff to hard brownish grey sandy clay. With traces of silt stone and sand stone. A rusty brown spot in the deposit.		21	N = 17	UDS7	20.00-20.45M	
				SPT12	20.50-20.95M	
				DS14	20.50-20.95M	
			23	N = 13	UDS8	23.00-23.45M
			24		SPT13	23.50-23.95M
					DS15	23.50-23.95M
			26	N = 33	UDS9	26.00-26.45M
			27		SPT14	26.50-26.95M
					DS16	26.50-26.95M
			29	N = 36	UDS10	29.00-29.45M
			30		SPT15	29.50-29.95M
					DS17	29.50-29.95M
		33	N = 36	SPT16	32.50-32.95M	
				DS18	32.50-32.95M	
		34	N = 42	SPT17	34.55-35.00M	
				DS19	34.55-35.00M	
Termination Depth 35.000 Mtr.		35				
		36				
		37				
		38				
		39				

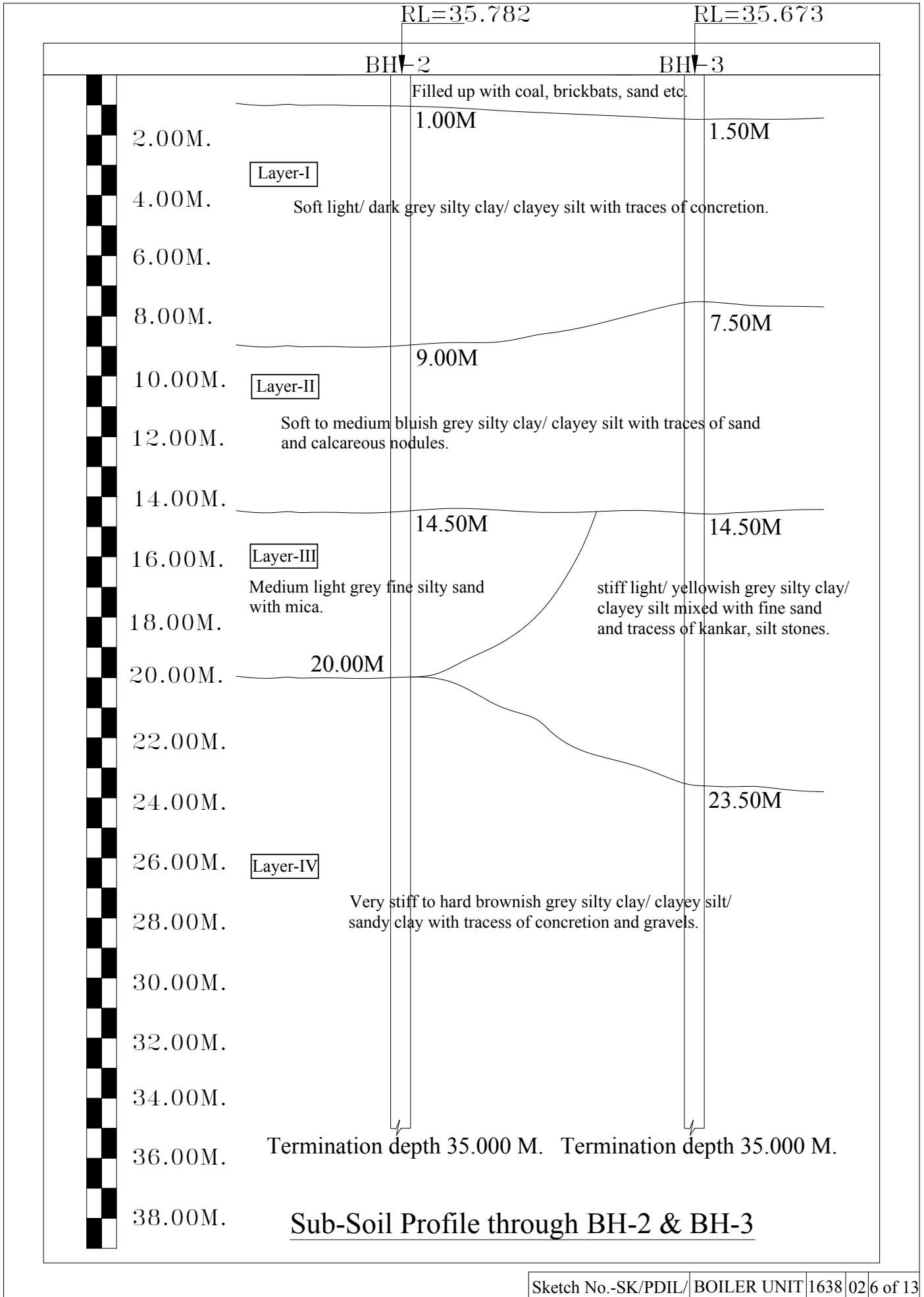
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

BORE LOG SHEET		Centre for Advanced Engineering					Bore Hole No.:BH-3 (Sheet-1)	
Project: SOIL PDIL DANKUNI BOILER UNIT							Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.673		Unit:			Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 03.11.2019
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 05.11.2019
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 2.40 M.
Depth of Drilling		VST		SCPT				Standing Water Table : 2.34 M.
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E				
				NO.	DEPTH			
Filled up with coal, brickbats, sand etc.		01		DS1	0.50 M			
				DS2	1.00 M			
Soft light/ dark grey silty clay/ clayey silt with traces of concretion.		02	N = 2	SPT1	1.50-1.95M			
				DS3	1.50-1.95M			
		03	N = 2	SPT2	3.00-3.45M			
				DS4	3.00-3.45M			
		05	N = 3	SPT3	4.50-4.95M			
				DS5	4.50-4.95M			
				UDS2	5.00-5.45M			
		06	N = 4	SPT4	6.00-6.45M			
				DS6	6.00-6.45M			
		Medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.		08	N = 5	SPT5	7.50-7.95M	
						DS7	7.50-7.95M	
						UDS3	8.00-8.45M	
09	N = 6			SPT6	9.00-9.45M			
				DS8	9.00-9.45M			
11	N = 6			SPT7	10.50-10.95M			
				DS9	10.50-10.95M			
				UDS4	11.00-11.45M			
13	N = 7			SPT8	12.50-12.95M			
				DS10	12.50-12.95M			
14		UDS5	14.00-14.45M					
stiff light/ yellowish grey silty clay/ clayey silt mixed with fine sand and traces of kankar, silt stones.		15	N = 9	SPT9	14.50-14.95M			
				DS11	14.50-14.95M			
		17	N = 12	SPT10	16.50-16.95M			
				DS12	16.50-16.95M			
				UDS6	17.00-17.45M			
		18						
		19	N = 15	SPT11	18.50-18.95M			
				DS13	18.50-18.95M			
Contd.....								
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample			WS - Water Sample	
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.			RCS - Rock Core Sample	

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-3 (Sheet-2)	
Project: SOIL PDIL DANKUNI BOILER UNIT						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.673		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 03.11.2019	
						Completed on : 05.11.2019	
						Water Struck At :2.40 M.	
						Standing Water Table : 2.34 M.	

DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E		
				NO.	DEPTH	
stiff light/ yellowish grey silty clay/ clayey silt mixed with fine sand and traces of kankar, silt stones.		21	N = 15	UDS7	20.00-20.45M	
				SPT12	20.50-20.95M	
				DS14	20.50-20.95M	
Very stiff to hard brownish grey silty clay/ clayey silt with traces of concretion and gravels.		22	N = 28	UDS8	23.00-23.45M	
				SPT13	23.50-23.95M	
				DS15	23.50-23.95M	
				N = 28	UDS9	26.00-26.45M
					SPT14	26.50-26.95M
					DS16	26.50-26.95M
				N = 29	UDS10	29.00-29.45M
					SPT15	29.50-29.95M
					DS17	29.50-29.95M
				N = 37	SPT16	32.50-32.95M
					DS18	32.50-32.95M
					N = 45	SPT17
DS19	34.55-35.00M					
Termination Depth 35.000 Mtr.		35				
		36				
		37				
		38				
		39				

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample



SUMMARY OF LABORATORY TEST RESULTS

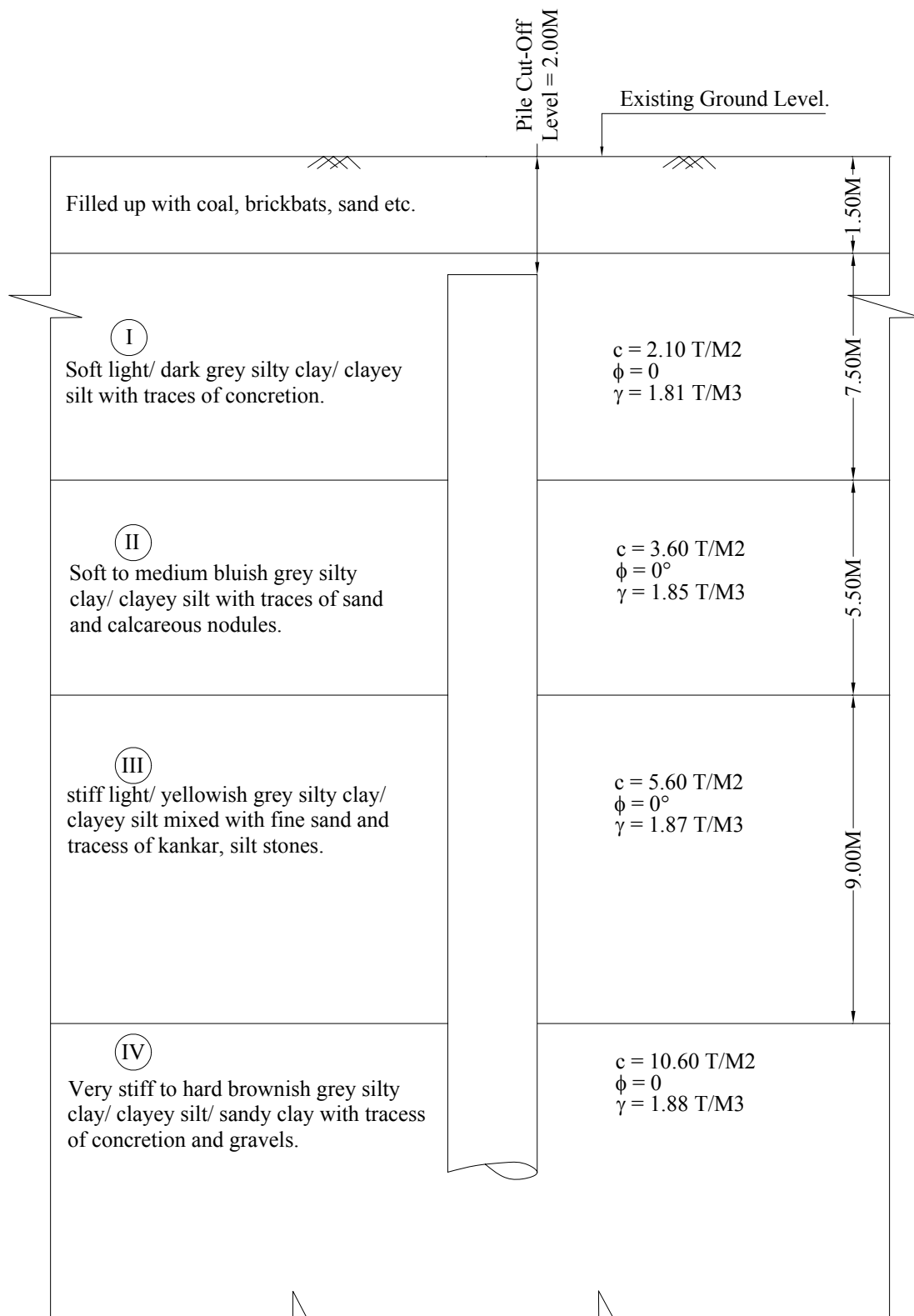
Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading				
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %	
						%	%	%						UU/CU/CD /DS	C	φ									
I	Soft light grey silty clay/ clayey silt with traces of sand.	2	1.50	DN	3	56	24	11.08			2.67								0.00	0	9	61	30		
		2	2.00	UD		52	21	12.17	1.80	37.63	2.66	1.31	0.51	UU	0.26	0	0.00-0.10	0.0239	0	2.54	0	7	65	28	
																	0.10-0.20	0.0299							
														CU	0.09	13	0.20-0.40	0.0421							
		2	4.50	DN	3	50	20	11.83			2.68														
CD	0																								
		2	7.50	DN	3	51	21	12.9			2.67								5.4	0	8	57	35		
II	Soft to medium bluish grey silty clay/ clayey silt with traces of sand.	2	9.00	DN	3	62	19	11.3			2.68								4.8	0	7	53	40		
		2	11.00	UD		53	20	11.6	1.83	29.66	2.66	1.41	0.72	UU	0.38	0	0.00-0.10	0.0231	0	3.2	0	9	60	31	
																	0.10-0.20	0.0286							
														CU	0.13	18	0.20-0.40	0.0418							
		2	12.50	DN	7	49	20	10.7			2.65														
CD	0																								
		2	18.50	DN	27	NP					2.66							0	0	99	1	0			
IV	Very stiff to hard brownish grey sandy clay. With traces of silt stone and sand stone. A rusty brown spot in the deposit.	2	20.50	DN	17	45	18	10.6			2.67								21.3	3	15	56	26		
		2	23.00	UD		48	20	11.05	1.88	24.74	2.67	1.51	2.09	UU	1.06	0	0.00-0.10	0.0114	0	18.4	14	18	42	26	
																	0.10-0.20	0.0168							
														CU	0.15	22	0.20-0.40	0.0289							
		2	26.50	DN	33	50	19	11.2			2.68														
		2	32.50	DN	36	49	19	12.06			2.66								22.5	0	25	51	24		
		2	34.55	DN	42	47	20	11.8			2.63								27	0	30	37	33		

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/CU/CD /DS	C	φ					%	%	%	%
I	Soft light/ dark grey silty clay/ clayey silt with traces of concretion.	3	1.50	DN	2	57	22	13.3			2.67								0	0	9	59	32	
		3	3.00	DN	2	62	25	14.39			2.67								1.8	0	12	54	34	
		3	4.50	DN	3	54	21	13.8			2.69								0	0	19	61	20	
		3	7.50	UD		41	18	12.1	1.81	30	2.65	1.39	0.40	UU	0.21	0	0.00-0.10	0.0234	0	6.88	0	15	59	26
																	0.10-0.20	0.0282						
														CU	0.10	15	0.20-0.40	0.0434						
												CD	0	19	0.80-1.60	0.0276								
															1.60-3.20	0.0191								
II	Medium bluish grey silty clay/ clayey silt with traces of calcareous nodules.	3	9.00	DN	6	57	18	11.9			2.67								10.2	0	8	55	37	
		3	11.00	UD		55	19	12.07	1.85	27.79	2.68	1.45	0.69	UU	0.36	0	0.00-0.10	0.0217	0	13.4	0	11	55	34
																	0.10-0.20	0.0269						
														CU	0.11	16	0.20-0.40	0.0418						
																	0.40-0.80	0.0343						
														CD	0	21	0.80-1.60	0.0257						
															1.60-3.20	0.0182								
III	stiff light/ yellowish grey silty clay/ clayey silt mixed with fine sand and traces of kankar, silt stones.	3	14.50	DN	9	44	21	13.4			2.67								0	0	14	64	22	
		3	17.00	UD		47	20	12.8	1.87	25.48	2.66	1.49	1.08	UU	0.56	0	0.00-0.10	0.0194	0	0	0	18	57	25
																	0.10-0.20	0.0259						
														CU	0.14	18	0.20-0.40	0.0383						
																	0.40-0.80	0.0217						
														CD	0	26	0.80-1.60	0.0174						
															1.60-3.20	0.0137								
IV	Very stiff to hard brownish grey silty clay/ clayey silt with traces of concretion and gravels.	3	23.50	DN	28	44	19	11.4			2.68								21.4	7	12	51	30	
		3	26.00	UD		48	18	12.03	1.92	24.15	2.67	1.55	2.15	UU	1.09	0	0.00-0.10	0.0086	0	23.2	4	6	60	30
																	0.10-0.20	0.0161						
														CU	0.17	22	0.20-0.40	0.0268						
																	0.40-0.80	0.0231						
														CD	0	29	0.80-1.60	0.0184						
															1.60-3.20	0.0149								
3	29.50	DN	29	41	17	11.8			2.68									25	7	12	59	22		
3	34.55	DN	45	45	19	10.6			2.69									13.7	8	8	47	37		

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ BOILER UNIT 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Boiler unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft light/ dark grey silty clay/ clayey silt with traces of concretions.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	2.000	9.000	1	2.1	8.796	18.473
2	0.500	28.000	2.000	9.000	1	2.1	10.996	23.091
3	0.550	28.000	2.000	9.000	1	2.1	12.095	25.400
4	0.600	28.000	2.000	9.000	1	2.1	13.195	27.709
5	0.750	28.000	2.000	9.000	1	2.1	16.493	34.636
6	1.000	28.000	2.000	9.000	1	2.1	21.991	46.181

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Boiler unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Soft to medium bluish grey silty clay/ clayey silt with traces of sand and calcareous nodules.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{SU} = α*C*A_s
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	9.000	14.500	1	3.6	6.912	24.881
2	0.500	28.000	9.000	14.500	1	3.6	8.639	31.102
3	0.550	28.000	9.000	14.500	1	3.6	9.503	34.212
4	0.600	28.000	9.000	14.500	1	3.6	10.367	37.322
5	0.750	28.000	9.000	14.500	1	3.6	12.959	46.653
6	1.000	28.000	9.000	14.500	1	3.6	17.279	62.204

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Boiler unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description: Stiff light/ yellowish grey silty clay/ clayey silt mixed with fine sand and traces of kankar, silt stones.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	14.500	23.500	0.9	5.6	11.310	57.001
2	0.500	28.000	14.500	23.500	0.9	5.6	14.137	71.251
3	0.550	28.000	14.500	23.500	0.9	5.6	15.551	78.376
4	0.600	28.000	14.500	23.500	0.9	5.6	16.965	85.502
5	0.750	28.000	14.500	23.500	0.9	5.6	21.206	106.877
6	1.000	28.000	14.500	23.500	0.9	5.6	28.274	142.503

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Boiler unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description Very stiff to hard brownish grey silty clay/ clayey silt/ sandy clay with traces of concretion and gravels.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	23.500	28.000	0.4	10.6	5.655	23.977
2	0.500	28.000	23.500	28.000	0.4	10.6	7.069	29.971
3	0.550	28.000	23.500	28.000	0.4	10.6	7.775	32.968
4	0.600	28.000	23.500	28.000	0.4	10.6	8.482	35.965
5	0.750	28.000	23.500	28.000	0.4	10.6	10.603	44.956
6	1.000	28.000	23.500	28.000	0.4	10.6	14.137	59.942

Ultimate End Bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Boiler unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description: Very stiff to hard brownish grey silty clay/ clayey silt/ sandy clay with traces of concretion and gravels.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Average Cohesion at the pile tip, C_P	Cross sectional area of the pile tip, A_P	Bearing capacity factor, N_C	UltimateEnd bearing capacityat pile tip, Q_{Bu} = A_P*N_C*C_P
	Mtr	Mtr.	Mtr	Mtr.	T/M ²	M ²		T
1	0.400	28.000	23.500	28.000	10.6	0.126	9.000	11.988
2	0.500	28.000	23.500	28.000	10.6	0.196	9.000	18.732
3	0.550	28.000	23.500	28.000	10.6	0.238	9.000	22.665
4	0.600	28.000	23.500	28.000	10.6	0.283	9.000	26.974
5	0.750	28.000	23.500	28.000	10.6	0.442	9.000	42.146
6	1.000	28.000	23.500	28.000	10.6	0.785	9.000	74.927

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.21 Kg/cm ²	
	=	20.601 Kn/M ²	
L (Length of Pile)	=	28.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.181 MN/M ³	
T (Stiffness Factor)	=	1.928 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	26.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.242 Mtr.	
Therefore,	Lf	=	4.242 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	24.77 Kn	
Horizontal Shear Capacity = H_{design}	=	2.52 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Boiler unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T
1	0.400	28.000	18.473	24.881	57.001	23.977	11.988	136.320	2.5	54.528	54	49	2.52
2	0.500	28.000	23.091	31.102	71.251	29.971	18.732	174.146	2.5	69.659	69	62	2.76
3	0.550	28.000	25.400	34.212	78.376	32.968	22.665	193.621	2.5	77.449	77	68	2.86
4	0.600	28.000	27.709	37.322	85.502	35.965	26.974	213.471	2.5	85.388	85	74	2.96
5	0.750	28.000	34.636	46.653	106.877	44.956	42.146	275.268	2.5	110.107	110	93	3.24
6	1.000	28.000	46.181	62.204	142.503	59.942	74.927	385.756	2.5	154.302	154	124	3.64

STATIC CONE PENETRATION TEST

Table -1

Project: Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Client.: Project & Development India Limited

Side ID :

Correction A	
1. Mass of Cone (m)	1.34 Kg
2. Mass of each sounding rod (m1)	1.55 Kg
3. Cone area at Base (b)	10 Sqcm
4. Plunger Area (b')	20 Sqcm
5. Correction factor to be added to gauge reading C1 = (m+nm1)/10	0.289 Kg
6. No of Rod Used (n)	5

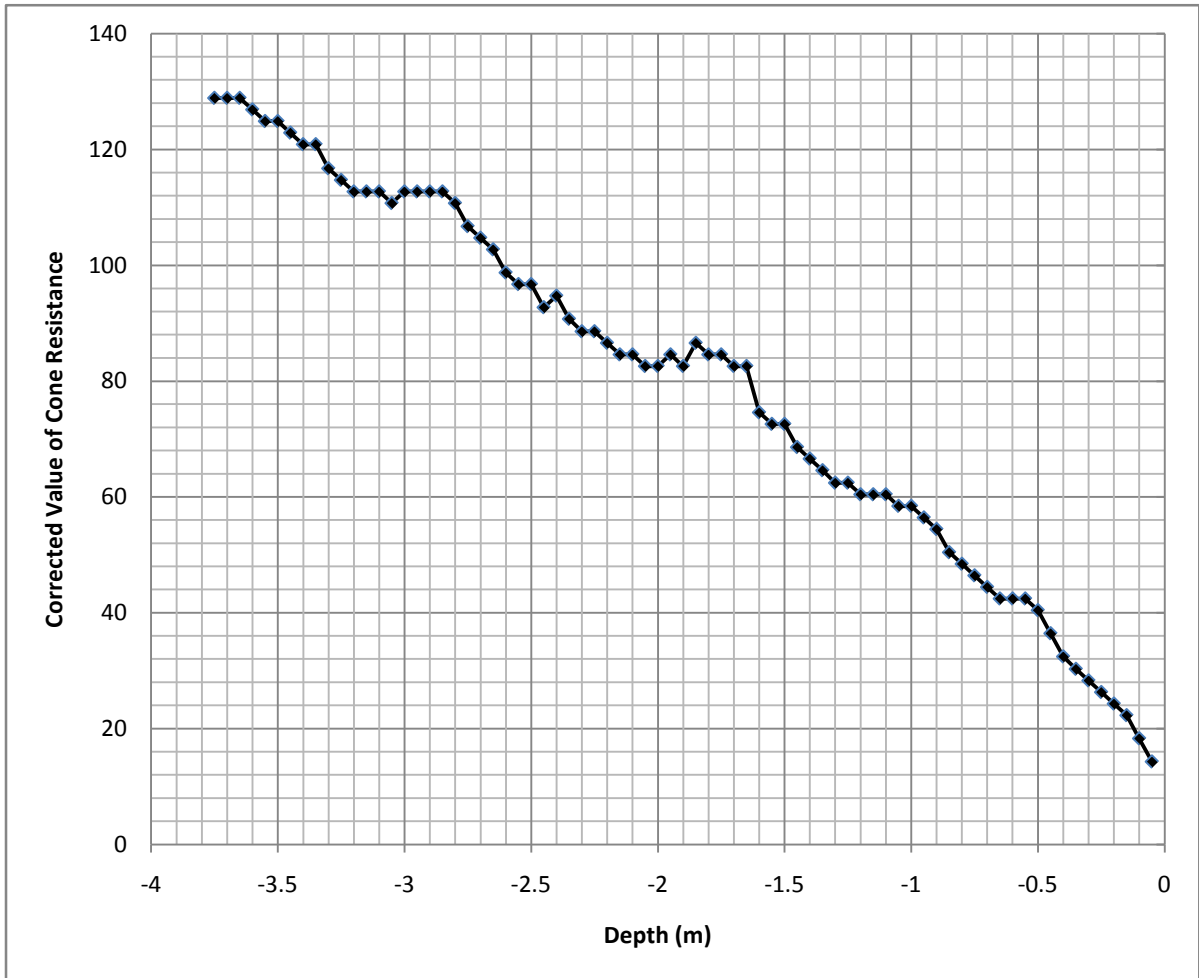
Correction B	
1. Mass of friction Jacket (m _f)	1.345 Kg
2. Outer dia, of Friction Jacket (d)	3.6 cm
3. Length of Friction Jacket (h)	13 Sqcm
4. Surface area of friction jacket (a) = π dh	147 Sqcm
5. Correction factor to be added to gauge reading C2 = (m _f /a)	0.01 Kg/ Sqcm
Test Number	SCPT-1

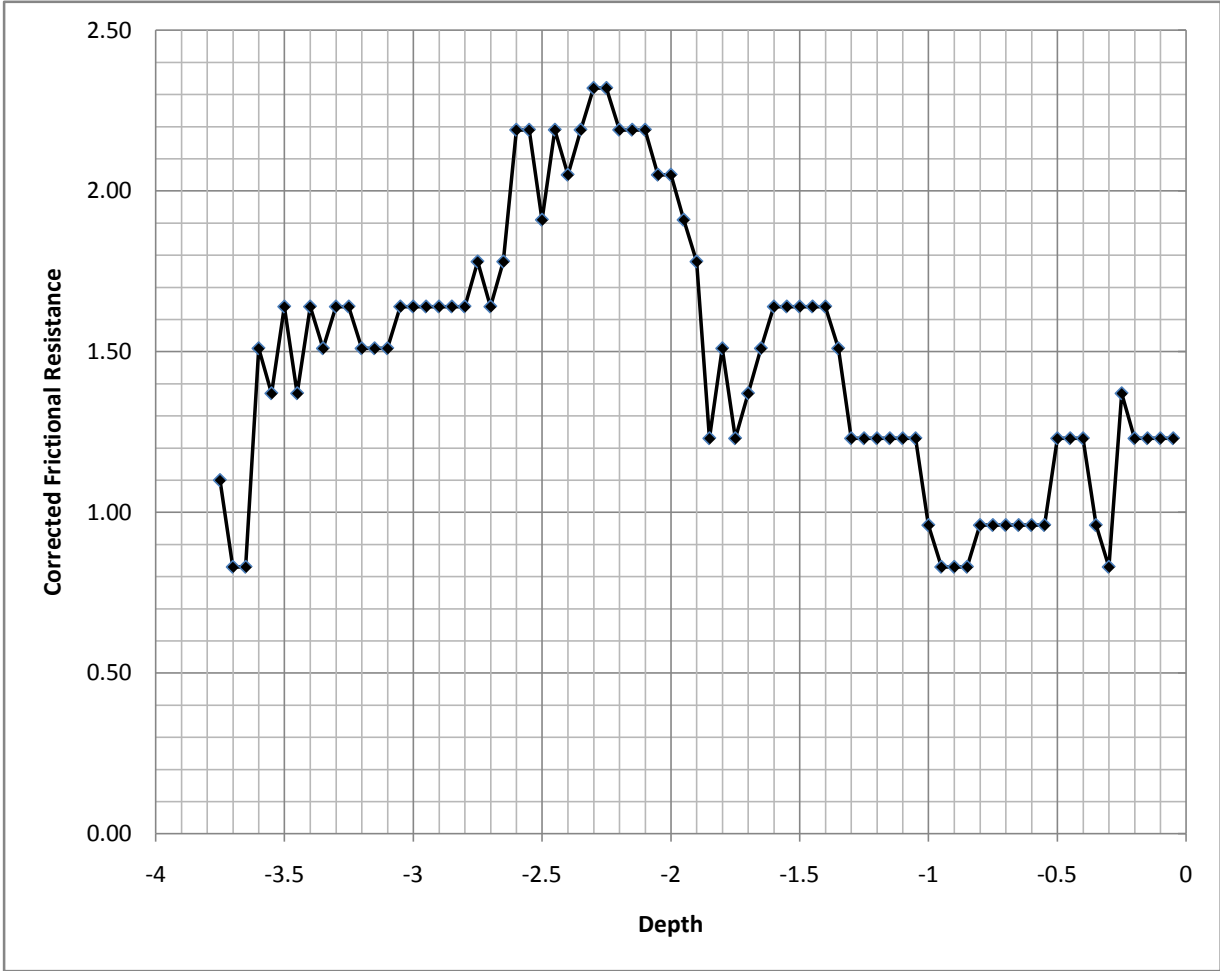
Depth	Number of Rod in Use	CONE				JACKET				
		Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	y=Y*(b'/b)	C1	R _c =y+C1	X	x=X*(b'/b)	x-y	Z=(x-y)*(b/a)	Rf= Z+(mf/a)
-0.05	1	7	14	0.29	14.29	16	32	18	1.22	1.23
-0.10	1	9	18	0.29	18.29	18	36	18	1.22	1.23
-0.15	1	11	22	0.29	22.29	20	40	18	1.22	1.23
-0.20	1	12	24	0.29	24.29	21	42	18	1.22	1.23
-0.25	1	13	26	0.29	26.29	23	46	20	1.36	1.37
-0.30	1	14	28	0.29	28.29	20	40	12	0.82	0.83
-0.35	1	15	30	0.29	30.29	22	44	14	0.95	0.96
-0.40	2	16	32	0.44	32.44	25	50	18	1.22	1.23
-0.45	2	18	36	0.44	36.44	27	54	18	1.22	1.23
-0.50	2	20	40	0.44	40.44	29	58	18	1.22	1.23
-0.55	2	21	42	0.44	42.44	28	56	14	0.95	0.96
-0.60	2	21	42	0.44	42.44	28	56	14	0.95	0.96
-0.65	2	21	42	0.44	42.44	28	56	14	0.95	0.96
-0.70	2	22	44	0.44	44.44	29	58	14	0.95	0.96

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-0.75	2	23	46	0.44	46.44	30	60	14	0.95	0.96
-0.80	2	24	48	0.44	48.44	31	62	14	0.95	0.96
-0.85	2	25	50	0.44	50.44	31	62	12	0.82	0.83
-0.90	2	27	54	0.44	54.44	33	66	12	0.82	0.83
-0.95	2	28	56	0.44	56.44	34	68	12	0.82	0.83
-1.00	2	29	58	0.44	58.44	36	72	14	0.95	0.96
-1.05	2	29	58	0.44	58.44	38	76	18	1.22	1.23
-1.10	2	30	60	0.44	60.44	39	78	18	1.22	1.23
-1.15	2	30	60	0.44	60.44	39	78	18	1.22	1.23
-1.20	2	30	60	0.44	60.44	39	78	18	1.22	1.23
-1.25	2	31	62	0.44	62.44	40	80	18	1.22	1.23
-1.30	2	31	62	0.44	62.44	40	80	18	1.22	1.23
-1.35	3	32	64	0.6	64.6	43	86	22	1.5	1.51
-1.40	3	33	66	0.6	66.6	45	90	24	1.63	1.64
-1.45	3	34	68	0.6	68.6	46	92	24	1.63	1.64
-1.50	3	36	72	0.6	72.6	48	96	24	1.63	1.64
-1.55	3	36	72	0.6	72.6	48	96	24	1.63	1.64
-1.60	3	37	74	0.6	74.6	49	98	24	1.63	1.64
-1.65	3	41	82	0.6	82.6	52	104	22	1.5	1.51
-1.70	3	41	82	0.6	82.6	51	102	20	1.36	1.37
-1.75	3	42	84	0.6	84.6	51	102	18	1.22	1.23
-1.80	3	42	84	0.6	84.6	53	106	22	1.5	1.51
-1.85	3	43	86	0.6	86.6	52	104	18	1.22	1.23
-1.90	3	41	82	0.6	82.6	54	108	26	1.77	1.78
-1.95	3	42	84	0.6	84.6	56	112	28	1.9	1.91
-2.00	3	41	82	0.6	82.6	56	112	30	2.04	2.05
-2.05	3	41	82	0.6	82.6	56	112	30	2.04	2.05
-2.10	3	42	84	0.6	84.6	58	116	32	2.18	2.19
-2.15	3	42	84	0.6	84.6	58	116	32	2.18	2.19

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-2.20	3	43	86	0.6	86.6	59	118	32	2.18	2.19
-2.25	3	44	88	0.6	88.6	61	122	34	2.31	2.32
-2.30	3	44	88	0.6	88.6	61	122	34	2.31	2.32
-2.35	4	45	90	0.75	90.75	61	122	32	2.18	2.19
-2.40	4	47	94	0.75	94.75	62	124	30	2.04	2.05
-2.45	4	46	92	0.75	92.75	62	124	32	2.18	2.19
-2.50	4	48	96	0.75	96.75	62	124	28	1.9	1.91
-2.55	4	48	96	0.75	96.75	64	128	32	2.18	2.19
-2.60	4	49	98	0.75	98.75	65	130	32	2.18	2.19
-2.65	4	51	102	0.75	102.75	64	128	26	1.77	1.78
-2.70	4	52	104	0.75	104.75	64	128	24	1.63	1.64
-2.75	4	53	106	0.75	106.75	66	132	26	1.77	1.78
-2.80	4	55	110	0.75	110.75	67	134	24	1.63	1.64
-2.85	4	56	112	0.75	112.75	68	136	24	1.63	1.64
-2.90	4	56	112	0.75	112.75	68	136	24	1.63	1.64
-2.95	4	56	112	0.75	112.75	68	136	24	1.63	1.64
-3.00	4	56	112	0.75	112.75	68	136	24	1.63	1.64
-3.05	4	55	110	0.75	110.75	67	134	24	1.63	1.64
-3.10	4	56	112	0.75	112.75	67	134	22	1.5	1.51
-3.15	4	56	112	0.75	112.75	67	134	22	1.5	1.51
-3.20	4	56	112	0.75	112.75	67	134	22	1.5	1.51
-3.25	4	57	114	0.75	114.75	69	138	24	1.63	1.64
-3.30	4	58	116	0.75	116.75	70	140	24	1.63	1.64
-3.35	5	60	120	0.91	120.91	71	142	22	1.5	1.51
-3.40	5	60	120	0.91	120.91	72	144	24	1.63	1.64
-3.45	5	61	122	0.91	122.91	71	142	20	1.36	1.37
-3.50	5	62	124	0.91	124.91	74	148	24	1.63	1.64
-3.55	5	62	124	0.91	124.91	72	144	20	1.36	1.37
-3.60	5	63	126	0.91	126.91	74	148	22	1.5	1.51

Depth	Number of Rod in Use	Gauge Reading of Cone Penetration	Cone Penetration Resistance	Correction Factor	Corrected Value of Cone Resistance	Gauge Reading of Cone + Jacket Resistance	Cone + Jacket Resistance	Total Resistance - Cone Resistance	Frictional Resistance	Corrected Frictional Resistance
		Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm	Kg/ Sqcm
m	n	Y	$y=Y*(b'/b)$	C1	$R_c=y+C1$	X	$x=X*(b'/b)$	x-y	$Z=(x-y)*(b/a)$	$Rf= Z+(mf/a)$
-3.65	5	64	128	0.91	128.91	70	140	12	0.82	0.83
-3.70	5	64	128	0.91	128.91	70	140	12	0.82	0.83
-3.75	5	64	128	0.91	128.91	72	144	16	1.09	1.10





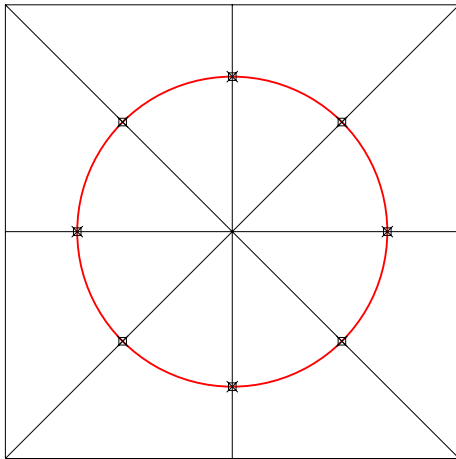
ELECTRICAL RESISTIVITY TEST

Table ERT - 2

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 12-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

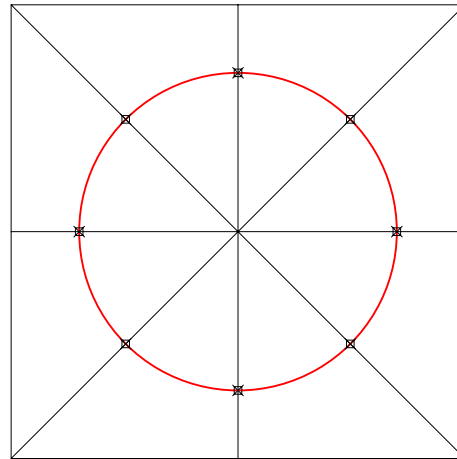
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")								
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West	
1	1.0	41	41	41	41	41	41	41	41	257.61	257.61	257.61	257.61	257.61	257.61	257.61	257.61	
2	2.0	42	42	42	42	42	42	42	42	527.79	527.79	527.79	527.79	527.79	527.79	527.79	527.79	
3	5.0	43	43	43	43	43	43	41	43	1,350.88	1,350.88	1,350.88	1,350.88	1,350.88	1,350.88	1,288.05	1,350.88	
4	10.0	44	44	44	44	44	44	43	44	2,764.60	2,764.60	2,764.60	2,764.60	2,764.60	2,764.60	2,701.77	2,764.60	
5	15.0	45	45	45	45	44	45	44	45	4,241.15	4,241.15	4,241.15	4,241.15	4,146.90	4,241.15	4,146.90	4,241.15	
6	20.0	Space Not Available																

Location - ERT-2



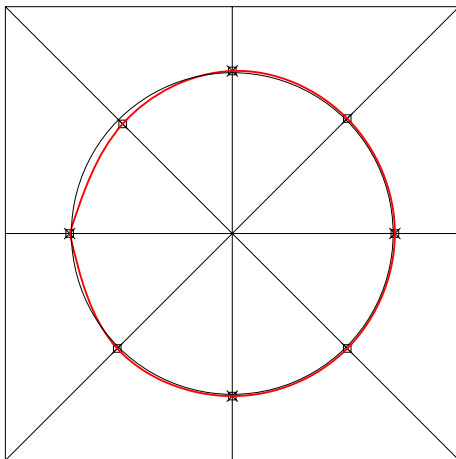
Electrode Spacing - 1.00M
R = 41.00 ohm, Resistivity = 257.61 Ohm-m

Location - ERT-2



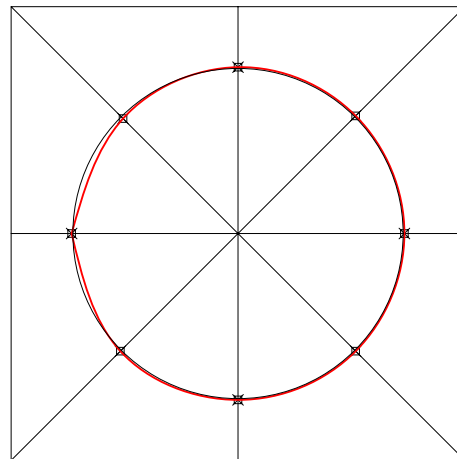
Electrode Spacing - 2.00M
R = 42.00 ohm, Resistivity = 527.79 Ohm-m

Location - ERT-2



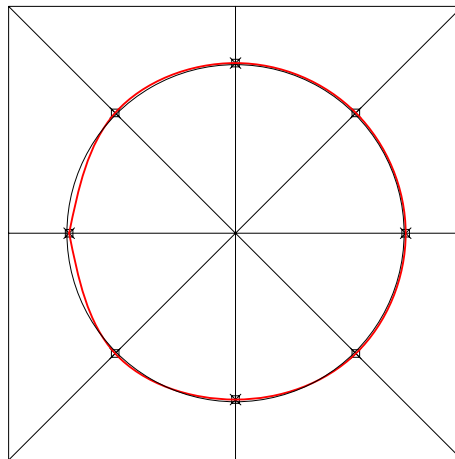
Electrode Spacing - 5.00M
R = 42.54 ohm, Resistivity = 1335.76 Ohm-m

Location - ERT-2



Electrode Spacing - 10.00M
R = 43.67 ohm, Resistivity = 2742.48 Ohm-m

Location - ERT-2



Electrode Spacing - 15.00M
R = 44.58 ohm, Resistivity = 4199.44 Ohm-m

ZONE-7

**DM PLANT &
STORAGE**

Total one (1) borehole was sunk in this area, viz borehole marked BH-6. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with clayey silt, fly ash etc. followed by first layer of soft light/ bluish grey silty clay/ clayey silt. The second layer is medium to stiff light/ bluish grey silty clay/ clayey silt. The third layer consists of medium light yellowish grey silty sand. The fourth layer is very stiff to hard mottled bluish/ brownish grey silty clay/ clayey silt and the fifth layer as encountered up to the explored depth is hard brownish grey silty clay/ clayey silt.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Plate Load Test:

One (1) plate load test has been carried out at this zone marked as PLT-1.

2. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-3.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-7). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-7).
Recommended Pile Capacity

Sl.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	32.000	2.000	61	56	2.38
2	0.500	32.000	2.000	80	72	2.60
3	0.550	32.000	2.000	90	81	2.69
4	0.600	32.000	2.000	101	90	2.79
5	0.750	32.000	2.000	134	117	3.05
6	1.000	32.000	2.000	197	166	3.42

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-6 (Sheet-1)	
Project: SOIL PDIL DANKUNI DM PLANT AND STORAGE								Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.508		Unit:				Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 20.10.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 23.10.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 0.30 M.	
Depth of Drilling		VST		SCPT				Standing Water Table : 0.20 M.	
DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with silty clay/ clayey silt, fly ash, sand, stone chaps etc.		01		DS1	0.50 M				
				DS2	1.00 M				
Soft light/ bluish grey silty clay/ clayey silt with traces of sand.		02	N = 2	SPT1	1.50-1.95M				
				DS3	1.50-1.95M				
			03	N = 2	SPT2	3.00-3.45M			
					DS4	3.00-3.45M			
			04	N = 4	SPT3	4.50-4.95M			
					DS5	4.50-4.95M			
					UDS2	5.00-5.45M			
			05	N = 4	SPT4	6.00-6.45M			
					DS6	6.00-6.45M			
			06	N = 5	SPT5	7.50-7.95M			
					DS7	7.50-7.95M			
					UDS3	8.00-8.45M			
07	N = 7	SPT6	9.00-9.45M						
		DS8	9.00-9.45M						
		08	N = 8	SPT7	10.50-10.95M				
				DS9	10.50-10.95M				
09	N = 8	UDS4	11.00-11.45M						
		SPT8	12.50-12.95M						
10	N = 8	DS10	12.50-12.95M						
		UDS5	14.00-14.45M						
11	N = 29	SPT9	14.50-14.95M						
		DS11	14.50-14.95M						
12	N = 32	SPT10	16.50-16.95M						
		DS12	16.50-16.95M						
		UDS6	17.00-17.45M						
13	N = 16	SPT11	18.50-18.95M						
		DS13	18.50-18.95M						
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BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-6 (Sheet-2)	
Project:SOIL PDIL DANKUNI DM PLANT AND STORAGE						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.508		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 20.10.2019	
						Completed on : 23.10.2019	
						Water Struck At :0.30 M.	
						Standing Water Table : 0.20 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Very stiff to hard mottled bluish/ brownish grey silty clay/ clayey silt mixed with kankar.		21	N = 15	UDS7	20.00-20.45M		
				SPT12	20.50-20.95M		
				DS14	20.50-20.95M		
			23	N = 27	UDS8	23.00-23.45M	
			24		SPT13	23.50-23.95M	
					DS15	23.50-23.95M	
			26	N = 34	UDS9	26.00-26.45M	
			27		SPT14	26.50-26.95M	
					DS16	26.50-26.95M	
	Hard brownish grey silty clay/ clayey silt with fine sand.		29	N = 37	UDS10	29.00-29.45M	
					SPT15	29.50-29.95M	
					DS17	29.50-29.95M	
			33	N = 43	SPT16	32.50-32.95M	
					DS18	32.50-32.95M	
			34		N = 44	SPT17	34.55-35.00M
			DS19	34.55-35.00M			
Termination Depth 35.000 Mtr.		35					
		36					
		37					
		38					
		39					

SPT - Standard Penetration Test
DCPT - Dynamic Cone Penetration Test.

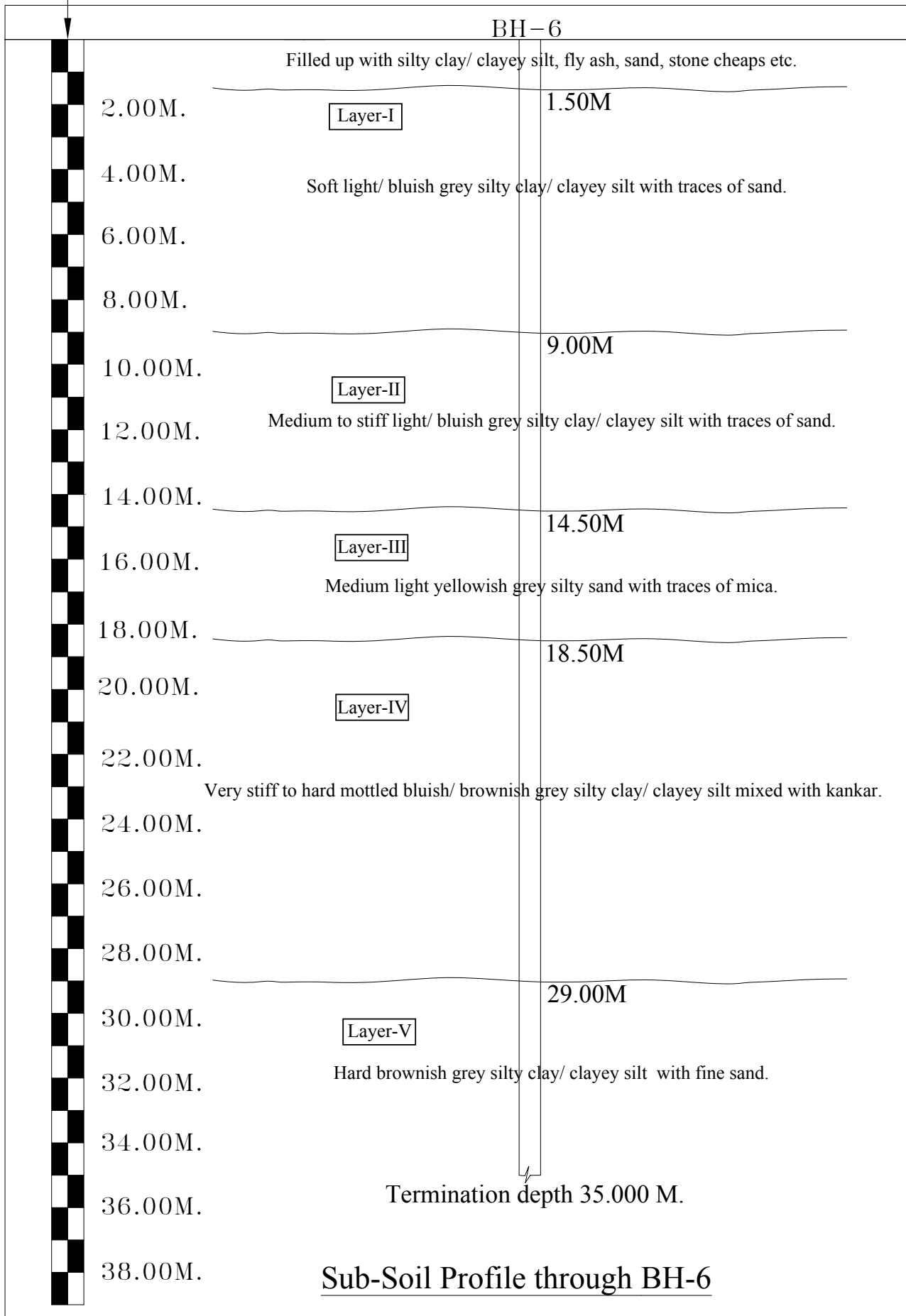
VST- Vane Shear Test
UDS - Undisturbed Sample

DS - Disturbed Sample
SCPT-Static Cone Penetration Test.

WS - Water Sample
RCS - Rock Core Sample

RL=35.508

BH-6



Sub-Soil Profile through BH-6

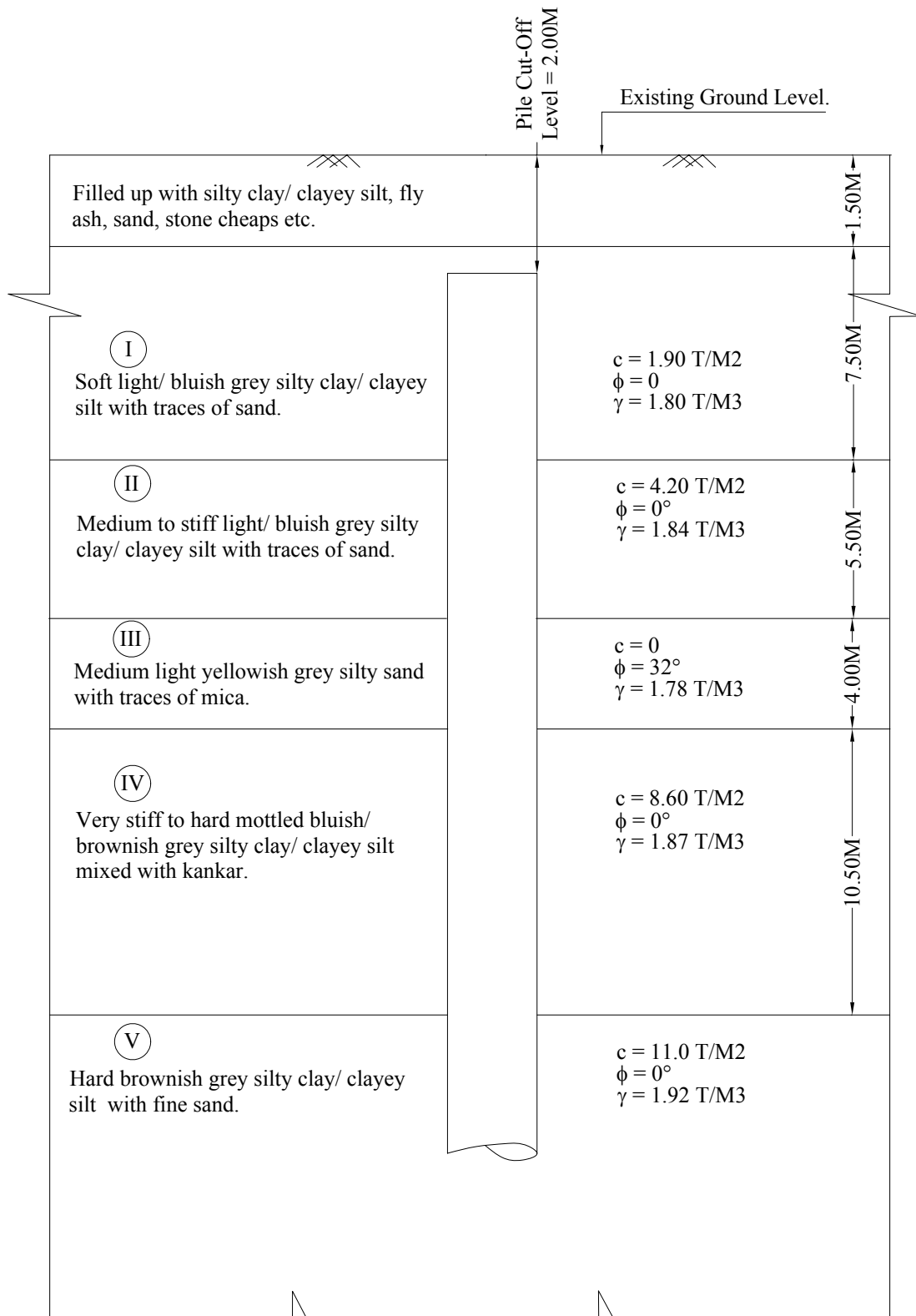
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc γ_b	Water Content in % m	Specific Gravity G	Dry Density in gm/cc γ_d	Unconfined Test in Kg/sqcm q_u	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/CU/CD /DS	C	ϕ								
I	Soft light/ bluish grey silty clay/ clayey silt with traces of sand.	6	1.50	DN	2	40	22	12.1			2.67							0.00	0	8	72	20		
		6	2.00	UD		42	21	13.1	1.80	37.64	2.68	1.31	0.35	UU	0.19	0	0.00-0.10	0.0217	0	0	0	6	75	19
																	0.10-0.20	0.0279						
														CU	0.08	11	0.20-0.40	0.0364						
CD	0	15	0.40-0.80	0.0485																				
		6	6.00	DN	4	44	20	12.6			2.72							2.68	0	9	56	35		
II	Medium to stiff light/ bluish grey silty clay/ clayey silt with traces of sand.	6	9.00	DN	7	64	24	16.09			2.68							21.67	0	6	57	37		
		6	14.00	UD		56	22	14.3	1.84	30.38	2.66	1.41	0.79	UU	0.42	0	0.00-0.10	0.0128	0	18.39	0	8	60	32
																	0.10-0.20	0.0212						
														CU	0.12	18	0.20-0.40	0.0384						
CD	0	24	0.40-0.80	0.0331																				
III	Medium light yellowish grey silty sand with traces of mica.	6	14.50	DN	29	NP			1.78		2.67							0	8	67	25	0		
IV	Very stiff to hard mottled bluish/ brownish grey silty clay/ clayey silt mixed with kankar.	6	18.50	DN	16	48	21	13.6			2.71							22.33	0	9	60	31		
		6	20.50	UD		52	20	12.7	1.87	27.63	2.68	1.47	1.67	UU	0.86	0	0.00-0.10	0.0089	0	19.94	0	11	59	30
																	0.10-0.20	0.0157						
														CU	0.17	24	0.20-0.40	0.0293						
CD	0	29	0.40-0.80	0.0232																				
		6	23.50	DN	27	56	19	11.8			2.66							24.62	0	8	57	35		
V	Hard brownish grey silty clay/ clayey silt with fine sand.	6	34.55	DN	44	50	18	10.6			2.67							22.38	0	9	62	29		

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ DM PLANT AND STORAGE 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft light/ bluish grey silty clay/ clayey silt with traces of sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	32.000	2.000	9.000	1	1.9	8.796	16.713
2	0.500	32.000	2.000	9.000	1	1.9	10.996	20.892
3	0.550	32.000	2.000	9.000	1	1.9	12.095	22.981
4	0.600	32.000	2.000	9.000	1	1.9	13.195	25.070
5	0.750	32.000	2.000	9.000	1	1.9	16.493	31.337
6	1.000	32.000	2.000	9.000	1	1.9	21.991	41.783

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description Medium to stiff light/ bluish grey silty clay/ clayey silt with traces of sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	32.000	9.000	14.500	1	4.2	6.912	29.028
2	0.500	32.000	9.000	14.500	1	4.2	8.639	36.285
3	0.550	32.000	9.000	14.500	1	4.2	9.503	39.914
4	0.600	32.000	9.000	14.500	1	4.2	10.367	43.542
5	0.750	32.000	9.000	14.500	1	4.2	12.959	54.428
6	1.000	32.000	9.000	14.500	1	4.2	17.279	72.571

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description : Medium light yellowish grey silty sand with traces of mica.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K * P_{Di} * \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K * P_{Di} * \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	32.000	14.500	18.500	1.000	32	29	27.86	16.44	19.34	1.78	0.78	1.3	15	4.68	0.51	3.372	4.68	3.372	3.372	5.027	16.952
2	0.500	32.000	14.500	18.500	1.000	32	29	27.86	16.44	19.34	1.78	0.78	1.3	15	5.85	0.51	4.216	5.85	4.216	4.216	6.283	26.487
3	0.550	32.000	14.500	18.500	1.000	32	29	27.86	16.44	19.34	1.78	0.78	1.3	15	6.435	0.51	4.637	6.435	4.637	4.637	6.912	32.049
4	0.600	32.000	14.500	18.500	1.000	32	29	27.86	16.44	19.34	1.78	0.78	1.3	15	7.02	0.51	5.059	7.02	5.059	5.059	7.540	38.141
5	0.750	32.000	14.500	18.500	1.000	32	29	27.86	16.44	19.34	1.78	0.78	1.3	15	8.775	0.51	6.323	8.775	6.323	6.323	9.425	59.596
6	1.000	32.000	14.500	18.500	1.000	32	29	27.86	16.44	19.34	1.78	0.78	1.3	15	11.31	0.51	8.150	11.7	8.431	8.291	12.566	104.182

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description Very stiff to hard mottled bluish/ brownish grey silty clay/ clayey silt mixed with kankar.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	32.000	18.500	29.000	0.55	8.6	13.195	62.411
2	0.500	32.000	18.500	29.000	0.55	8.6	16.493	78.014
3	0.550	32.000	18.500	29.000	0.55	8.6	18.143	85.815
4	0.600	32.000	18.500	29.000	0.55	8.6	19.792	93.616
5	0.750	32.000	18.500	29.000	0.55	8.6	24.740	117.020
6	1.000	32.000	18.500	29.000	0.55	8.6	32.987	156.027

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description Hard brownish grey silty clay/ clayey silt with fine sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	32.000	29.000	32.000	0.4	11.0	3.770	16.588
2	0.500	32.000	29.000	32.000	0.4	11.0	4.712	20.735
3	0.550	32.000	29.000	32.000	0.4	11.0	5.184	22.808
4	0.600	32.000	29.000	32.000	0.4	11.0	5.655	24.881
5	0.750	32.000	29.000	32.000	0.4	11.0	7.069	31.102
6	1.000	32.000	29.000	32.000	0.4	11.0	9.425	41.469

Ultimate End Bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Layer No:

5

Soil Description

Hard brownish grey silty clay/ clayey silt with fine sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Average Cohesion at the pile tip, C_P	Cross sectional area of the pile tip, A_P	Bearing capacity factor, N_C	UltimateEnd bearing capacityat pile tip, Q_{Bu} = A_P*N_C*C_P
	Mtr	Mtr.	Mtr	Mtr.	T/M ²	M ²		T
1	0.400	32.000	29.000	32.000	11.0	0.126	9.000	12.441
2	0.500	32.000	29.000	32.000	11.0	0.196	9.000	19.439
3	0.550	32.000	29.000	32.000	11.0	0.238	9.000	23.521
4	0.600	32.000	29.000	32.000	11.0	0.283	9.000	27.992
5	0.750	32.000	29.000	32.000	11.0	0.442	9.000	43.737
6	1.000	32.000	29.000	32.000	11.0	0.785	9.000	77.754

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.19 Kg/cm ²	
	=	18.639 Kn/M ²	
L (Length of Pile)	=	32.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.069 MN/M ³	
T (Stiffness Factor)	=	1.967 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	30.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.327 Mtr.	
Therefore,	Lf	=	4.327 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	23.32 Kn	
Horizontal Shear Capacity = H_{design}	=	2.38 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: DM Plant & Storage unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	Skin friction from layer 5	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T	T
1	0.400	32.000	16.713	29.028	16.952	62.411	16.588	12.441	154.132	2.5	61.653	61	56	2.38
2	0.500	32.000	20.892	36.285	26.487	78.014	20.735	19.439	201.851	2.5	80.740	80	72	2.60
3	0.550	32.000	22.981	39.914	32.049	85.815	22.808	23.521	227.087	2.5	90.835	90	81	2.69
4	0.600	32.000	25.070	43.542	38.141	93.616	24.881	27.992	253.243	2.5	101.297	101	90	2.79
5	0.750	32.000	31.337	54.428	59.596	117.020	31.102	43.737	337.220	2.5	134.888	134	117	3.05
6	1.000	32.000	41.783	72.571	104.182	156.027	41.469	77.754	493.786	2.5	197.515	197	166	3.42

PLATE LOAD TEST

Modulus of Subgrade Reaction and Modulus of Elasticity have been calculated for Plate Load Test as follows.

Calculation for Modulus of Subgrade Reaction (K) for PLT-1

From Load-Settlement curve of PLT-1, Pressure corresponding to settlement of 1.25mm is 0.28 Kg/Cm².

$$\begin{aligned} \text{Hence, } K &= \text{Pressure} / \text{Settlement.} \\ &= 0.28 / 0.125 \text{ Kg/Cm}^3 \\ &= 2.24 \text{ Kg/Cm}^3 \end{aligned}$$

Calculation for Modulus of Elasticity (Es) for PLT-1.

Modulus of Elasticity has been calculated for initial load of 4.20 T/M² and corresponding settlement of 0.186 cm.

$$\begin{aligned} E_s &= \{q \cdot (1 - \mu^2) \cdot B \cdot I_w\} / S \\ &= \{0.36 \cdot (1 - 0.3^2) \cdot 75 \cdot 0.82\} / 0.121 \\ &= 101.1 \text{ Kg/Cm}^2 \end{aligned}$$

Where,

- Es = Modulus of Elasticity.
- q = Pressure = 0.42 Kg/Cm²
- μ = Poisson's Ratio = 0.3
- B = Least dimension of the plate = 60 Cm
- Iw = Influence Factor = 0.8
- S = Settlement = 0.2 Cm

Modulus of Subgrade Reaction and Modulus of Elasticity, obtain from Plate Load Test.

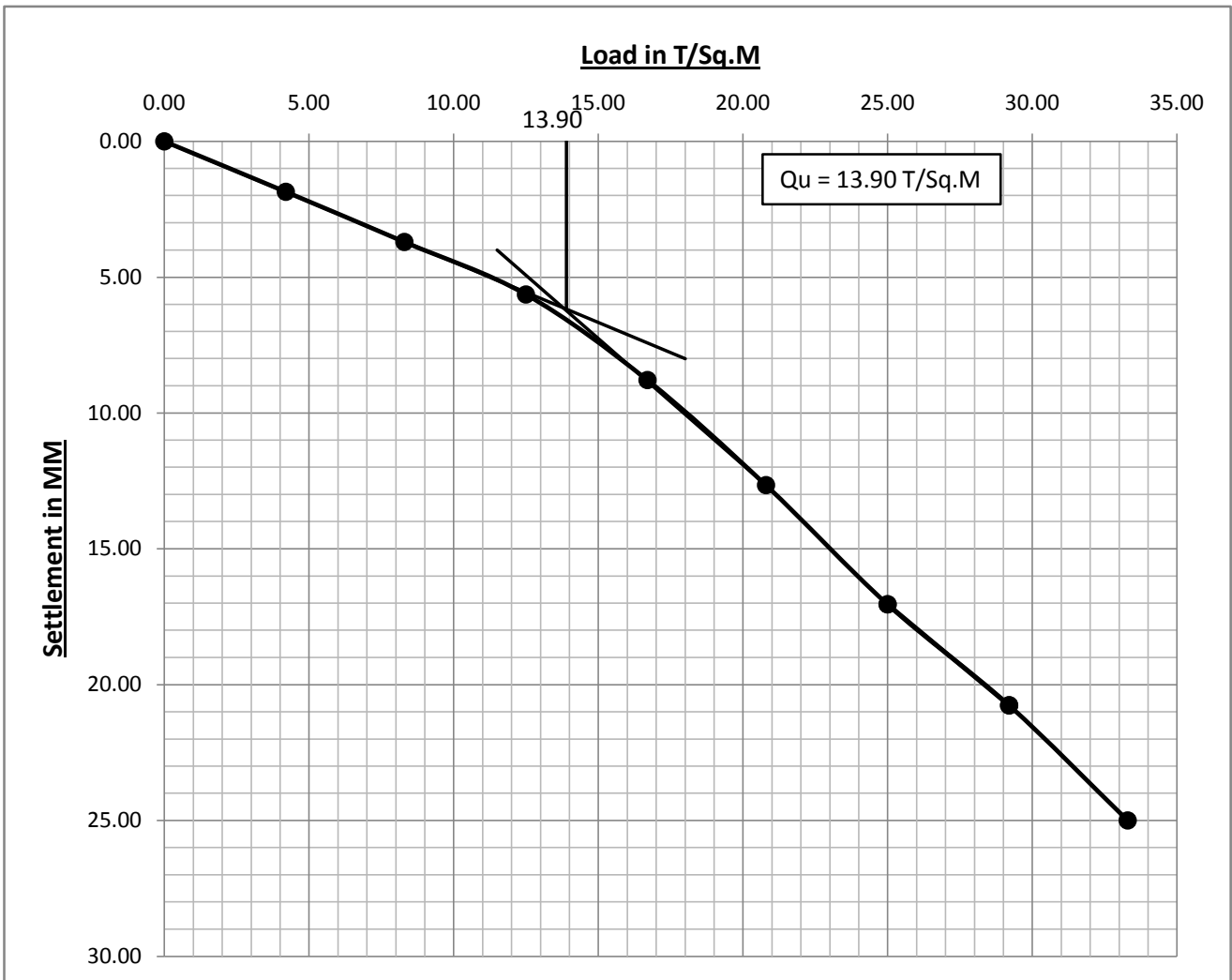
Test No.	Depth of Test	Modulus of Subgrade Reaction, K	Modulus of Elasticity, Es
	(M)	(Kg/Cm ³)	(Kg/Cm ²)
PLT-1	2	2.24 Kg/Cm ³	101.1 Kg/Cm ²

PLATE LOAD TEST SITE DATA SHEET

Client : Projects & Development India Limited
 Location : In right side of Training Centre.
 Test Number : PLT-1
 Plate Size : 60x60 3600 Sqcm
 Pit Size : 3.00M X 3.00M X 2.00M
 Ground Water Table : Not Encountered
 L.C. of Dial Guage : 0.01 mm
 Jack Ram Dia : 10.5 cm
 Jack Ram Area : 86.59 Sqcm

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
30-11-2019	12:15:00	0.00	0	2500	2500	0.00	0.00	0.00	
	12:15:00	1500	0.42	2500	2500	0.00	0.00	0.00	
	12:16:00			2372	2369	1.28	1.31	1.30	
	12:17:15			2365	2362	1.35	1.38	1.37	
	12:19:00			2359	2357	1.41	1.43	1.42	
	12:21:15			2357	2354	1.43	1.46	1.45	
	12:24:00			2355	2352	1.45	1.48	1.47	
	12:31:00			2351	2348	1.49	1.52	1.51	
	12:40:00			2348	2345	1.52	1.55	1.54	
	13:15:00			2315	2314	1.85	1.86	1.86	
	13:15:00	3000	0.83	2315	2314	1.85	1.86	1.86	
	13:16:00			2200	2193	3.00	3.07	3.04	
	13:17:15			2194	2186	3.06	3.14	3.10	
	13:19:00			2188	2181	3.12	3.19	3.16	
	13:21:15			2179	2171	3.21	3.29	3.25	
	13:24:00			2175	2166	3.25	3.34	3.30	
	13:31:00			2170	2161	3.30	3.39	3.35	
	13:40:00			2148	2145	3.52	3.55	3.54	
	14:15:00			2132	2127	3.68	3.73	3.71	
	14:15:00	4500	1.25	2132	2127	3.68	3.73	3.71	
	14:16:00			2057	2040	4.43	4.60	4.52	
	14:17:15			2052	2035	4.48	4.65	4.57	
	14:19:00			2025	2010	4.75	4.90	4.83	
	14:21:15			1994	1995	5.06	5.05	5.06	
	14:24:00			1988	1989	5.12	5.11	5.12	
	14:31:00			1982	1983	5.18	5.17	5.18	
	14:40:00			1979	1979	5.21	5.21	5.21	
	15:15:00			1937	1936	5.63	5.64	5.64	
	15:15:00	6000	1.67	1937	1936	5.63	5.64	5.64	
	15:16:00			1730	1712	7.70	7.88	7.79	

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
	15:17:15			1725	1708	7.75	7.92	7.84	
	15:19:00			1712	1696	7.88	8.04	7.96	
	15:21:15			1098	1680	14.02	8.20	11.11	
	15:24:00			1673	1651	8.27	8.49	8.38	
	15:31:00			1659	1639	8.41	8.61	8.51	
	15:40:00			1651	1631	8.49	8.69	8.59	
	16:15:00			1638	1604	8.62	8.96	8.79	
	16:15:00	7500	2.08	1638	1604	8.62	8.96	8.79	
	16:16:00			1365	1310	11.35	11.90	11.63	
	16:17:15			1350	1300	11.50	12.00	11.75	
	16:19:00			1341	1292	11.59	12.08	11.84	
	16:21:15			1335	1286	11.65	12.14	11.90	
	16:24:00			1314	1265	11.86	12.35	12.11	
	16:31:00			1291	1244	12.09	12.56	12.33	
	16:40:00			1266	1220	12.34	12.80	12.57	
	17:15:00			1258	1210	12.42	12.90	12.66	
	17:15:00	9000	2.50	1258	1210	12.42	12.90	12.66	
	17:16:00			1114	1131	13.86	13.69	13.78	
	17:17:15			1009	1037	14.91	14.63	14.77	
	17:19:00			906	936	15.94	15.64	15.79	
	17:21:15			868	890	16.32	16.10	16.21	
	17:24:00			827	850	16.73	16.50	16.62	
	17:31:00			802	819	16.98	16.81	16.90	
	17:40:00			798	803	17.02	16.97	17.00	
	18:15:00			792	799	17.08	17.01	17.05	
	18:15:00	10500	2.92	792	799	17.08	17.01	17.05	
	18:16:00			777	783	17.23	17.17	17.20	
	18:17:15			658	604	18.42	18.96	18.69	
	18:19:00			588	537	19.12	19.63	19.38	
	18:21:15			507	489	19.93	20.11	20.02	
	18:24:00			457	474	20.43	20.26	20.35	
	18:31:00			420	450	20.80	20.50	20.65	
	18:40:00			414	442	20.86	20.58	20.72	
	19:15:00			410	438	20.90	20.62	20.76	
	19:15:00	12000	3.33	410	438	20.90	20.62	20.76	
	19:16:00			318	392	21.82	21.08	21.45	
	19:17:15			224	244	22.76	22.56	22.66	
	19:19:00			107	116	23.93	23.84	23.89	
	19:21:15			57	88	24.43	24.12	24.28	
	19:24:00			30	54	24.70	24.46	24.58	
	19:31:00			18	29	24.82	24.71	24.77	
	19:40:00			0	12	25.00	24.88	24.94	
	20:15:00			0	0	25.00	25.00	25.00	



Load Vs Settlement Curve for PLT-1

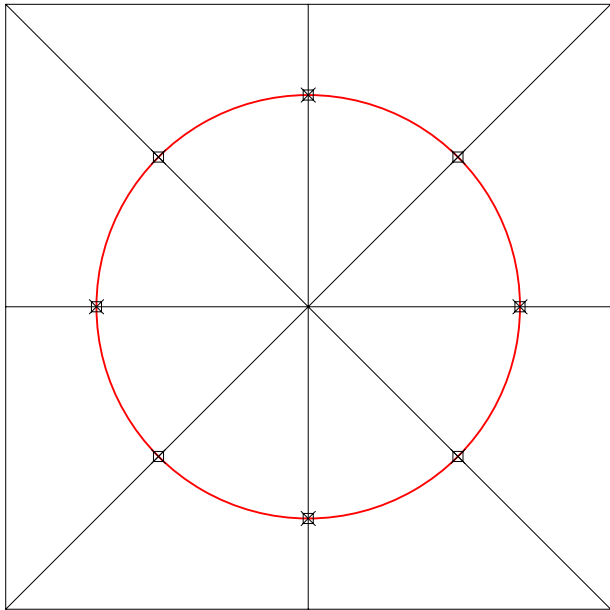
ELECTRICAL RESISTIVITY TEST

Table ERT - 3

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 21-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

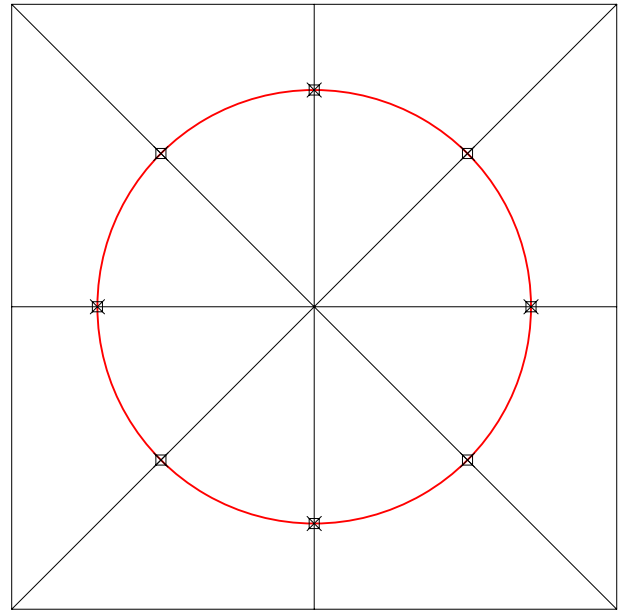
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	42	42	42	42	42	42	42	42	263.89	263.89	263.89	263.89	263.89	263.89	263.89	263.89
2	2.0	43	43	43	43	43	43	43	43	540.35	540.35	540.35	540.35	540.35	540.35	540.35	540.35
3	5.0	42	42	42	42	42	42	42	42	1,319.47	1,319.47	1,319.47	1,319.47	1,319.47	1,319.47	1,319.47	1,319.47
4	10.0	Space Not Available															
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Location - ERT-3



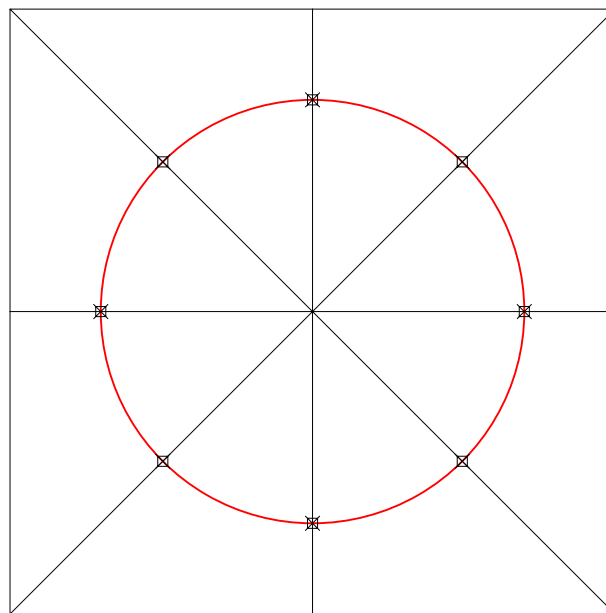
Electrode Spacing - 1.00M
R = 42.00 ohm, Resistivity = 263.89 Ohm-m

Location - ERT-3



Electrode Spacing - 2.00M
R = 43.00 ohm, Resistivity = 540.35 Ohm-m

Location - ERT-3



Electrode Spacing - 5.00M
R = 42.00 ohm, Resistivity = 1319.47 Ohm-m

ZONE-8

COAL STORAGE AREA INCLUDING CRUSHER

Total one (1) borehole was sunk in this area, viz borehole marked BH-1. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with coal dust etc. followed by first layer of soft brownish grey silty clay/ clayey silt. The second layer is medium to stiff bluish grey silty clay/ clayey silt. The third layer consists of stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt. The fourth layer is hard mottled bluish/ brownish grey silty clay/ clayey silt and the fifth layer as encountered up to the explored depth is dense brownish grey silty sand.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-1.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-8). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

**Table-2A (Zone-8).
Recommended Pile Capacity**

SI.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	34.000	2.000	71	65	2.73
2	0.500	34.000	2.000	93	83	2.99
3	0.550	34.000	2.000	105	92	3.10
4	0.600	34.000	2.000	118	100	3.21
5	0.750	34.000	2.000	162	128	3.51
6	1.000	34.000	2.000	256	175	3.94

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-1 (Sheet-1)	
Project: SOIL PDIL DANKUNI		COAL STORAGE AREA INCLUDING CRUSHER						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 36.172		Unit:				Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 11.11.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 13.11.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 2.20 M.	
Depth of Drilling		VST		SCPT				Standing Water Table : 2.10 M.	
DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with coal dust etc.		01		DS1 DS2	0.50 M 1.00 M				
Soft brownish grey silty clay/ clayey silt with traces of sand.		02	N = 2	SPT1 DS3 UDS1	1.50-1.95M 1.50-1.95M 2.00-2.45M				
		03	N = 3	SPT2 DS4	3.00-3.45M 3.00-3.45M				
		04							
		05	N = 3	SPT3 DS5 UDS2	4.50-4.95M 4.50-4.95M 5.00-5.45M				
		06	N = 4	SPT4 DS6	6.00-6.45M 6.00-6.45M				
		07							
	Medium to stiff bluish grey silty clay/ clayey silt with traces of calcareous nodules.		08	N = 4	SPT5 DS7 UDS3	7.50-7.95M 7.50-7.95M 8.00-8.45M			
			09	N = 6	SPT6 DS8	9.00-9.45M 9.00-9.45M			
			10						
			11	N = 9	SPT7 DS9 UDS4	10.50-10.95M 10.50-10.95M 11.00-11.45M			
			12						
Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of sand and silt stones.		13	N = 17	SPT8 DS10	12.50-12.95M 12.50-12.95M				
		14							
		15	N = 11	UDS5 SPT9 DS11	14.00-14.45M 14.50-14.95M 14.50-14.95M				
		16							
		17	N = 13	SPT10 DS12 UDS6	16.50-16.95M 16.50-16.95M 17.00-17.45M				
		18							
		19	N = 14	SPT11 DS13	18.50-18.95M 18.50-18.95M				
Contd.....									
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample			WS - Water Sample		
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.			RCS - Rock Core Sample		

RL=36.172

BH-1

Filled up with coal dust etc.

2.00M.

Layer-I

1.50M

Soft brownish grey silty clay/ clayey silt with traces of sand.

4.00M.

6.00M.

6.00M

8.00M.

Layer-II

Medium to stiff bluish grey silty clay/ clayey silt with traces of calcareous nodules.

10.00M.

12.00M.

12.50M

14.00M.

16.00M.

Layer-III

Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of sand and silt stones.

18.00M.

20.00M.

22.00M.

24.00M.

26.00M.

28.00M.

30.00M.

Layer-IV

29.00M

Hard mottled bluish/ brownish grey silty clay/ clayey silt with traces of sand and silt stones.

32.00M.

34.00M.

Layer-V

32.50M

Dense brownish grey silty sand.

36.00M.

Termination depth 35.000 M.

38.00M.

Sub-Soil Profile through BH-1

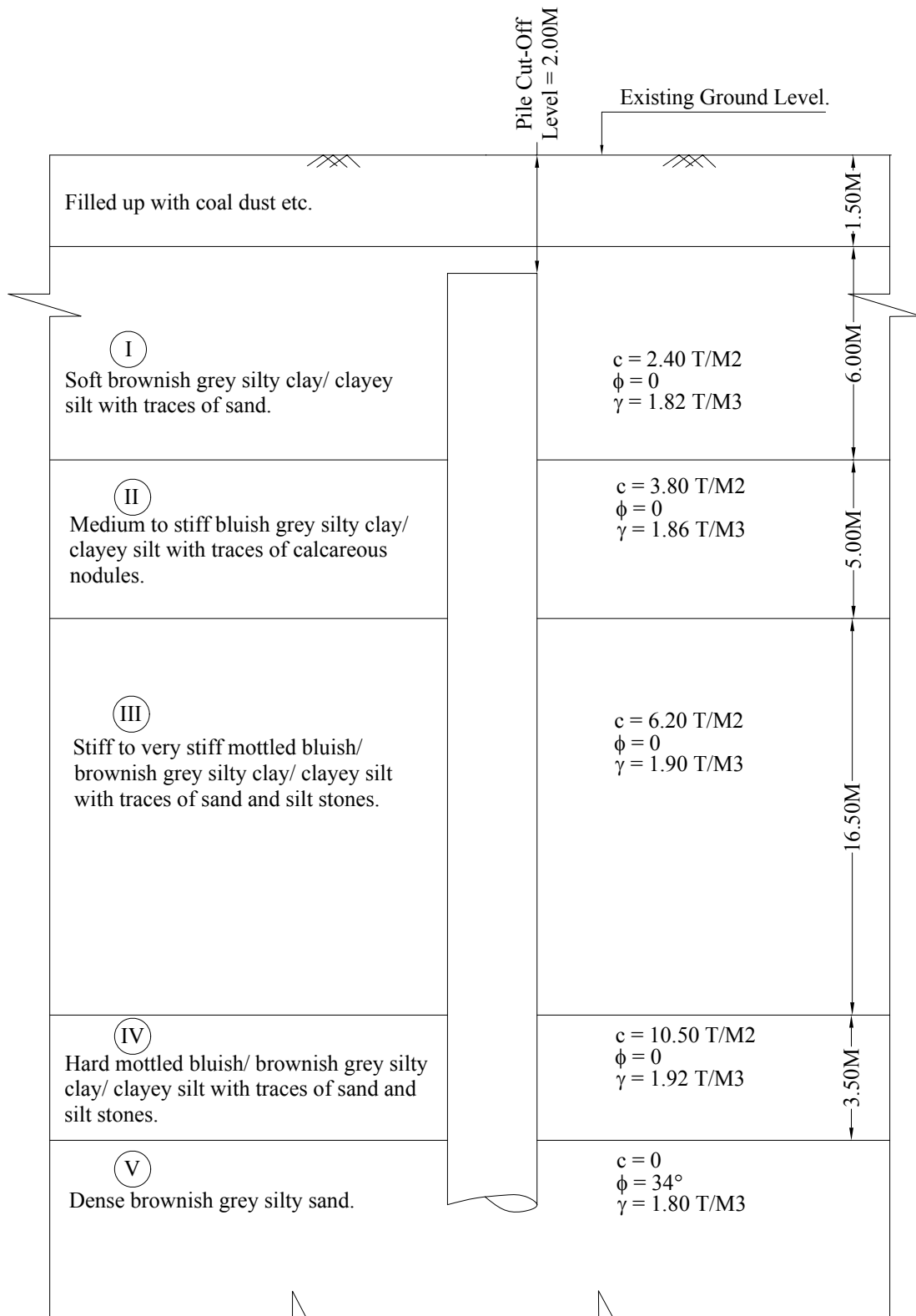
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc γ_b	Water Content in % m	Specific Gravity G	Dry Density in gm/cc γ_d	Unconfined Test in Kg/sqcm q_u	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/CU/CD /Ds	C	ϕ					%	%	%	%
I	Soft brownish grey silty clay/ clayey silt with traces of sand.	1	1.50	DN	2	55	24	14											8.90	0	8	63	29	
		1	5.00	UD		52	22	13.5	1.82	33.62	2.67	1.36	0.46	UU	0.24	0	0.00-0.10	0.0154	0	12.6	0	9	61	30
																	0.10-0.20	0.0229						
														CU	0.08	12	0.20-0.40	0.0364						
														CD	0	18	0.40-0.80	0.0289						
II	Medium to stiff bluish grey silty clay/ clayey silt with traces of calcareous nodules.	1	7.50	DN	4	61	19	12.2			2.71								36	0	6	54	40	
		1	10.50	DN	9	52	21	13.4			2.68								15	5	9	58	28	
		1	11.00	UD		53	20	13.8	1.86	29.27	2.67	1.44	0.72	UU	0.38	0	0.00-0.10	0.0137	0	14.4	2	10	57	31
																	0.10-0.20	0.0209						
														CU	0.13	19	0.20-0.40	0.0357						
													CD	0	25	0.40-0.80	0.0277							
																0.80-1.60	0.0239							
																1.60-3.20	0.0164							
III	Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of sand and silt stones.	1	12.50	DN	17	56	19	11.2			2.61								10.4	0	7	58	35	
		1	16.50	DN	13	51	21	13.3			2.67								11.3	0	9	61	30	
		1	17.00	UD		53	20	13	1.90	27.28	2.66	1.49	1.18	UU	0.62	0	0.00-0.10	0.0127	0	9.5	0	8	61	31
																	0.10-0.20	0.0203						
														CU	0.15	23	0.20-0.40	0.0349						
													CD	0	30	0.40-0.80	0.0268							
																0.80-1.60	0.0231							
																1.60-3.20	0.0154							
																			8.70	0	10	52	38	
																			8.30	0	16	60	24	
V	Dense brownish grey silty sand.	1	32.50	DN	48	NP			1.80		2.65			DS	0	34			0.00	0	98	2	0	

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft brownish grey silty clay/ clayey silt with traces of sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} =$ $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	34.000	2.000	7.500	1	2.4	6.912	16.588
2	0.500	34.000	2.000	7.500	1	2.4	8.639	20.735
3	0.550	34.000	2.000	7.500	1	2.4	9.503	22.808
4	0.600	34.000	2.000	7.500	1	2.4	10.367	24.881
5	0.750	34.000	2.000	7.500	1	2.4	12.959	31.102
6	1.000	34.000	2.000	7.500	1	2.4	17.279	41.469

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description Medium to stiff bluish grey silty clay/ clayey silt with traces of calcareous nodules.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	34.000	7.500	12.500	1	3.8	6.283	23.876
2	0.500	34.000	7.500	12.500	1	3.8	7.854	29.845
3	0.550	34.000	7.500	12.500	1	3.8	8.639	32.830
4	0.600	34.000	7.500	12.500	1	3.8	9.425	35.814
5	0.750	34.000	7.500	12.500	1	3.8	11.781	44.768
6	1.000	34.000	7.500	12.500	1	3.8	15.708	59.690

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description: Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of sand and silt stones.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	34.000	12.500	29.000	0.75	6.2	20.735	96.415
2	0.500	34.000	12.500	29.000	0.75	6.2	25.918	120.519
3	0.550	34.000	12.500	29.000	0.75	6.2	28.510	132.571
4	0.600	34.000	12.500	29.000	0.75	6.2	31.102	144.623
5	0.750	34.000	12.500	29.000	0.75	6.2	38.877	180.779
6	1.000	34.000	12.500	29.000	0.75	6.2	51.836	241.039

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description: Hard mottled bluish/ brownish grey silty clay/ clayey silt with traces of sand and silt stones.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{SU} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	34.000	29.000	32.500	0.45	10.5	4.398	20.782
2	0.500	34.000	29.000	32.500	0.45	10.5	5.498	25.977
3	0.550	34.000	29.000	32.500	0.45	10.5	6.048	28.575
4	0.600	34.000	29.000	32.500	0.45	10.5	6.597	31.172
5	0.750	34.000	29.000	32.500	0.45	10.5	8.247	38.966
6	1.000	34.000	29.000	32.500	0.45	10.5	10.996	51.954

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description : Dense brownish grey silty sand.

Sl.No	Pile Dia, D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	34.000	32.500	34.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	4.8	0.54	3.749	4.8	3.749	3.749	1.885	7.067
2	0.500	34.000	32.500	34.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	6	0.54	4.687	6	4.687	4.687	2.356	11.043
3	0.550	34.000	32.500	34.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	6.6	0.54	5.155	6.6	5.155	5.155	2.592	13.362
4	0.600	34.000	32.500	34.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	7.2	0.54	5.624	7.2	5.624	5.624	2.827	15.902
5	0.750	34.000	32.500	34.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	9	0.54	7.030	9	7.030	7.030	3.534	24.846
6	1.000	34.000	32.500	34.000	1.000	34	31	32.67	20.63	25.99	1.80	0.8	1.3	15	12	0.54	9.373	12	9.373	9.373	4.712	44.171

Ultimate end bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description : Dense brownish grey silty sand.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $=(\phi -3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Dl} at pile tip	A_p	End Bearing
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			M ²	T
1	0.400	34.000	32.500	34.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	4.8	0.126	12.967
2	0.500	34.000	32.500	34.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	6	0.196	25.326
3	0.550	34.000	32.500	34.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	6.6	0.238	33.709
4	0.600	34.000	32.500	34.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	7.2	0.283	43.763
5	0.750	34.000	32.500	34.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	9	0.442	85.475
6	1.000	34.000	32.500	34.000	0.000	34	31	32.67	20.63	25.99	1.8	0.8	15	12	0.785	202.607

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.24 Kg/cm ²	
	=	23.544 Kn/M ²	
L (Length of Pile)	=	34.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.350 MN/M ³	
T (Stiffness Factor)	=	1.878 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	32.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.132 Mtr.	
Therefore,	Lf	=	4.132 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	26.80 Kn	
Horizontal Shear Capacity = H_{design}	=	2.73 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Coal Storage Area including Crusher unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	Skin friction from layer 5	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T	T
1	0.400	34.000	16.588	23.876	96.415	20.782	7.067	12.967	177.695	2.5	71.078	71	65	2.73
2	0.500	34.000	20.735	29.845	120.519	25.977	11.043	25.326	233.445	2.5	93.378	93	83	2.99
3	0.550	34.000	22.808	32.830	132.571	28.575	13.362	33.709	263.854	2.5	105.542	105	92	3.10
4	0.600	34.000	24.881	35.814	144.623	31.172	15.902	43.763	296.156	2.5	118.462	118	100	3.21
5	0.750	34.000	31.102	44.768	180.779	38.966	24.846	85.475	405.935	2.5	162.374	162	128	3.51
6	1.000	34.000	41.469	59.690	241.039	51.954	44.171	202.607	640.930	2.5	256.372	256	175	3.94

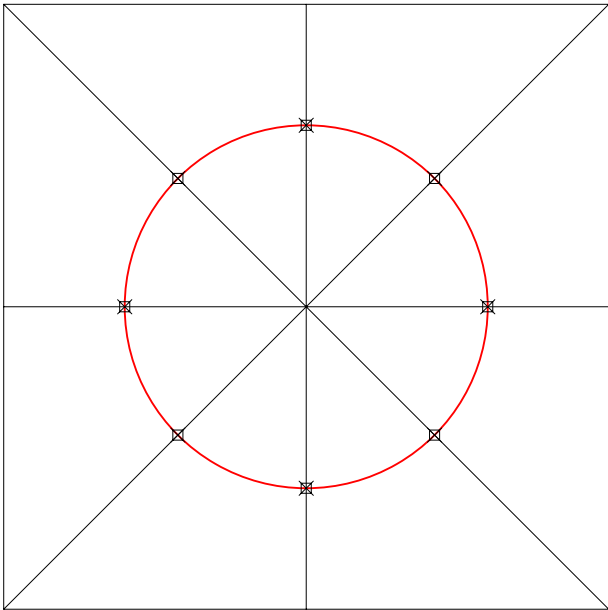
ELECTRICAL RESISTIVITY TEST

Table ERT - 1

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 11-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

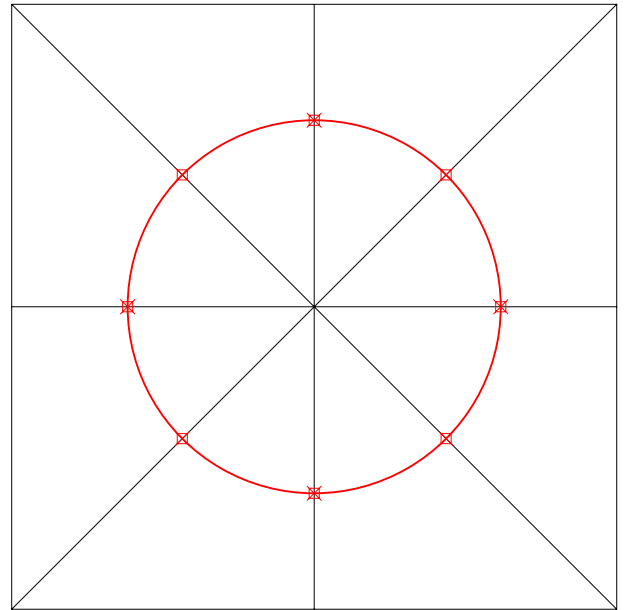
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")							
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West
1	1.0	36	36	36	36	36	36	36	36	226.19	226.19	226.19	226.19	226.19	226.19	226.19	226.19
2	2.0	37	37	37	37	37	37	37	37	464.96	464.96	464.96	464.96	464.96	464.96	464.96	464.96
3	5.0	36	36	36	38	36	36	36	37	1,130.97	1,130.97	1,130.97	1,193.81	1,130.97	1,130.97	1,130.97	1,162.39
4	10.0	37	37	37	39	37	37	37	36	2,324.78	2,324.78	2,324.78	2,450.44	2,324.78	2,324.78	2,324.78	2,261.95
5	15.0	Space Not Available															
6	20.0	Space Not Available															

Location - ERT-1



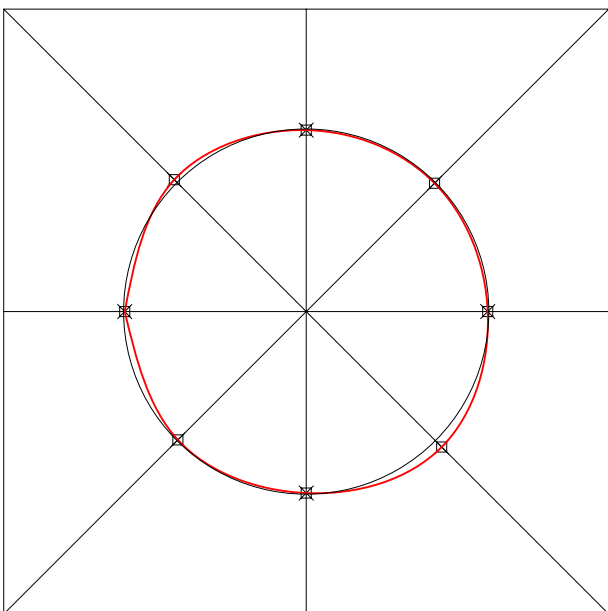
Electrode Spacing - 1.00M
R = 36.00 ohm, Resistivity = 226.19 Ohm-m

Location - ERT-1



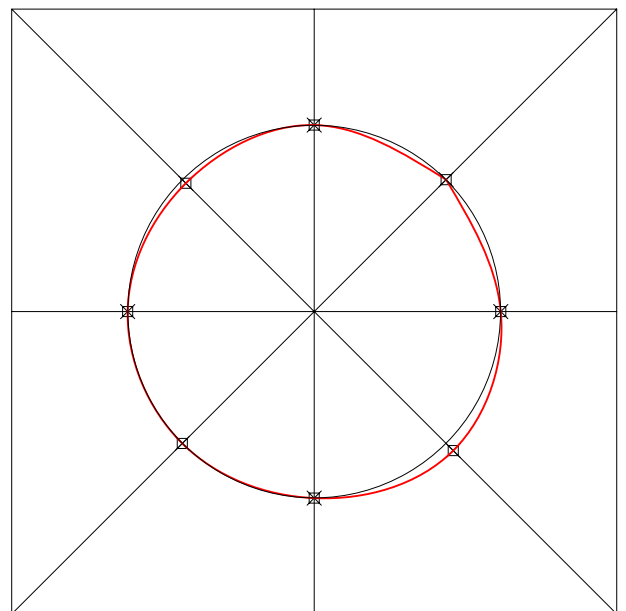
Electrode Spacing - 2.00M
R = 37.00 ohm, Resistivity = 464.96 Ohm-m

Location - ERT-1



Electrode Spacing - 5.00M
R = 36.22 ohm, Resistivity = 1137.31 Ohm-m

Location - ERT-1



Electrode Spacing - 10.00M
R = 36.96 ohm, Resistivity = 2321.09 Ohm-m

ZONE-9

**METHANOL STORAGE
TANK**

Total one (1) borehole was sunk in this area, viz borehole marked BH-5. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with coal dust, clayey silt etc. followed by first layer of soft to medium brownish/ bluish grey silty clay/ clayey silt. The second layer is stiff mottled bluish/ brownish grey silty clay/ clayey silt. The third layer consists of soft to medium mottled bluish/ brownish grey silty clay/ clayey silt. The fourth layer is stiff brownish grey silty clay/ clayey silt and the fifth layer as encountered up to the explored depth is hard brownish grey silty clay/ clayey silt.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-9). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-9).
Recommended Pile Capacity

Sl.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	30.000	2.000	56	52	3.06
2	0.500	30.000	2.000	72	65	3.35
3	0.550	30.000	2.000	80	72	3.48
4	0.600	30.000	2.000	88	78	3.60
5	0.750	30.000	2.000	114	98	3.93
6	1.000	30.000	2.000	159	131	4.41

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-5 (Sheet-1)	
Project: SOIL PDIL DANKUNI METHANOL STORAGE TANK								Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.814		Unit:		Bore Hole Dia. : 150 MM.			
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 07.11.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 10.11.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 2.20 M.	
Depth of Drilling		VST		SCPT				Standing Water Table : 2.15 M.	
DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with coal dust, clayey silt, brick bats etc.		01		DS1	0.50 M				
				DS2	1.00 M				
Soft to medium brownish/ bluish grey silty clay/ clayey silt with traces of sand and silt stone.		02	N = 2	SPT1	1.50-1.95M				
				DS3	1.50-1.95M				
			N = 3	UDS1	2.00-2.45M				
				SPT2	3.00-3.45M				
			N = 3	DS4	3.00-3.45M				
				SPT3	4.50-4.95M				
			N = 5	DS5	4.50-4.95M				
				UDS2	5.00-5.45M				
			N = 4	SPT4	6.00-6.45M				
				DS6	6.00-6.45M				
			N = 4	SPT5	7.50-7.95M				
				DS7	7.50-7.95M				
N = 5	UDS3	8.00-8.45M							
	SPT6	9.00-9.45M							
N = 5	DS8	9.00-9.45M							
Stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of calcareous nodules and concretion.		11	N = 12	SPT7	10.50-10.95M				
				DS9	10.50-10.95M				
			N = 14	UDS4	11.00-11.45M				
				SPT8	12.50-12.95M				
			N = 16	DS10	12.50-12.95M				
				UDS5	14.00-14.45M				
N = 3	SPT9	14.50-14.95M							
	DS11	14.50-14.95M							
Soft to medium mottled bluish/ brownish grey silty clay/ clayey silt.		17	N = 3	SPT10	16.50-16.95M				
				DS12	16.50-16.95M				
N = 6	UDS6	17.00-17.45M							
	SPT11	18.50-18.95M							
N = 6	DS13	18.50-18.95M							
Contd.....									
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample			WS - Water Sample				
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.			RCS - Rock Core Sample				

RL=35.814

BH-5

Filled up with coal dust, clayey silt, brick bats etc.

2.00M.

1.50M

Layer-I

4.00M.

Soft to medium brownish/ bluish grey silty clay/ clayey silt with traces of sand and silt stone.

6.00M.

8.00M.

10.00M.

10.50M

Layer-II

12.00M.

Stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of calcareous nodules and concretion.

14.00M.

16.00M.

Layer-III

16.50M

18.00M.

Soft to medium mottled bluish/ brownish grey silty clay/ clayey silt.

20.00M.

Layer-IV

20.00M

22.00M.

Stiff brownish grey silty clay/ clayey silt with traces of iron oxide and sand.

24.00M.

23.50M

Layer-V

26.00M.

Hard brownish grey silty clay/ clayey silt with traces of iron oxide and sand.

28.00M.

30.00M.

32.00M.

34.00M.

36.00M.

Termination depth 35.000 M.

38.00M.

Sub-Soil Profile through BH-5

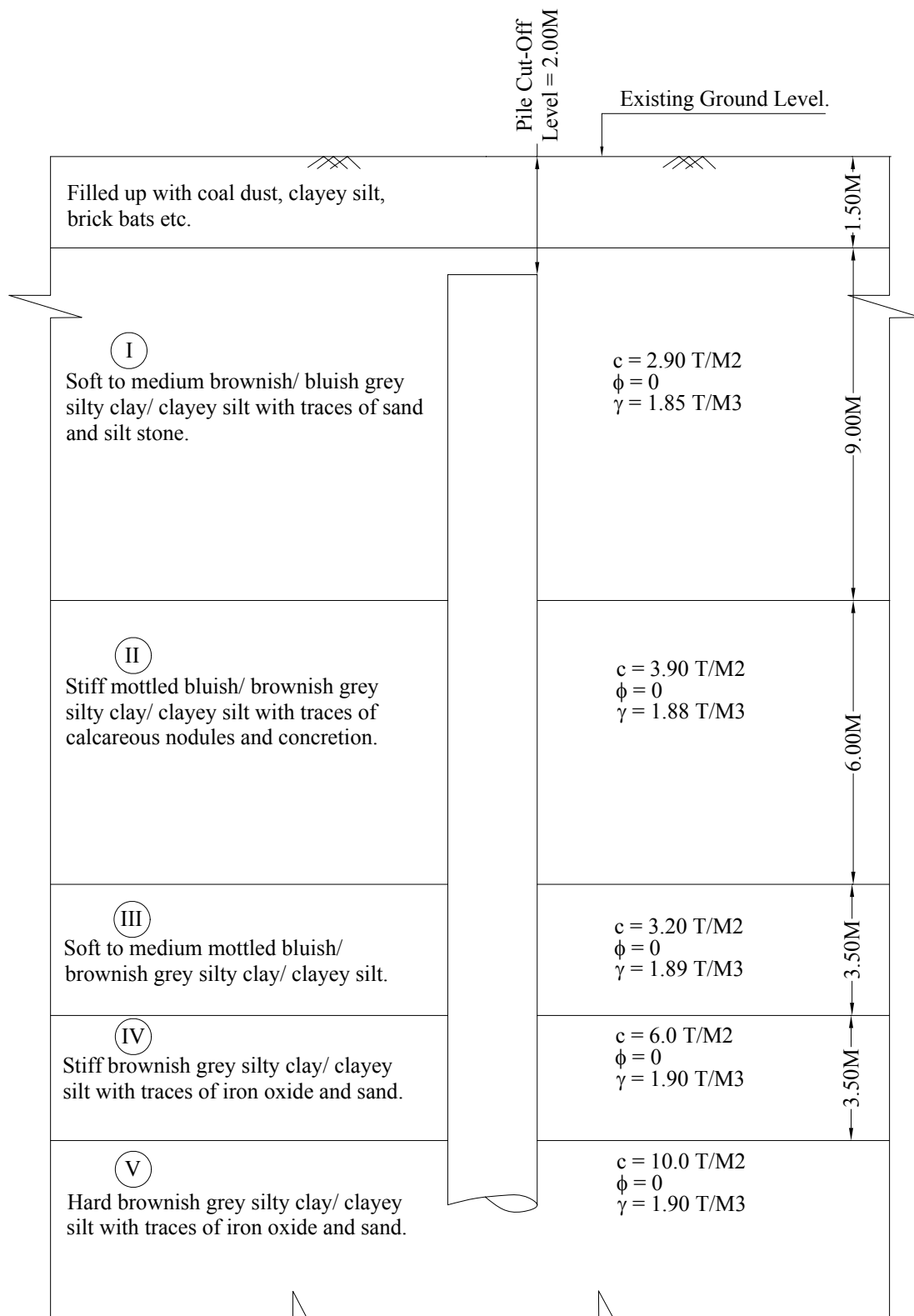
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc γ_b	Water Content in % m	Specific Gravity G	Dry Density in gm/cc γ_d	Unconfined Test in Kg/sqcm q_u	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading						
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					UU/CU/CD /Ds	C	ϕ	Gravel (> 4.75 mm)	Sand (0.075 - 4.75 mm)	Silt (0.002 - 0.075 mm)	Clay (< 0.002 mm)
						%	%	%																%	%	%	%
I	Soft to medium brownish/ bluish grey silty clay/ clayey silt with traces of sand and silt stone.	5	3.00	DN	3	45	22	13.4			2.66							2.30	0	9	70	21					
		5	5.00	UD		49	20	11.9	1.85	30.44	2.66	1.42	0.55	UU	0.29	0	0.00-0.10	0.0183	0	4.8	0	7	66	27			
																	0.10-0.20	0.0262									
														CU	0.11	16	0.20-0.40	0.0439									
															CD	0	20	0.80-1.60	0.0264								
II	Stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of calcareous nodules and concretion.	5	11.00	UD		47	19	10.4	1.88	25.66	2.67	1.50	0.75	UU	0.39	0	0.00-0.10	0.0172	0	12.4	0	5	69	26			
																	0.10-0.20	0.0254									
														CU	0.09	18	0.20-0.40	0.0428									
																	0.40-0.80	0.0339									
															CD	0	22	0.80-1.60	0.0254								
III	Soft to medium mottled bluish/ brownish grey silty clay/ clayey silt.	5	17.00	UD		51	20	12.7	1.89	24.77	2.68	1.51	0.6	UU	0.32	0	0.00-0.10	0.0166	0	18.6	0	10	60	30			
																	0.10-0.20	0.0247									
														CU	0.10	17	0.20-0.40	0.0417									
																	0.40-0.80	0.0324									
															CD	0	21	0.80-1.60	0.0246								
V	Hard brownish grey silty clay/ clayey silt with traces of iron oxide and sand.	5	23.50	DN	33	48	20	12.7			2.66																
		5	29.50	DN	34	45	18	11.4			2.67																
		5	34.55	DN	44	46	19	11.9			2.66																

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ METHANOL STORAGE TANK 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Layer No:

1

Soil Description

Soft to medium brownish/ bluish grey silty clay/ clayey silt with traces of sand and silt stone.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	2.000	10.500	1	2.9	10.681	30.976
2	0.500	30.000	2.000	10.500	1	2.9	13.352	38.720
3	0.550	30.000	2.000	10.500	1	2.9	14.687	42.592
4	0.600	30.000	2.000	10.500	1	2.9	16.022	46.464
5	0.750	30.000	2.000	10.500	1	2.9	20.028	58.080
6	1.000	30.000	2.000	10.500	1	2.9	26.704	77.440

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of calcareous nodules and concretion.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	10.500	16.500	1	3.9	7.540	29.405
2	0.500	30.000	10.500	16.500	1	3.9	9.425	36.757
3	0.550	30.000	10.500	16.500	1	3.9	10.367	40.432
4	0.600	30.000	10.500	16.500	1	3.9	11.310	44.108
5	0.750	30.000	10.500	16.500	1	3.9	14.137	55.135
6	1.000	30.000	10.500	16.500	1	3.9	18.850	73.513

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description Soft to medium mottled bluish/ brownish grey silty clay/ clayey silt.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	16.500	20.000	1	3.2	4.398	14.074
2	0.500	30.000	16.500	20.000	1	3.2	5.498	17.593
3	0.550	30.000	16.500	20.000	1	3.2	6.048	19.352
4	0.600	30.000	16.500	20.000	1	3.2	6.597	21.112
5	0.750	30.000	16.500	20.000	1	3.2	8.247	26.389
6	1.000	30.000	16.500	20.000	1	3.2	10.996	35.186

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description Stiff brownish grey silty clay/ clayey silt with traces of iron oxide and sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	20.000	23.500	0.75	6.0	4.398	19.792
2	0.500	30.000	20.000	23.500	0.75	6.0	5.498	24.740
3	0.550	30.000	20.000	23.500	0.75	6.0	6.048	27.214
4	0.600	30.000	20.000	23.500	0.75	6.0	6.597	29.688
5	0.750	30.000	20.000	23.500	0.75	6.0	8.247	37.110
6	1.000	30.000	20.000	23.500	0.75	6.0	10.996	49.480

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description Hard brownish grey silty clay/ clayey silt with traces of iron oxide and sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	23.500	30.000	0.45	10.0	8.168	36.757
2	0.500	30.000	23.500	30.000	0.45	10.0	10.210	45.946
3	0.550	30.000	23.500	30.000	0.45	10.0	11.231	50.540
4	0.600	30.000	23.500	30.000	0.45	10.0	12.252	55.135
5	0.750	30.000	23.500	30.000	0.45	10.0	15.315	68.919
6	1.000	30.000	23.500	30.000	0.45	10.0	20.420	91.892

Ultimate End Bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Layer No: 5

Soil Description Hard brownish grey silty clay/ clayey silt with traces of iron oxide and sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Average Cohesion at the pile tip, C_P	Cross sectional area of the pile tip, A_P	Bearing capacity factor, N_C	UltimateEnd bearing capacityat pile tip, Q_{Bu} = A_P*N_C*C_P
	Mtr	Mtr.	Mtr	Mtr.	T/M ²	M ²		T
1	0.400	30.000	23.500	30.000	10.0	0.126	9.000	11.310
2	0.500	30.000	23.500	30.000	10.0	0.196	9.000	17.671
3	0.550	30.000	23.500	30.000	10.0	0.238	9.000	21.382
4	0.600	30.000	23.500	30.000	10.0	0.283	9.000	25.447
5	0.750	30.000	23.500	30.000	10.0	0.442	9.000	39.761
6	1.000	30.000	23.500	30.000	10.0	0.785	9.000	70.686

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.29 Kg/cm ²	
	=	28.449 Kn/M ²	
L (Length of Pile)	=	30.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.631 MN/M ³	
T (Stiffness Factor)	=	1.808 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	28.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	3.978 Mtr.	
Therefore,			
Lf	=	3.978 Mtr.	
L1	=	0.000 Mtr.	
<u>For Fixed Head Pile, deflection at the pile head,</u>			
Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	30.03 Kn	
Horizontal Shear Capacity = H_{design}	=	3.06 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Methanol Storage Tank unit, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	Skin friction from layer 5	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T	T
1	0.400	30.000	30.976	29.405	14.074	19.792	36.757	11.310	142.314	2.5	56.926	56	52	3.06
2	0.500	30.000	38.720	36.757	17.593	24.740	45.946	17.671	181.427	2.5	72.571	72	65	3.35
3	0.550	30.000	42.592	40.432	19.352	27.214	50.540	21.382	201.514	2.5	80.605	80	72	3.48
4	0.600	30.000	46.464	44.108	21.112	29.688	55.135	25.447	221.954	2.5	88.781	88	78	3.60
5	0.750	30.000	58.080	55.135	26.389	37.110	68.919	39.761	285.394	2.5	114.158	114	98	3.93
6	1.000	30.000	77.440	73.513	35.186	49.480	91.892	70.686	398.197	2.5	159.279	159	131	4.41

ZONE-10

ETP

Total one (1) borehole was sunk in this area, viz borehole marked BH-13. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with sand, silt, clay, stone cheeps etc. followed by first layer of soft to medium bluish/ dark grey silty clay/ clayey silt. The second layer is stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt and the third layer as encountered up to the explored depth is medium to dense yellowish grey silty sand.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-11.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-10). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-10).
Recommended Pile Capacity

Sl.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	30.000	2.000	56	51	2.52
2	0.500	30.000	2.000	75	65	2.76
3	0.550	30.000	2.000	87	73	2.86
4	0.600	30.000	2.000	98	81	2.96
5	0.750	30.000	2.000	140	106	3.24
6	1.000	30.000	2.000	232	152	3.64

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-13 (Sheet-1)	
Project: SOIL PDIL DANKUNI ETP								Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.807		Unit:				Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 13.10.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 16.10.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At :1.10 M.	
Depth of Drilling		VST		SCPT				Standing Water Table :1.00 M.	
DESCRIPTION	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with sand, silt, clay, stone cheaps etc.		01		DS1 DS2	0.50 M 1.00 M				
Soft to medium bluish/ dark grey silty clay/ clayey silt with traces of vegetative organic matter. Calcareous nodules found occasionally.		02	N = 2	SPT1 DS3 UDS1	1.50-1.95M 1.50-1.95M 2.00-2.45M				
		03	N = 2	SPT2 DS4	3.00-3.45M 3.00-3.45M				
		04							
		05	N = 2	SPT3 DS5 UDS2	4.50-4.95M 4.50-4.95M 5.00-5.45M				
		06	N = 3	SPT4 DS6	6.00-6.45M 6.00-6.45M				
		07							
		08	N = 5	SPT5 DS7 UDS3	7.50-7.95M 7.50-7.95M 8.00-8.45M				
		09	N = 7	SPT6 DS8	9.00-9.45M 9.00-9.45M				
		10							
		11	N = 5	SPT7 DS9 UDS4	10.50-10.95M 10.50-10.95M 11.00-11.45M				
Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of kankar.		12							
		13	N = 13	SPT8 DS10	12.50-12.95M 12.50-12.95M				
		14							
		15	N =13	UDS5 SPT9 DS11	14.00-14.45M 14.50-14.95M 14.50-14.95M				
		16							
		17	N = 10	SPT10 DS12 UDS6	16.50-16.95M 16.50-16.95M 17.00-17.45M				
Contd.....		18							
		19	N = 12	SPT11 DS13	18.50-18.95M 18.50-18.95M				
SPT - Standard Penetration Test		VST- Vane Shear Test		DS - Disturbed Sample		WS - Water Sample			
DCPT - Dynamic Cone Penetration Test.		UDS - Undisturbed Sample		SCPT-Static Cone Penetration Test.		RCS - Rock Core Sample			

RL=35.807

BH-13

Filled up with sand, silt, clay, stone cheaps etc.

2.00M.

1.50M

4.00M.

Layer-I

6.00M.

Soft to medium bluish/ dark grey silty clay/ clayey silt with traces of vegetative organic matter. Calcareous nodules found occasionally.

8.00M.

10.00M.

12.00M.

12.50M

14.00M.

Layer-II

16.00M.

18.00M.

Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of kankar.

20.00M.

22.00M.

24.00M.

26.00M.

26.50M

28.00M.

Layer-III

30.00M.

Medium to dense yellowish grey silty sand. Sand grains are fine and micaceous.

32.00M.

34.00M.

36.00M.

Termination depth 35.000 M.

38.00M.

Sub-Soil Profile through BH-13

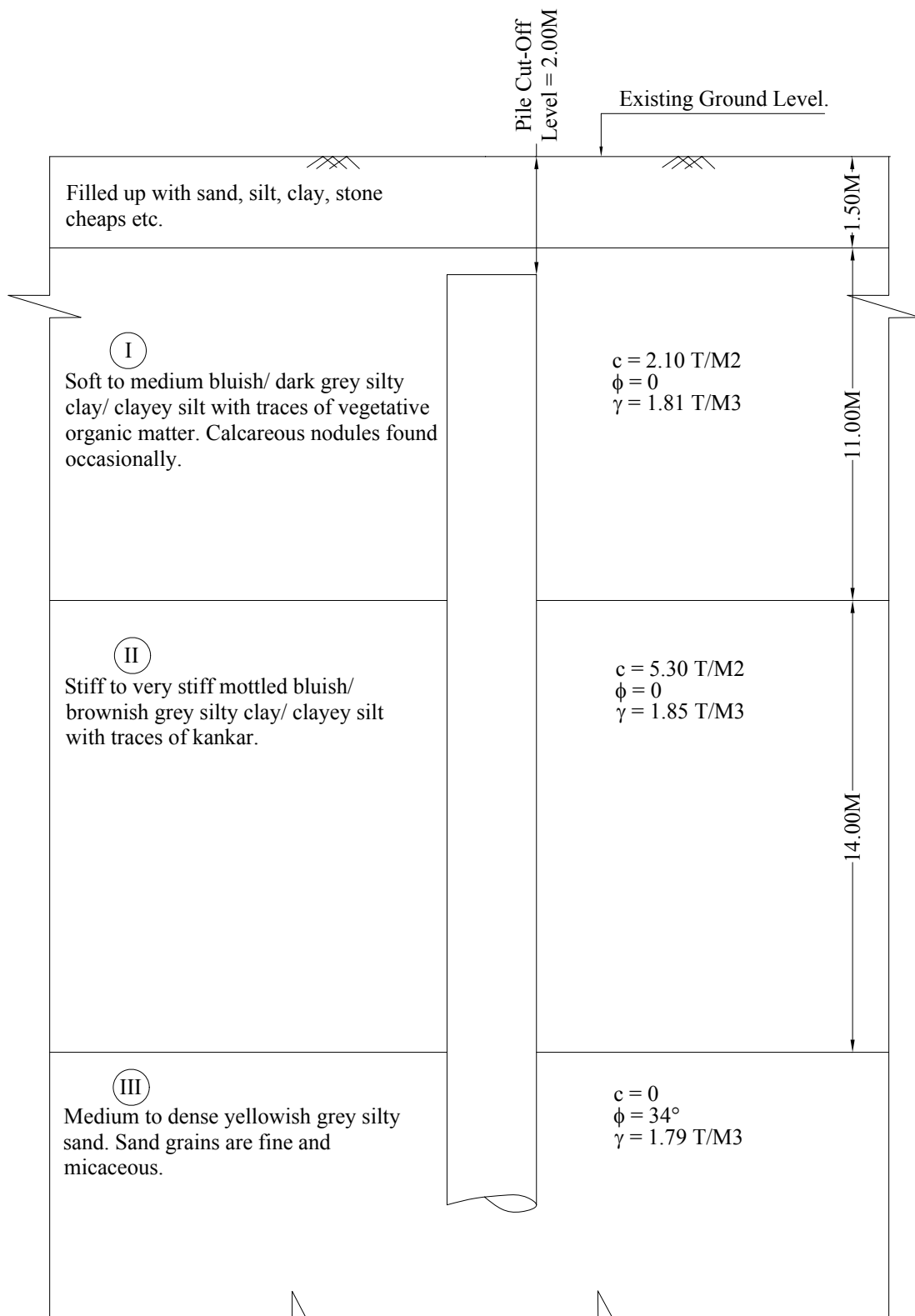
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc	Water Content in %	Specific Gravity	Dry Density in gm/cc	Unconfined Test in Kg/sqcm	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm	Friction angle in degree					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/CU/CD /DS	C	φ								
I	Soft to medium bluish/ dark grey silty clay/ clayey silt with traces of vegetative organic matter. Calcareous nodules found occasionally.	13	1.50	DN	2	59	23	14			2.71								6.90	0	11	56	33	
		13	3.00	UD		65	24	15	1.81	34	2.72	1.35	0.4	UU	0.21	0	0.00-0.10	0.0075	0	24	0	13	61	26
																	0.10-0.20	0.0131						
														CU	0.07	14	0.20-0.40	0.0261						
															CD	0	18	0.40-0.80	0.0359					
II	Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of kankar.	13	12.50	DN	13	48	21	14.3			2.69								2.58	0	7	69	24	
		13	14.00	UD		47	20	12.3	1.85	30.7	2.66	1.42	1.01	UU	0.53	0	0.00-0.10	0.0068	0	3.3	0	10	64	26
																	0.10-0.20	0.0127						
														CU	0.13	18	0.20-0.40	0.0254						
															CD	0	26	0.40-0.80	0.0353					
III	Medium to dense yellowish grey silty sand. Sand grains are fine and micaceous.	13	29.50	DN	34	NP			1.79		2.65			DS	0.03	34			0	0	99	1	0	

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/	ETP	1638	03
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Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: ETP unit, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description: Soft to medium bluish/ dark grey silty clay/ clayey silt with traces of vegetative organic matter. Calcareous nodules found occasionally.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, Q_{su} = $\alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	2.000	12.500	1	2.1	13.195	27.709
2	0.500	30.000	2.000	12.500	1	2.1	16.493	34.636
3	0.550	30.000	2.000	12.500	1	2.1	18.143	38.100
4	0.600	30.000	2.000	12.500	1	2.1	19.792	41.563
5	0.750	30.000	2.000	12.500	1	2.1	24.740	51.954
6	1.000	30.000	2.000	12.500	1	2.1	32.987	69.272

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: ETP unit, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of kankar.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	30.000	12.500	26.500	0.9	5.3	17.593	83.918
2	0.500	30.000	12.500	26.500	0.9	5.3	21.991	104.898
3	0.550	30.000	12.500	26.500	0.9	5.3	24.190	115.388
4	0.600	30.000	12.500	26.500	0.9	5.3	26.389	125.877
5	0.750	30.000	12.500	26.500	0.9	5.3	32.987	157.347
6	1.000	30.000	12.500	26.500	0.9	5.3	43.982	209.796

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: ETP unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description : Medium to dense yellowish grey silty sand. Sand grains are fine and micaceous.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $=(\phi -3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	30.000	26.500	30.000	1.000	34	31	32.67	20.63	25.99	1.79	0.79	1.3	15	4.74	0.54	3.703	4.74	3.703	3.703	4.398	16.284
2	0.500	30.000	26.500	30.000	1.000	34	31	32.67	20.63	25.99	1.79	0.79	1.3	15	5.925	0.54	4.628	5.925	4.628	4.628	5.498	25.444
3	0.550	30.000	26.500	30.000	1.000	34	31	32.67	20.63	25.99	1.79	0.79	1.3	15	6.518	0.54	5.091	6.518	5.091	5.091	6.048	30.788
4	0.600	30.000	26.500	30.000	1.000	34	31	32.67	20.63	25.99	1.79	0.79	1.3	15	7.11	0.54	5.554	7.11	5.554	5.554	6.597	36.640
5	0.750	30.000	26.500	30.000	1.000	34	31	32.67	20.63	25.99	1.79	0.79	1.3	15	8.888	0.54	6.942	8.888	6.942	6.942	8.247	57.250
6	1.000	30.000	26.500	30.000	1.000	34	31	32.67	20.63	25.99	1.79	0.79	1.3	15	11.85	0.54	9.256	11.85	9.256	9.256	10.996	101.778

Ultimate end bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: ETP unit, Dankuni Coal Complex, West Bengal

Layer No: 3

Soil Description : Medium to dense yellowish grey silty sand. Sand grains are fine and micaceous.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $=(\phi -3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{D_1} at pile tip	A_p	End Bearing
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			M ²	T
1	0.400	30.000	26.500	30.000	0.000	34	31	32.67	20.63	25.99	1.79	0.79	15	4.74	0.126	12.805
2	0.500	30.000	26.500	30.000	0.000	34	31	32.67	20.63	25.99	1.79	0.79	15	5.925	0.196	25.009
3	0.550	30.000	26.500	30.000	0.000	34	31	32.67	20.63	25.99	1.79	0.79	15	6.5175	0.238	33.287
4	0.600	30.000	26.500	30.000	0.000	34	31	32.67	20.63	25.99	1.79	0.79	15	7.11	0.283	43.216
5	0.750	30.000	26.500	30.000	0.000	34	31	32.67	20.63	25.99	1.79	0.79	15	8.8875	0.442	84.406
6	1.000	30.000	26.500	30.000	0.000	34	31	32.67	20.63	25.99	1.79	0.79	15	11.85	0.785	200.074

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.21 Kg/cm ²	
	=	20.601 Kn/M ²	
L (Length of Pile)	=	30.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.181 MN/M ³	
T (Stiffness Factor)	=	1.928 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	28.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.242 Mtr.	
Therefore,	Lf	=	4.242 Mtr.
	L1	=	0.000 Mtr.

For Fixed Head Pile, deflection at the pile head,

Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	24.77 Kn	
Horizontal Shear Capacity = H_{design}	=	2.52 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: ETP unit, Dankuni Coal Complex, West Bengal

SI.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T
1	0.400	30.000	27.709	83.918	16.284	12.805	140.716	2.5	56.287	56	51	2.52
2	0.500	30.000	34.636	104.898	25.444	25.009	189.988	2.5	75.995	75	65	2.76
3	0.550	30.000	38.100	115.388	30.788	33.287	217.562	2.5	87.025	87	73	2.86
4	0.600	30.000	41.563	125.877	36.640	43.216	247.297	2.5	98.919	98	81	2.96
5	0.750	30.000	51.954	157.347	57.250	84.406	350.957	2.5	140.383	140	106	3.24
6	1.000	30.000	69.272	209.796	101.778	200.074	580.920	2.5	232.368	232	152	3.64

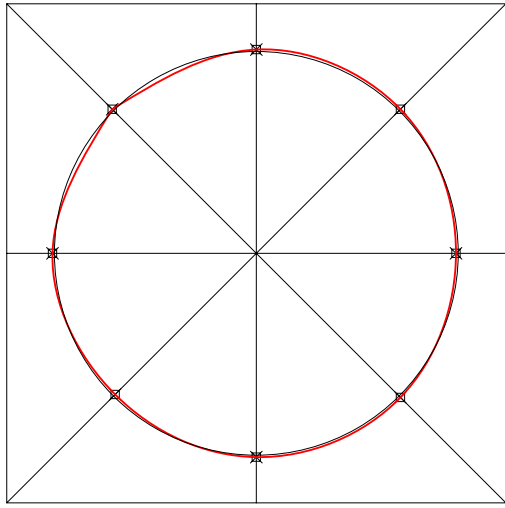
ELECTRICAL RESISTIVITY TEST

Table ERT - 11

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 21-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

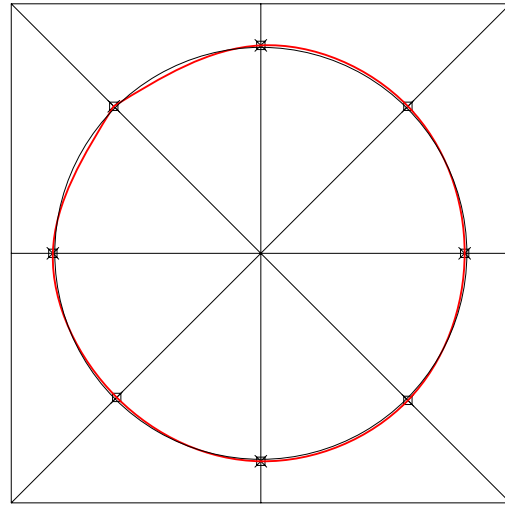
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")								
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West	
1	1.0	49	49	48	49	49	48	49	49	307.88	307.88	301.59	307.88	307.88	301.59	307.88	307.88	
2	2.0	50	50	49	50	50	49	50	50	628.32	628.32	615.75	628.32	628.32	615.75	628.32	628.32	
3	5.0	51	51	51	51	51	51	51	51	1,602.21	1,602.21	1,602.21	1,602.21	1,602.21	1,602.21	1,602.21	1,602.21	
4	10.0	52	52	52	52	52	52	52	52	3,267.26	3,267.26	3,267.26	3,267.26	3,267.26	3,267.26	3,267.26	3,267.26	
5	15.0	53	53	52	53	53	52	53	53	4,995.13	4,995.13	4,900.88	4,995.13	4,995.13	4,900.88	4,995.13	4,995.13	
6	20.0	Space Not Available																

Location - ERT-11



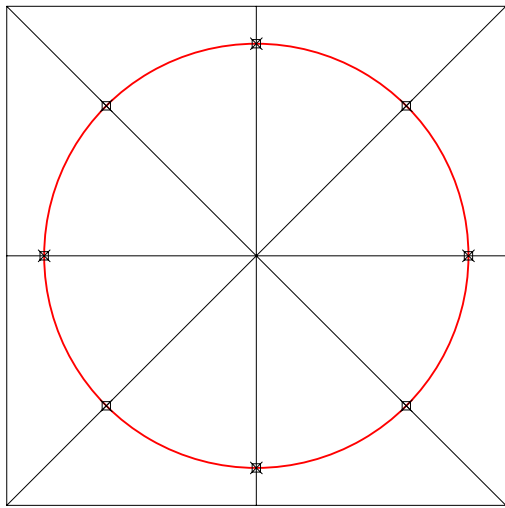
Electrode Spacing - 1.00M
R = 48.54 ohm, Resistivity = 304.83 Ohm-m

Location - ERT-11



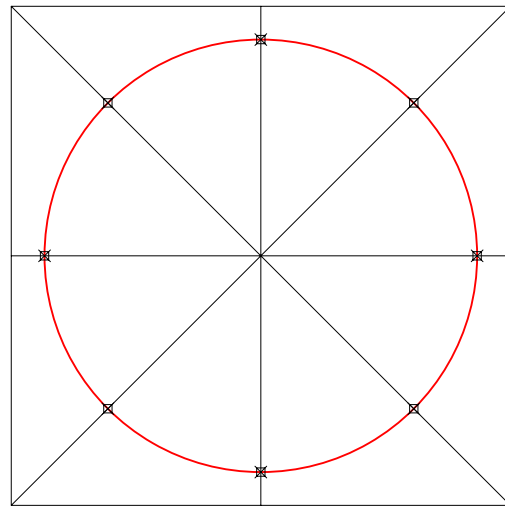
Electrode Spacing - 2.00M
R = 49.53 ohm, Resistivity = 622.10 Ohm-m

Location - ERT-11



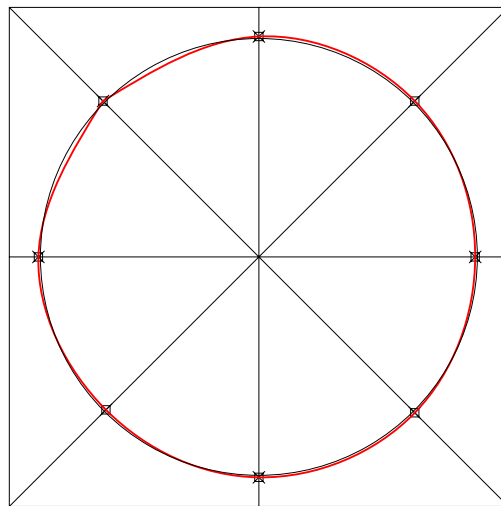
Electrode Spacing - 5.00M
R = 51.00 ohm, Resistivity = 1602.21 Ohm-m

Location - ERT-11



Electrode Spacing - 10.00M
R = 52.00 ohm, Resistivity = 3267.26 Ohm-m

Location - ERT-11



Electrode Spacing - 15.00M
R = 52.52 ohm, Resistivity = 4947.38 Ohm-m

ZONE-11

WORK SHOP

Modulus of Subgrade Reaction and Modulus of Elasticity have been calculated for Plate Load Test as follows.

Calculation for Modulus of Subgrade Reaction (K) for PLT-2

From Load-Settlement curve of PLT-2, Pressure corresponding to settlement of 1.25mm is 0.79 Kg/Cm².

$$\begin{aligned} \text{Hence, } K &= \text{Pressure / Settlement.} \\ &= 0.79 / 0.125 \text{ Kg/Cm}^3 \\ &= 6.32 \text{ Kg/Cm}^3 \end{aligned}$$

Calculation for Modulus of Elasticity (Es) for PLT-2.

Modulus of Elasticity has been calculated for initial load of 4.20 T/M² and corresponding settlement of 0.061 cm.

$$\begin{aligned} E_s &= \{q \cdot (1 - \mu^2) \cdot B \cdot I_w\} / S \\ &= \{0.36 \cdot (1 - 0.3^2) \cdot 75 \cdot 0.82\} / 0.121 \\ &= 308.27 \text{ Kg/Cm}^2 \end{aligned}$$

Where,

- Es = Modulus of Elasticity.
- q = Pressure = 0.42 Kg/Cm²
- μ = Poisson's Ratio = 0.3
- B = Least dimension of the plate = 60 Cm
- Iw = Influence Factor = 0.82
- S = Settlement = 0.06 Cm

Modulus of Subgrade Reaction and Modulus of Elasticity, obtain from Plate Load Test.

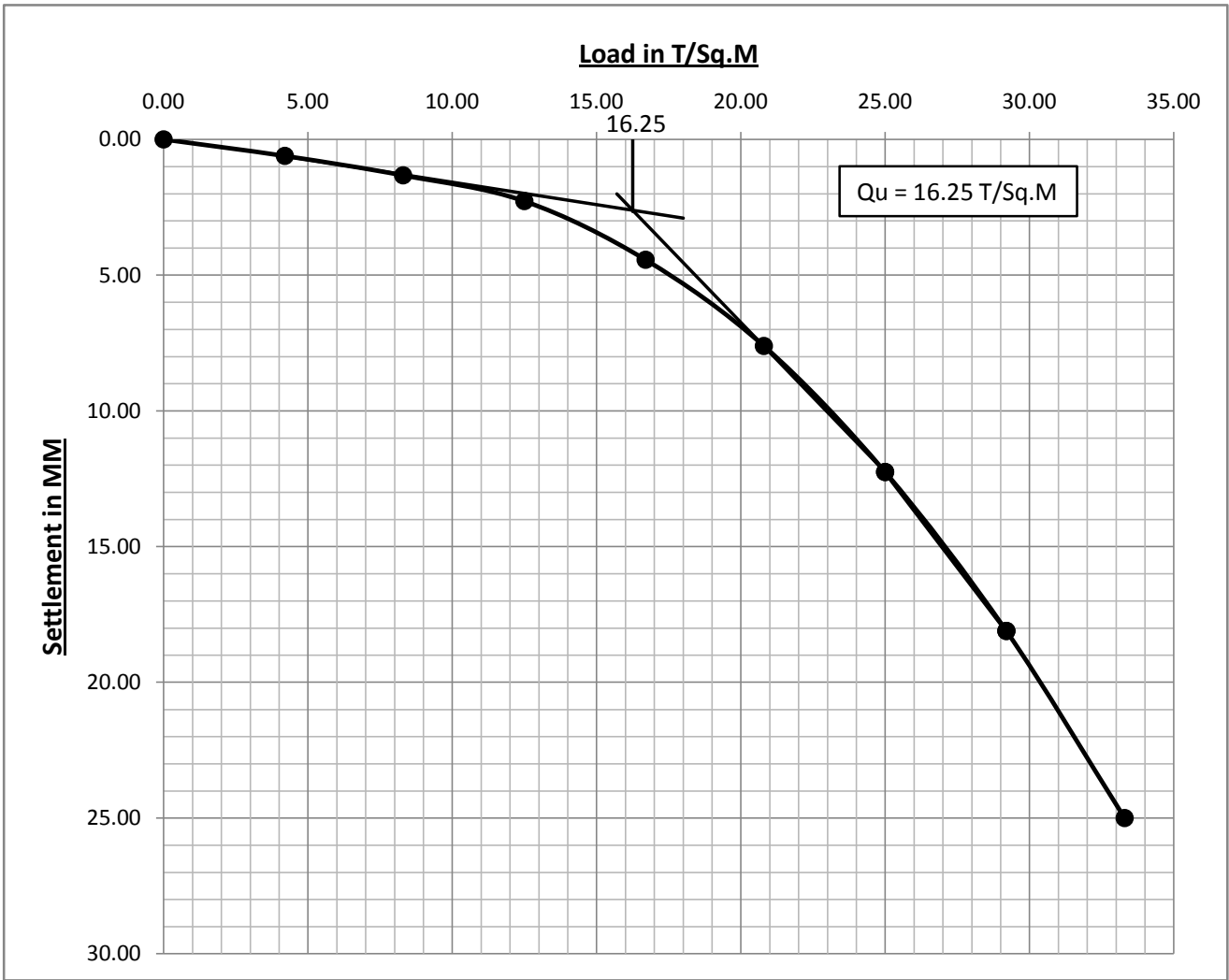
Test No.	Depth of Test	Modulus of Subgrade Reaction, K	Modulus of Elasticity, Es
	(M)	(Kg/Cm ³)	(Kg/Cm ²)
PLT-2	2	6.32 Kg/Cm ³	308.27 Kg/Cm ²

PLATE LOAD TEST SITE DATA SHEET

Client : Projects & Development India Limited
 Location : Near Ex. Sales & Marketing Office.
 Test Number : PLT-2
 Plate Size : 60x60 3600 Sqcm
 Pit Size : 3.00M X 3.00M X 2.00M
 Ground Water Table : Not Encountered
 L.C. of Dial Guage : 0.01 mm
 Jack Ram Dia : 10.5 cm
 Jack Ram Area : 86.59 Sqcm

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
03-12-2019	10:50:00	0.00	0	2500	2500	0.00	0.00	0.00	
	10:50:00	1500	0.42	2500	2500	0.00	0.00	0.00	
	10:51:00			2444	2459	0.56	0.41	0.49	
	10:52:15			2440	2456	0.60	0.44	0.52	
	10:54:00			2439	2455	0.61	0.45	0.53	
	10:56:15			2438	2453	0.62	0.47	0.55	
	10:59:00			2437	2452	0.63	0.48	0.56	
	11:06:00			2436	2449	0.64	0.51	0.58	
	11:15:00			2435	2447	0.65	0.53	0.59	
	11:50:00			2433	2445	0.67	0.55	0.61	
	11:50:00	3000	0.83	2433	2445	0.67	0.55	0.61	
	11:51:00			2374	2390	1.26	1.10	1.18	
	11:52:15			2371	2388	1.29	1.12	1.21	
	11:54:00			2367	2386	1.33	1.14	1.24	
	11:56:15			2366	2384	1.34	1.16	1.25	
	11:59:00			2364	2381	1.36	1.19	1.28	
	12:06:00			2363	2377	1.37	1.23	1.30	
	12:15:00			2362	2375	1.38	1.25	1.32	
	12:50:00			2361	2374	1.39	1.26	1.33	
	12:50:00	4500	1.25	2361	2374	1.39	1.26	1.33	
	12:51:00			2345	2326	1.55	1.74	1.65	
	12:52:15			2336	2293	1.64	2.07	1.86	
	12:54:00			2330	2286	1.70	2.14	1.92	
	12:56:15			2322	2280	1.78	2.20	1.99	
	12:59:00			2310	2274	1.90	2.26	2.08	
	13:06:00			2295	2267	2.05	2.33	2.19	
	13:15:00			2290	2260	2.10	2.40	2.25	
	13:50:00			2288	2257	2.12	2.43	2.28	
	13:50:00	6000	1.67	2288	2257	2.12	2.43	2.28	
	13:51:00			2112	2133	3.88	3.67	3.78	

DATE	TIME (Hrs)	LOAD IN (KG)	PRESSURE IN Kg/Sqcm	DIAL GUAGE READING (mm)		SETTLEMENT (mm)		MEAN SETTLEMENT (mm)	REMARKS
				DIAL-1	DIAL-2	DIAL-1	DIAL-2		
	13:52:15			2105	2124	3.95	3.76	3.86	
	13:54:00			2099	2116	4.01	3.84	3.93	
	13:56:15			2092	2109	4.08	3.91	4.00	
	13:59:00			2082	2103	4.18	3.97	4.08	
	14:06:00			2075	2088	4.25	4.12	4.19	
	14:15:00			2066	2078	4.34	4.22	4.28	
	14:50:00			2051	2062	4.49	4.38	4.44	
	14:50:00	7500	2.08	2051	2062	4.49	4.38	4.44	
	14:51:00			1985	1965	5.15	5.35	5.25	
	14:52:15			1960	1940	5.40	5.60	5.50	
	14:54:00			1933	1909	5.67	5.91	5.79	
	14:56:15			1922	1898	5.78	6.02	5.90	
	14:59:00			1890	1866	6.10	6.34	6.22	
	15:06:00			1821	1792	6.79	7.08	6.94	
	15:15:00			1780	1761	7.20	7.39	7.30	
	15:50:00			1742	1736	7.58	7.64	7.61	
	15:50:00	9000	2.50	1742	1736	7.58	7.64	7.61	
	15:51:00			1600	1604	9.00	8.96	8.98	
	15:52:15			1580	1585	9.20	9.15	9.18	
	15:54:00			1531	1539	9.69	9.61	9.65	
	15:56:15			1464	1474	10.36	10.26	10.31	
	15:59:00			1415	1404	10.85	10.96	10.91	
	16:06:00			1374	1368	11.26	11.32	11.29	
	16:15:00			1331	1334	11.69	11.66	11.68	
	16:50:00			1260	1290	12.40	12.10	12.25	
	16:50:00	10500	2.92	1260	1290	12.40	12.10	12.25	
	16:51:00			997	1064	15.03	14.36	14.70	
	16:52:15			853	869	16.47	16.31	16.39	
	16:54:00			792	804	17.08	16.96	17.02	
	16:56:15			757	768	17.43	17.32	17.38	
	16:59:00			727	724	17.73	17.76	17.75	
	17:06:00			708	702	17.92	17.98	17.95	
	17:15:00			700	690	18.00	18.10	18.05	
	17:50:00			696	683	18.04	18.17	18.11	
	17:50:00	12000	3.33	696	683	18.04	18.17	18.11	
	17:51:00			296	327	22.04	21.73	21.89	
	17:52:15			181	192	23.19	23.08	23.14	
	17:54:00			106	113	23.94	23.87	23.91	
	17:56:15			69	71	24.31	24.29	24.30	
	17:59:00			47	41	24.53	24.59	24.56	
	18:06:00			30	25	24.70	24.75	24.73	
	18:15:00			12	9	24.88	24.91	24.90	
	18:50:00			0	0	25.00	25.00	25.00	



Load Vs Settlement Curve for PLT-2

ZONE-12

WARE HOUSE

Total one (1) borehole was sunk in this area, viz borehole marked BH-14. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with sand, silt, clay, stone cheeps etc. followed by first layer of soft light brownish grey silty clay/ clayey silt and the second layer as encountered up to the explored depth is stiff to very stiff bluish/ brownish grey silty clay/ clayey silt.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-12). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-12).
Recommended Pile Capacity

SI.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	28.000	2.000	50	47	2.60
2	0.500	28.000	2.000	64	59	2.83
3	0.550	28.000	2.000	71	65	2.94
4	0.600	28.000	2.000	78	71	3.05
5	0.750	28.000	2.000	100	89	3.33
6	1.000	28.000	2.000	138	119	3.74

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-14 (Sheet-1)	
Project: SOIL PDIL DANKUNI WARE HOUSE							Job No.: Soil - 1638
Co-ord:		E.G.L.: 34.650		Unit:		Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	30.000 M.	SPT	15	UDS	10	WS	
Type of Drilling		DCPT		DS	17	RCS	
Depth of Drilling		VST		SCPT			
							Commenced on : 13.10.2019
							Completed on : 16.10.2019
							Water Struck At : 1.10 M.
							Standing Water Table : 1.00 M.
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Filled up with sand, silt, clay, stone cheaps etc.		01		DS1	0.50 M		
Soft light brownish grey silty clay/ clayey silt.		02	N = 4	DS2	1.00 M		
				SPT1	1.50-1.95M		
				DS3	1.50-1.95M		
				UDS1	2.00-2.45M		
		03	N = 3	SPT2	3.00-3.45M		
				DS4	3.00-3.45M		
		04					
		05	N = 2	SPT3	4.50-4.95M		
				DS5	4.50-4.95M		
				UDS2	5.00-5.45M		
	06	N = 2	SPT4	6.00-6.45M			
			DS6	6.00-6.45M			
	07						
	08	N = 2	SPT5	7.50-7.95M			
			DS7	7.50-7.95M			
			UDS3	8.00-8.45M			
	09	N = 2	SPT6	9.00-9.45M			
			DS8	9.00-9.45M			
	10						
Stiff to very stiff bluish/ brownish grey silty clay/ clayey silt with traces of silt stone.		11	N = 12	SPT7	10.50-10.95M		
				DS9	10.50-10.95M		
				UDS4	11.00-11.45M		
		12					
		13	N = 12	SPT8	12.50-12.95M		
				DS10	12.50-12.95M		
		14					
		15	N = 15	UDS5	14.00-14.45M		
				SPT9	14.50-14.95M		
				DS11	14.50-14.95M		
	16						
	17	N = 13	SPT10	16.50-16.95M			
			DS12	16.50-16.95M			
			UDS6	17.00-17.45M			
	18						
	19	N = 10	SPT11	18.50-18.95M			
			DS13	18.50-18.95M			
Contd.....							
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample			WS - Water Sample		
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.			RCS - Rock Core Sample		

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-14 (Sheet-2)	
Project:SOIL PDIL DANKUNI WARE HOUSE						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 34.650		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	30.000 M.	SPT	15	UDS	10	WS	
Type of Drilling		DCPT		DS	17	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 13.10.2019	
						Completed on : 16.10.2019	
						Water Struck At :1.10 M.	
						Standing Water Table :1.00 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Stiff to very stiff bluish/ brownish grey silty clay/ clayey silt with traces of silt stone.		21	N = 11	UDS7	20.00-20.45M		
				SPT12	20.50-20.95M		
				DS14	20.50-20.95M		
			22	N = 14			
			23		UDS8	23.00-23.45M	
			24		SPT13	23.50-23.95M	
				DS15	23.50-23.95M		
			25	N = 18			
			26		UDS9	26.00-26.45M	
			27		SPT14	26.50-26.95M	
				DS16	26.50-26.95M		
			28	N = 26			
			29		UDS10	29.00-29.45M	
			30		SPT15	29.55-30.00M	
	Termination Depth 30.000 Mtr.				DS17	29.55-30.00M	
			31				
		32					
		33					
		34					
		35					
		36					
		37					
		38					
		39					

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

RL=34.650

BH-14

Filled up with sand, silt, clay, stone cheaps etc.

1.00M

2.00M.

4.00M.

Layer-I

6.00M.

Soft light brownish grey silty clay/ clayey silt.

8.00M.

10.00M.

10.50M

12.00M.

14.00M.

Layer-II

16.00M.

Stiff to very stiff bluish/ brownish grey silty clay/ clayey silt with traces of silt stone.

18.00M.

20.00M.

22.00M.

24.00M.

26.00M.

28.00M.

30.00M.

Termination depth 30.000 M.

32.00M.

34.00M.

36.00M.

38.00M.

Sub-Soil Profile through BH-14

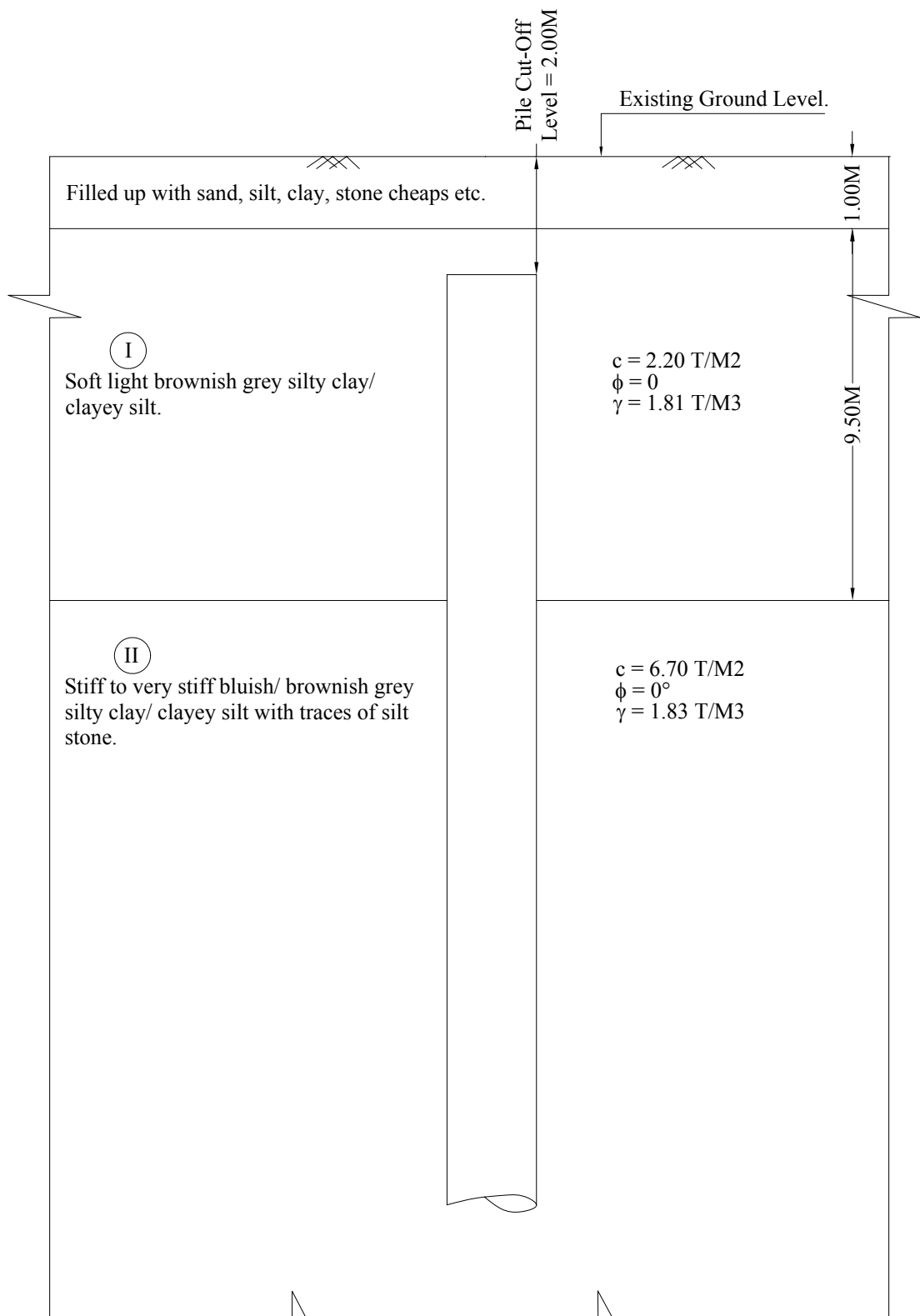
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc γ_b	Water Content in % m	Specific Gravity G	Dry Density in gm/cc γ_d	Unconfined Test in Kg/sqcm q_u	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading			
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm C	Friction angle in degree ϕ					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %
						%	%	%						UU/CU/CD /DS										
I	Soft light brownish grey silty clay/ clayey silt.	14	1.50	DN	4	51	20	12.5			2.67								10.00	0	9	62	29	
		14	2.00	UD		49	19	11.7	1.81	33.28	2.66	1.36	0.4	UU	0.22	0	0.00-0.10	0.0187	0	8.6	0	7	65	28
																	0.10-0.20	0.0251						
														CU	0.07	12	0.20-0.40	0.0389						
																	0.40-0.80	0.0326						
CD	0	16	0.80-1.60	0.0252																				
			1.60-3.20	0.0188																				
14	7.50	DN	2	50	21	13.2			2.66									9.4	0	5	73	22		
II	Stiff to very stiff bluish/ brownish grey silty clay/ clayey silt with traces of silt stone.	14	11.00	UD		49	20	13.6	1.83	25.8	2.67	1.45	1.28	UU	0.67	0	0.00-0.10	0.0154	0	6.82	1	8	65	26
																	0.10-0.20	0.0217						
														CU	0.13	16	0.20-0.40	0.0358						
																	0.40-0.80	0.0295						
		CD	0	27	0.80-1.60	0.0243																		
			1.60-3.20	0.0151																				
14	14.50	DN	15	56	20	12			2.67									3.57	3	11	54	32		
14	29.55	DN	26	43	19	11			2.65									0	4	18	57	21		

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ WARE HOUSE 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Ware House, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft light brownish grey silty clay/ clayey silt.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	2.000	10.500	1	2.2	10.681	23.499
2	0.500	28.000	2.000	10.500	1	2.2	13.352	29.374
3	0.550	28.000	2.000	10.500	1	2.2	14.687	32.311
4	0.600	28.000	2.000	10.500	1	2.2	16.022	35.249
5	0.750	28.000	2.000	10.500	1	2.2	20.028	44.061
6	1.000	28.000	2.000	10.500	1	2.2	26.704	58.748

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Ware House, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Stiff to very stiff bluish/ brownish grey silty clay/ clayey silt with traces of silt stone.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	10.500	28.000	0.65	6.7	21.991	95.771
2	0.500	28.000	10.500	28.000	0.65	6.7	27.489	119.714
3	0.550	28.000	10.500	28.000	0.65	6.7	30.238	131.686
4	0.600	28.000	10.500	28.000	0.65	6.7	32.987	143.657
5	0.750	28.000	10.500	28.000	0.65	6.7	41.233	179.571
6	1.000	28.000	10.500	28.000	0.65	6.7	54.978	239.429

Ultimate End Bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Ware House, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Stiff to very stiff bluish/ brownish grey silty clay/ clayey silt with traces of silt stone.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Average Cohesion at the pile tip, C_P	Cross sectional area of the pile tip, A_P	Bearing capacity factor, N_C	UltimateEnd bearing capacityat pile tip, Q_{Bu} = A_P*N_C*C_P
	Mtr	Mtr.	Mtr	Mtr.	T/M ²	M ²		T
1	0.400	28.000	10.500	28.000	6.7	0.126	9.000	7.578
2	0.500	28.000	10.500	28.000	6.7	0.196	9.000	11.840
3	0.550	28.000	10.500	28.000	6.7	0.238	9.000	14.326
4	0.600	28.000	10.500	28.000	6.7	0.283	9.000	17.049
5	0.750	28.000	10.500	28.000	6.7	0.442	9.000	26.640
6	1.000	28.000	10.500	28.000	6.7	0.785	9.000	47.360

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.22 Kg/cm ²	
	=	21.582 Kn/M ²	
L (Length of Pile)	=	28.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
f_{ck}	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.238 MN/M ³	
T (Stiffness Factor)	=	1.91 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	26.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.202 Mtr.	
Therefore,	Lf	=	4.202 Mtr.
	L1	=	0.000 Mtr.
<u>For Fixed Head Pile, deflection at the pile head,</u>			
Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	25.47 Kn	
Horizontal Shear Capacity = H_{design}	=	2.60 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Ware House, Dankuni Coal Complex, West Bengal

SI.No	Pile Dia, D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T
1	0.400	28.000	23.499	95.771	7.578	126.848	2.5	50.739	50	47	2.60
2	0.500	28.000	29.374	119.714	11.840	160.928	2.5	64.371	64	59	2.83
3	0.550	28.000	32.311	131.686	14.326	178.323	2.5	71.329	71	65	2.94
4	0.600	28.000	35.249	143.657	17.049	195.955	2.5	78.382	78	71	3.05
5	0.750	28.000	44.061	179.571	26.640	250.272	2.5	100.109	100	89	3.33
6	1.000	28.000	58.748	239.429	47.360	345.536	2.5	138.214	138	119	3.74

ZONE-13

CANTEEN

Total one (1) borehole was sunk in this area, viz borehole marked BH-12. From the general sub soil profile it has been observed that the top soil is heterogeneous fill with clay, brickbats, pebbles etc. followed by first layer of soft dark grey silty clay/ clayey silt. The second layer is soft bluish grey silty clay/ clayey silt. The third layer consists of stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt and the forth layer as encountered up to the explored depth is dense to very dense brownish grey silty sand.

In addition the following field tests have been carried out at this zone and results are being indicated in this chapter.

1. Electrical Resistivity Test:

One (1) electrical resistivity tests has been carried out at this zone marked as ERT-10.

Discussion and Recommendation:

Based on the subsoil condition pile foundation has been recommended for foundation system of medium to heavily loaded structures. Pile capacities in compression, pull-out and horizontal shear for different diameter of pile are indicated in the Table-2A (Zone-13). It is further recommended to carry out initial pile load test for load under compression, pull-out and horizontal shear, in order to confirm the recommended pile capacities and to take corrective measures, if required.

Table-2A (Zone-13).
Recommended Pile Capacity

SI.No	Pile Dia , D	Total Length of Pile, L	Cut-off Level	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	Mtr.	T	T	T
1	0.400	28.000	2.000	54	49	2.73
2	0.500	28.000	2.000	72	62	2.99
3	0.550	28.000	2.000	82	69	3.10
4	0.600	28.000	2.000	93	76	3.21
5	0.750	28.000	2.000	130	97	3.51
6	1.000	28.000	2.000	213	134	3.94

BORE LOG SHEET		Centre for Advanced Engineering						Bore Hole No.:BH-12 (Sheet-1)	
Project: SOIL PDIL DANKUNI CANTEEN								Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.289		Unit:				Bore Hole Dia. : 150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.	Commenced on : 01.10.2019	
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS		Completed on : 04.10.2019	
Type of Drilling		DCPT		DS	19	RCS		Water Struck At : 0.50 M.	
Depth of Drilling		VST		SCPT				Standing Water Table : 0.34 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E					
				NO.	DEPTH				
Filled up with silty clay, brickbats, pebbles etc.		01		DS1	0.50 M				
Soft dark grey silty clay/ clayey silt with traces of vegetative organic matter.		02	N = 2	DS2 SPT1 DS3 UDS1	1.00 M 1.50-1.95M 1.50-1.95M 2.00-2.45M				
		03	N = 2	SPT2 DS4	3.00-3.45M 3.00-3.45M				
		04							
		05	N = 2	SPT3 DS5 UDS2	4.50-4.95M 4.50-4.95M 5.00-5.45M				
		06							
		07	N = 3	SPT4 DS6	6.00-6.45M 6.00-6.45M				
Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.		08	N = 3	SPT5 DS7 UDS3	7.50-7.95M 7.50-7.95M 8.00-8.45M				
		09	N = 3	SPT6 DS8	9.00-9.45M 9.00-9.45M				
		10							
Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of fine sand.		11	N = 10	SPT7 DS9 UDS4	10.50-10.95M 10.50-10.95M 11.00-11.45M				
		12							
		13	N = 8	SPT8 DS10	12.50-12.95M 12.50-12.95M				
		14							
		15	N = 18	UDS5 SPT9 DS11	14.00-14.45M 14.50-14.95M 14.50-14.95M				
		16							
Contd.....		17	N = 19	SPT10 DS12 UDS6	16.50-16.95M 16.50-16.95M 17.00-17.45M				
		18							
		19	N = 12	SPT11 DS13	18.50-18.95M 18.50-18.95M				

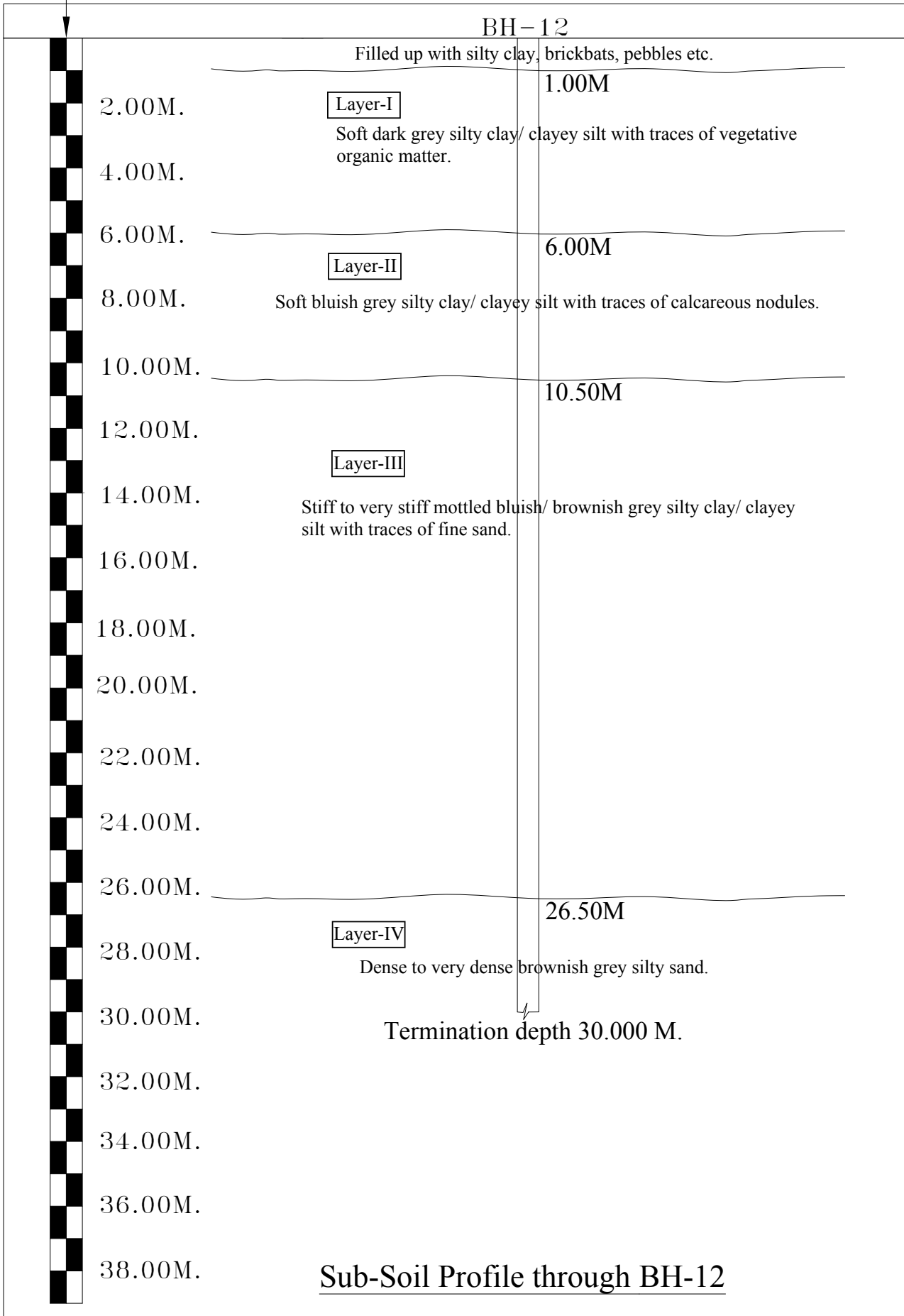
SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

BORE LOG SHEET		Centre for Advanced Engineering				Bore Hole No.:BH-12 (Sheet-2)	
Project:SOIL PDIL DANKUNI CANTEEN						Job No.: Soil - 1638	
Co-ord:		E.G.L.: 35.289		Unit:		Bore Hole Dia. :150 MM.	
Type of Boring	Shell & Auger	FIELDTEST	NOS.	SAMPLES	NOS.	SAMPLES	NOS.
Depth of Boring	35.000 M.	SPT	17	UDS	10	WS	
Type of Drilling		DCPT		DS	19	RCS	
Depth of Drilling		VST		SCPT			
						Commenced on : 01.10.2019	
						Completed on : 04.10.2019	
						Water Struck At :0.50 M.	
						Standing Water Table : 0.34 M.	
D E S C R I P T I O N	SYMBOL	DEPTH	N-V A L U E	S A M P L E			
				NO.	DEPTH		
Stiff to very stiff mottled bluish/ brownish grey silty clay/ clayey silt with traces of fine sand.		21	N = 17	UDS7	20.00-20.45M		
				SPT12	20.50-20.95M		
				DS14	20.50-20.95M		
		23	N = 24	UDS8	23.00-23.45M		
				SPT13	23.50-23.95M		
				DS15	23.50-23.95M		
Dense to very dense brownish grey silty sand.		27	N = 56	UDS9	26.00-26.45M		
				SPT14	26.50-26.95M		
				DS16	26.50-26.95M		
		29	N = 66	UDS10	29.00-29.45M		
				SPT15	29.50-29.95M		
				DS17	29.50-29.95M		
		32	N = 43	SPT16	32.00-32.45M		
				DS18	32.00-32.45M		
Termination Depth 35.000 Mtr.		35	N = 49	SPT17	34.55-35.00M		
				DS19	34.55-35.00M		
		36					
		37					
		38					
		39					

SPT - Standard Penetration Test	VST- Vane Shear Test	DS - Disturbed Sample	WS - Water Sample
DCPT - Dynamic Cone Penetration Test.	UDS - Undisturbed Sample	SCPT-Static Cone Penetration Test.	RCS - Rock Core Sample

RL=35.289

BH-12



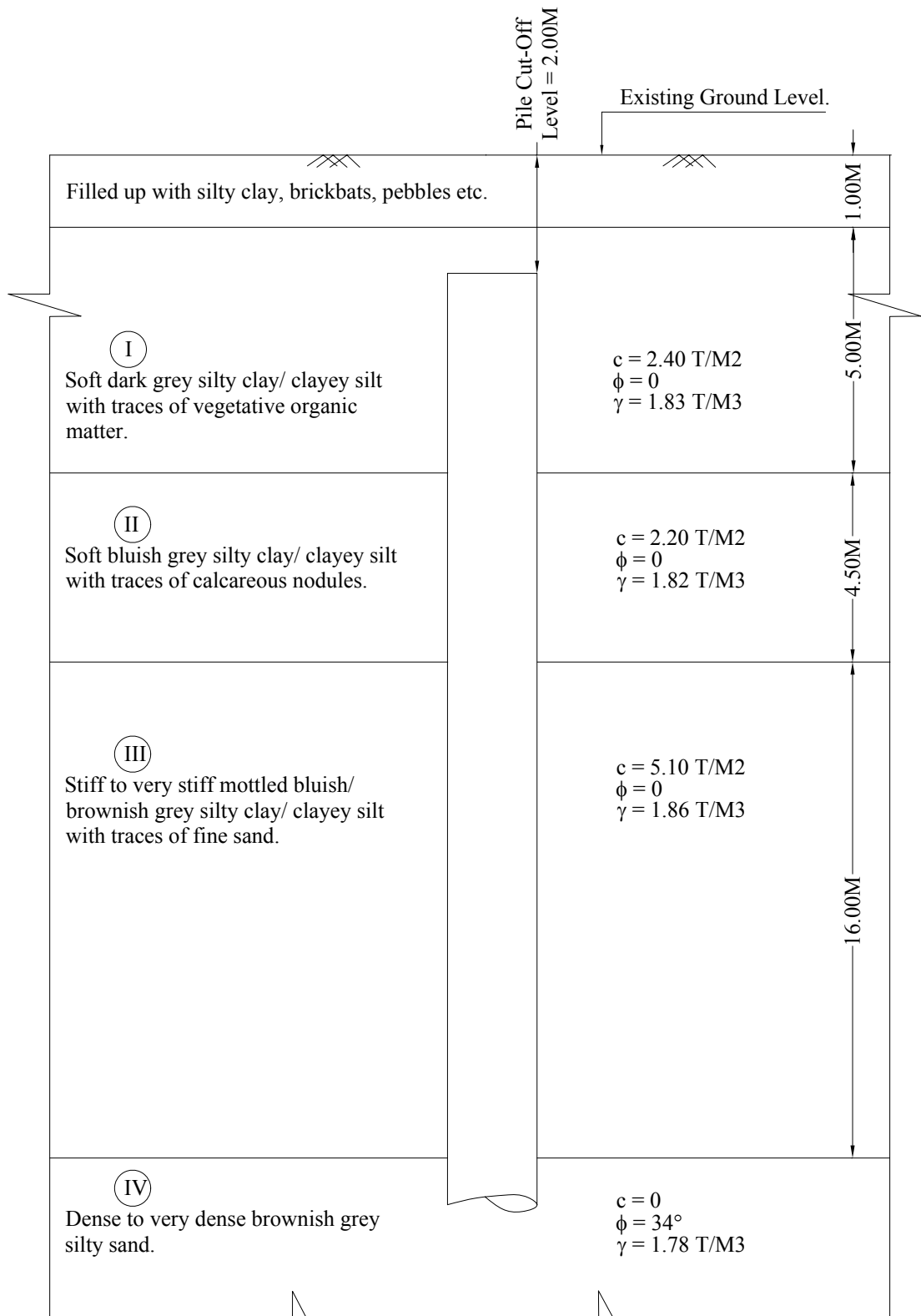
SUMMARY OF LABORATORY TEST RESULTS

Table-3

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Layer No.	Description of layer	Bore Hole No.	Depth Meter	Sample Type - UD/D/ DN	SPT VALUE (N)	Atterberg Limits			Bulk Density in gm/cc γ_b	Water Content in % m	Specific Gravity G	Dry Density in gm/cc γ_d	Unconfined Test in Kg/sqcm q_u	Shear Test			Pressure (Kg/sqcm)	Co-eff. of volume compressibility in sqcm/kg	Swell Pressure (Kg/sqcm)	Free Swell Index (%)	Grading				
						LL	PL	SL						Type of Test	Cohesion in kg/sqcm C	Friction angle in degree ϕ					Gravel (> 4.75 mm) %	Sand (0.075 - 4.75 mm) %	Silt (0.002 - 0.075 mm) %	Clay (< 0.002 mm) %	
						%	%	%						UU/CU/CD /DS											
I	Soft dark grey silty clay/ clayey silt with traces of vegetative organic matter.	12	1.50	DN	2					2.59									14.24	0	9	69	22		
		12	2.00	UD		58	20	12.5	1.83	39.64	2.68	1.31	0.45	UU	0.24	0	0.00-0.10	0.0327	0	21.33	0	8	63	29	
																	0.10-0.20	0.0221							
														CU	0.09	13	0.20-0.40	0.0965							
													CD	0	17	0.40-0.80	0.0676								
		12	4.50	DN	2	51	20	11.6			2.68								15.38	0	8	62	30		
II	Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.	12	6.00	DN	3	55	20	13.8			2.68								12.64	0	9	67	24		
		12	8.00	UD		57	21	14.1	1.82	41.64	2.67	1.28	0.41	UU	0.22	0	0.00-0.10	0.0284	0	16.69	2	10	54	34	
																	0.10-0.20	0.0363							
														CU	0.07	11	0.20-0.40	0.0489							
													CD	0	16	0.40-0.80	0.0417								
		12	9.00	DN	3	63	19	13.2			2.69								11.48	1	8	50	41		
III	Stiff to very stiff mottles bluish/ brownish grey silty clay/ clayey silt with traces of fine sand.	12	11.00	UD		48	20	12.4	1.86	30.33	2.66	1.43	0.99	UU	0.51	0	0.00-0.10	0.0177	0	13.38	0	13	61	26	
																	0.10-0.20	0.0251							
														CU	0.16	22	0.20-0.40	0.0381							
																	0.40-0.80	0.0298							
															CD	0	26	0.80-1.60	0.0242						
				12	12.50	DN	8	50	19	11.8			2.70								18.83	0	10	69	21
		12	14.50	DN	18	51	18	10.6			2.66								14.29	0	11	62	27		
		12	18.50	DN	12	46	21	13.5			2.68								15.64	0	10	70	20		
		12	23.50	DN	24	43	20	12.8			2.67								13.22	0	13	66	21		
IV	Dense to very dense brownish grey silty sand.	12	26.50	DN	56	NP			1.80		2.65			DS	0.00	36			0	0	97	3	0		
		12	32.00	DN	43	NP			1.78		2.65			DS	0.01	34			0	0	99	1	0		

SAMPLE CALCULATION FOR PILE FOUNDATION



Pile Model

Scale :- N.T.S.

Sketch No.-SK/PDIL/ CANTEEN 1638 03

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Canteen, Dankuni Coal Complex, West Bengal

Layer No: 1

Soil Description Soft dark grey silty clay/ clayey silt with traces of vegetative organic matter.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	2.000	6.000	1	2.4	5.027	12.064
2	0.500	28.000	2.000	6.000	1	2.4	6.283	15.080
3	0.550	28.000	2.000	6.000	1	2.4	6.912	16.588
4	0.600	28.000	2.000	6.000	1	2.4	7.540	18.096
5	0.750	28.000	2.000	6.000	1	2.4	9.425	22.619
6	1.000	28.000	2.000	6.000	1	2.4	12.566	30.159

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Canteen, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911(Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	6.000	10.500	1	2.2	5.655	12.441
2	0.500	28.000	6.000	10.500	1	2.2	7.069	15.551
3	0.550	28.000	6.000	10.500	1	2.2	7.775	17.106
4	0.600	28.000	6.000	10.500	1	2.2	8.482	18.661
5	0.750	28.000	6.000	10.500	1	2.2	10.603	23.326
6	1.000	28.000	6.000	10.500	1	2.2	14.137	31.102

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Canteen, Dankuni Coal Complex, West Bengal

Layer No: 2

Soil Description: Stiff to very stiff mottles bluish/ brownish grey silty clay/ clayey silt with traces of fine sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top from EGL	Depth of layer bottom from EGL	Reduction factor, α (Note 1 IS 2911 (Part1/Sec2)	Average Cohesion along the length of the pile in this layer, C	Surface area of the pile shaft in this layer, A_s	Ultimate Skin friction capacity of the shaft in this layer, $Q_{su} = \alpha * C * A_s$
	Mtr	Mtr.	Mtr	Mtr.		T/M ²	M ²	
1	0.400	28.000	10.500	26.500	0.9	5.1	20.106	92.287
2	0.500	28.000	10.500	26.500	0.9	5.1	25.133	115.359
3	0.550	28.000	10.500	26.500	0.9	5.1	27.646	126.895
4	0.600	28.000	10.500	26.500	0.9	5.1	30.159	138.431
5	0.750	28.000	10.500	26.500	0.9	5.1	37.699	173.039
6	1.000	28.000	10.500	26.500	0.9	5.1	50.265	230.719

Ultimate skin friction capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Canteen, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description : Dense to very dense brownish grey silty sand.

Sl.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $= (\phi - 3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	k- Value, as per note 3 IS 2911 part 1/ Sec2-1979	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Di} at layer top	$\delta = \phi$	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer top, maximum = $10T/M^2$	P_{Di} at layer bottom	Unit friction, $f_s = K \cdot P_{Di} \cdot \tan \delta$ - at layer bottom, maximum = $10T/M^2$	Average unit friction, adopted for shaft friction capacity.	A_{Si}	Shaft friction, F
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			T/M ²	Radian	T/M ²	T/M ²	T/M ²	T/M ²	M ²	T
1	0.400	28.000	26.500	28.000	1.000	34	31	32.67	20.63	25.99	1.78	0.78	1.3	15	4.68	0.54	3.656	4.68	3.656	3.656	1.885	6.891
2	0.500	28.000	26.500	28.000	1.000	34	31	32.67	20.63	25.99	1.78	0.78	1.3	15	5.85	0.54	4.570	5.85	4.570	4.570	2.356	10.767
3	0.550	28.000	26.500	28.000	1.000	34	31	32.67	20.63	25.99	1.78	0.78	1.3	15	6.435	0.54	5.026	6.435	5.026	5.026	2.592	13.028
4	0.600	28.000	26.500	28.000	1.000	34	31	32.67	20.63	25.99	1.78	0.78	1.3	15	7.02	0.54	5.483	7.02	5.483	5.483	2.827	15.504
5	0.750	28.000	26.500	28.000	1.000	34	31	32.67	20.63	25.99	1.78	0.78	1.3	15	8.775	0.54	6.854	8.775	6.854	6.854	3.534	24.225
6	1.000	28.000	26.500	28.000	1.000	34	31	32.67	20.63	25.99	1.78	0.78	1.3	15	11.7	0.54	9.139	11.7	9.139	9.139	4.712	43.067

Ultimate end bearing capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Canteen, Dankuni Coal Complex, West Bengal

Layer No: 4

Soil Description : Dense to very dense brownish grey silty sand.

SI.No	Pile Dia , D	Total Length of Pile, L	Depth of layer top, from EGL	Depth of layer bottom, from EGL	Water table	ϕ	ϕ adopted $=(\phi -3)^\circ$ considering loosening effect	N_c	N_q	N_γ	Unit weight, γ	Effective unit weight, γ'	Limiting L/D for calcn. Of maxm. Effective overburden press. At pile tip	P_{Dl} at pile tip	A_p	End Bearing
	Mtr	Mtr.	Mtr	Mtr.	Mtr.	Degree	Degree				T/M ³	T/M ³			M ²	T
1	0.400	28.000	26.500	28.000	0.000	34	31	32.67	20.63	25.99	1.78	0.78	15	4.68	0.126	12.643
2	0.500	28.000	26.500	28.000	0.000	34	31	32.67	20.63	25.99	1.78	0.78	15	5.85	0.196	24.693
3	0.550	28.000	26.500	28.000	0.000	34	31	32.67	20.63	25.99	1.78	0.78	15	6.435	0.238	32.866
4	0.600	28.000	26.500	28.000	0.000	34	31	32.67	20.63	25.99	1.78	0.78	15	7.02	0.283	42.669
5	0.750	28.000	26.500	28.000	0.000	34	31	32.67	20.63	25.99	1.78	0.78	15	8.775	0.442	83.338
6	1.000	28.000	26.500	28.000	0.000	34	31	32.67	20.63	25.99	1.78	0.78	15	11.7	0.785	197.542

Horizontal Shear Capacity of Pile

Reference : Code of Practice for Design and Construction of Pile Foundation - IS 2911 (Part1/Sec2)

Sample Calculation:-

C Value	=	0.24 Kg/cm ²	
	=	23.544 Kn/M ²	
L (Length of Pile)	=	28.00 Mtr.	
Cut-off Level of Pile	=	2.00 Mtr.	
Dia of Pile (D)	=	0.400 Mtr.	
fck	=	25 N/MM ²	
E=E _{conc} =Young's modulus	=	25000 MN/M ²	
I (Moment of inertia of the pile cross-section)	=	0.00126 M ⁴	
Neglecting the effect of steel we get EI	=	31.5 KN/M ⁶	
n_h = Modulus of Subgrade Reaction (if top of the soil is clay) (Table3)	=	1.350 MN/M ³	
T (Stiffness Factor)	=	1.878 Mtr.	[Where T = (EI/nh) ^{1/5}]
Le (Embedment Length of the Pile)	=	26.00 Mtr.	
Hence, As per Table-5 pile is a LONG ELASTIC PILE			Since Le >= 4T
Where L1 = free head of Pile above ground	=	0.000 Mtr.	
And for fixed head file Lf/T (as per IS Code)	=	2.200	
Where Lf is the length of fixicity below cut-off level of pile =	=	4.132 Mtr.	
Therefore,	Lf	=	4.132 Mtr.
	L1	=	0.000 Mtr.
<u>For Fixed Head Pile, deflection at the pile head,</u>			
Y = H(e+zf)³ / 12EI	=	0.005 Mtr.	(Adopt)
Lateral Load = H	=	26.80 Kn	
Horizontal Shear Capacity = H_{design}	=	2.73 T	

Recommended Pile Capacity

Project: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location: Canteen, Dankuni Coal Complex, West Bengal

Sl.No	Pile Dia , D	Total Length of Pile, L	Skin friction from layer 1	Skin friction from layer 2	Skin friction from layer 3	Skin friction from layer 4	End Bearing	Total	F.O.S	Allowable Pile Capacity	Recommended Pile Capacity in Compression	Recommended Pile Capacity in Pull-Out	Recommended Pile Capacity in Horizontal Shear
	Mtr	Mtr.	T	T	T	T	T	T	T	T	T	T	T
1	0.400	28.000	12.064	12.441	92.287	6.891	12.643	136.325	2.5	54.530	54	49	2.73
2	0.500	28.000	15.080	15.551	115.359	10.767	24.693	181.449	2.5	72.580	72	62	2.99
3	0.550	28.000	16.588	17.106	126.895	13.028	32.866	206.483	2.5	82.593	82	69	3.10
4	0.600	28.000	18.096	18.661	138.431	15.504	42.669	233.361	2.5	93.344	93	76	3.21
5	0.750	28.000	22.619	23.326	173.039	24.225	83.338	326.548	2.5	130.619	130	97	3.51
6	1.000	28.000	30.159	31.102	230.719	43.067	197.542	532.588	2.5	213.035	213	134	3.94

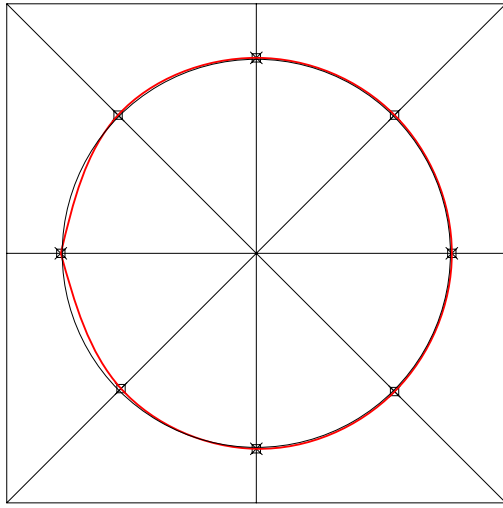
ELECTRICAL RESISTIVITY TEST

Table ERT - 10

Project : Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)
 Location of site: Dankuni Coal Complex, Dankuni, WB
 Client : Project & Development India Limited
 Test Date : 12-12-2019
 Instrument : Metravi ERT-1501, SL. No.: 10109809

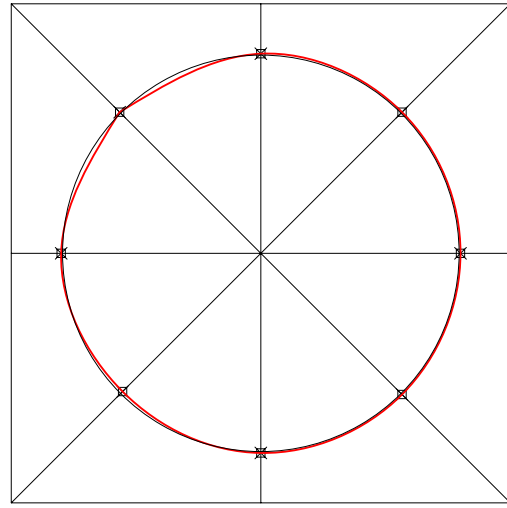
Sl. No.	Electrode Spacing 's' m	Measured Resistance "R" (Ω)								Apparent Resistivity " ρ " (Ω -m")								
		North	North-East	East	East-South	South	South-West	West	North-West	North	North-East	East	East-South	South	South-West	West	North-West	
1	1.0	47	47	47	47	47	46	47	47	295.31	295.31	295.31	295.31	295.31	289.03	295.31	295.31	
2	2.0	48	48	48	48	48	47	48	48	603.19	603.19	603.19	603.19	603.19	590.62	603.19	603.19	
3	5.0	49	49	49	49	49	48	49	49	1,539.38	1,539.38	1,539.38	1,539.38	1,539.38	1,507.96	1,539.38	1,539.38	
4	10.0	51	50	50	50	51	49	51	50	3,204.42	3,141.59	3,141.59	3,141.59	3,204.42	3,078.76	3,204.42	3,141.59	
5	15.0	51	51	51	51	51	51	51	51	4,806.64	4,806.64	4,806.64	4,806.64	4,806.64	4,806.64	4,806.64	4,806.64	
6	20.0	Space Not Available																

Location - ERT-10



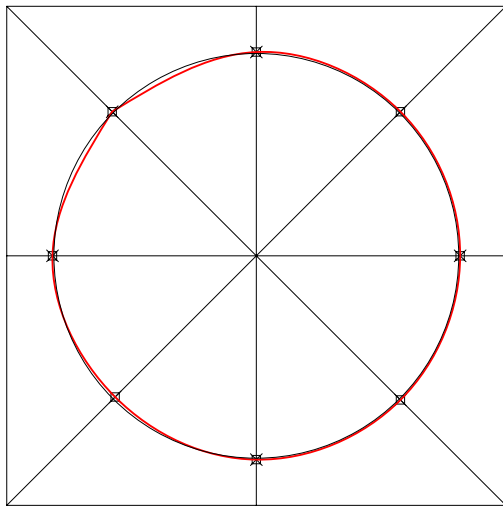
Electrode Spacing - 1.00M
R = 46.66 ohm, Resistivity = 293.02 Ohm-m

Location - ERT-10



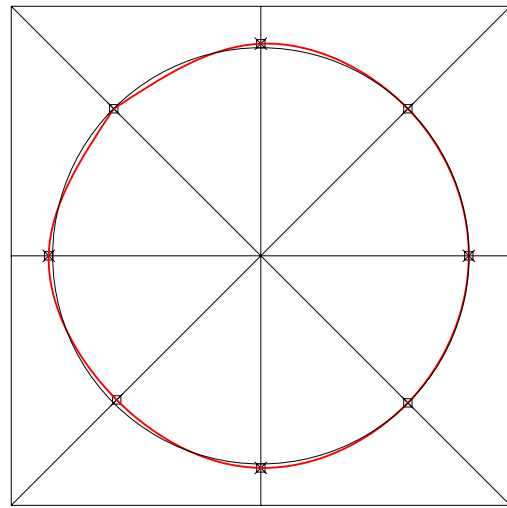
Electrode Spacing - 2.00M
R = 47.67 ohm, Resistivity = 598.74 Ohm-m

Location - ERT-10



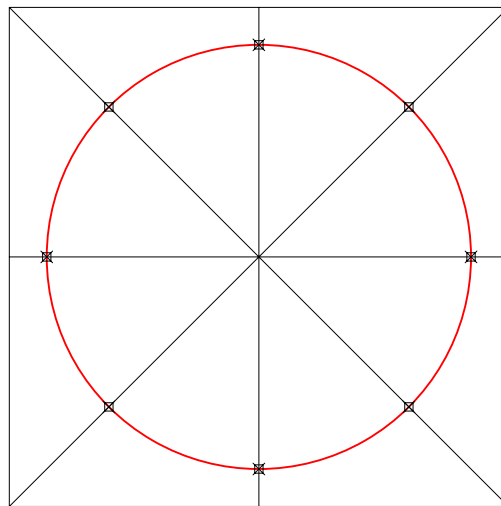
Electrode Spacing - 5.00M
R = 48.66 ohm, Resistivity = 1527.92 Ohm-m

Location - ERT-10



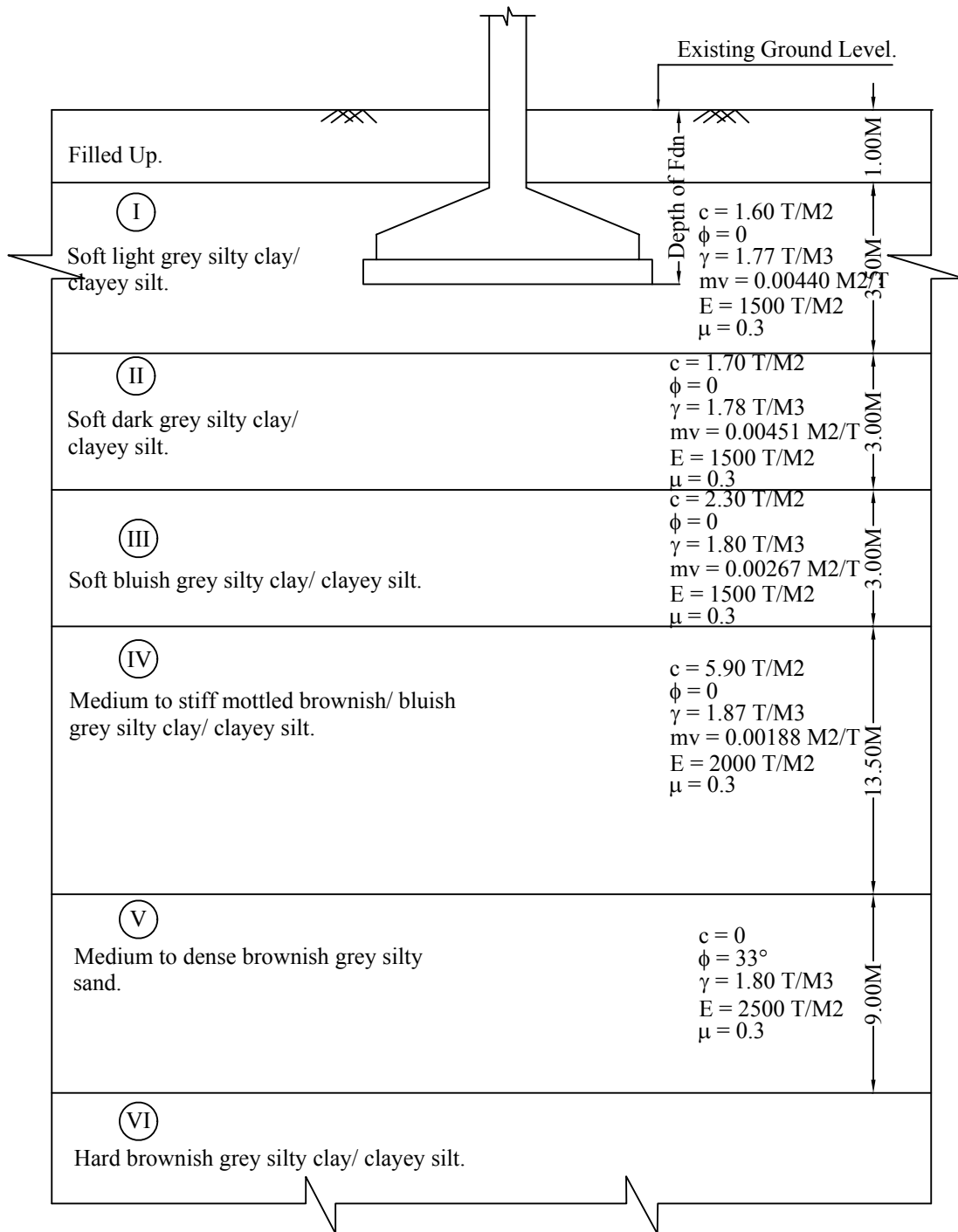
Electrode Spacing - 10.00M
R = 50.04 ohm, Resistivity = 3142.51 Ohm-m

Location - ERT-10



Electrode Spacing - 15.00M
R = 51.00 ohm, Resistivity = 4806.64 Ohm-m

SAMPLE CALCULATION FOR SHALLOW FOUNDATION ON NATURAL SOIL



Foundation Model on Natural Soil

Scale :- N.T.S.

Sketch No.-SK/PDIL	DANKUNI	1638	04	1 of 2
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SUMMARY OF FIELD/LABORATORY DATA AND CONSIDERED DESIGN PARAMETERS

Sub-soil Stratification & Properties considered in foundation model

	Description of layer	Layer Thickness	Field N Observed		Corrected N Value
			Depth	Value	
		Meter	Meter		
Strata1	Filledup	1.00			
Strata 2	Soft light grey silty clay/ clayey silt with traces of kankar.	3.50	1.5	2	3
Strata 3	Soft dark grey silty clay/ clayey silt with peat.	3.00	4.5	2	2
Strata4	Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.	3.00	7.5	2	2
Strata5	Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.	13.50	10.5	3	2
Strata6	Medium to dense brownish grey silty sand with traces of clay binders.	9.00	23.5	29	16
Strata7	Hard brownish grey silty clay/ clayey silt.	2.00	32.5	49	22
Strata8	Not explored				

Depth of water Table from EGL = 0.850 Meter

LABORATORY RESULTS

	Description of layer	Cohesion in T/sqm	Friction angle in degree	Bulk Density in T/cum	Co-eff. of volume compressibility in sqm/T
		c	ϕ	γ	m_v
Strata1	Filledup				
Strata 2	Soft light grey silty clay/ clayey silt with traces of kankar.	1.6	0	1.77	0.0044
Strata 3	Soft dark grey silty clay/ clayey silt with peat.	1.7	0	1.78	0.00451
Strata4	Soft bluish grey silty clay/ clayey silt with traces of calcareous nodules.	2.3	0	1.8	0.00267
Strata5	Medium to stiff mottled brownish/ bluish grey silty clay/ clayey silt with traces of concretion.	5.9	0	1.87	0.00188
Strata6	Medium to dense brownish grey silty sand with traces of	0	33	1.8	
Strata7	Hard brownish grey silty clay/ clayey silt.				
Strata8	NA				

DESIGN PARAMETERS

C	ϕ	Depth of Water Table from EGL*	γ	m_v	E	μ
T/sqm	Degrees	meter	T/Cum	Sqm/T	T/sqm	
1.6	0	0	1.77	0.00440	1500	0.3

* For design purpose, Ground Water Table has been considered as at EGL due to seasonal variation in GWT

CHECK FOR TYPE OF SHEAR FAILURE

Design value of ϕ , in degrees = 0

Friction Angle ≤ 28 degrees, Local Shear Failure

As per IS 6403-1981, cl. No. 5.1.2, the Ultimate Net Safe Bearing Capacity (Net q_{ult})

1 For General Shear Failure, $q_{ult} = cN_cscdcic + q(Nq-1)sqdqiq + 0.5\gamma BN^1\gamma_s\gamma_d\gamma_i\gamma'W'$

2 For Local Shear Failure, $q_{ult} = c'N'cscdcic + q(N'q-1)sqdqiq + 0.5\gamma BN^1\gamma_s\gamma_d\gamma_i\gamma'W'$

3 For Intermediate Shear Failure, q_{ult} = Value in between the General & Local Shear Failure

CALCULATION OF NET SAFE BEARING CAPACITY FROM SHEAR CRITERIA

	FOOTING DIMENSIONS			Load inclination w.r.t. Vertical (α)	SOIL PARAMETERS					BEARING CAPACITY FACTORS			SHAPE FACTORS			DEPTH FACTORS			INCLINATION FACTORS			Water Table Correction Factor	Factor of safety	NET SAFE BEARING CAPACITY	
	L	B	Df		C	C'	ϕ	ϕ'	γ																Nc
	Meter	Meter	Meter	Degree	T/sqm	T/sqm	Deg.	Deg.	T/cum																
ISOLATED SQUARE FOOTINGS	2.00	2.00	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.15	1.00	1.00	1	1	1	0.5	2.5	4.9	
	2.50	2.50	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.12	1.00	1.00	1	1	1	0.5	2.5	4.7	
	3.00	3.00	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.10	1.00	1.00	1	1	1	0.5	2.5	4.7	
	2.00	2.00	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.18	1.00	1.00	1	1	1	0.5	2.5	5.0	
	2.50	2.50	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.14	1.00	1.00	1	1	1	0.5	2.5	4.8	
	3.00	3.00	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.12	1.00	1.00	1	1	1	0.5	2.5	4.7	
	2.00	2.00	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.20	1.00	1.00	1	1	1	0.5	2.5	5.1	
	2.50	2.50	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.16	1.00	1.00	1	1	1	0.5	2.5	4.9	
	3.00	3.00	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.30	1.20	0.80	1.13	1.00	1.00	1	1	1	0.5	2.5	4.8	
ISOLATED RECTANGULAR FOOTINGS	3.00	2.00	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.15	1.00	1.00	1	1	1	0.5	2.5	4.2	
	3.75	2.50	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.12	1.00	1.00	1	1	1	0.5	2.5	4.1	
	4.50	3.00	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.10	1.00	1.00	1	1	1	0.5	2.5	4.1	
	3.00	2.00	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.18	1.00	1.00	1	1	1	0.5	2.5	4.3	
	3.75	2.50	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.14	1.00	1.00	1	1	1	0.5	2.5	4.2	
	4.50	3.00	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.12	1.00	1.00	1	1	1	0.5	2.5	4.1	
	3.00	2.00	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.20	1.00	1.00	1	1	1	0.5	2.5	4.4	
	3.75	2.50	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.16	1.00	1.00	1	1	1	0.5	2.5	4.3	
	4.50	3.00	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.13	1.13	0.73	1.13	1.00	1.00	1	1	1	0.5	2.5	4.2	
CONTINUOUS STRIP FOOTINGS	1.50	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.20	1.00	1.00	1	1	1	0.5	2.5	3.9		
	2.00	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.15	1.00	1.00	1	1	1	0.5	2.5	3.7		
	2.50	1.50	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.12	1.00	1.00	1	1	1	0.5	2.5	3.6		
	1.50	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.23	1.00	1.00	1	1	1	0.5	2.5	4.0		
	2.00	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.18	1.00	1.00	1	1	1	0.5	2.5	3.8		
	2.50	1.75	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.14	1.00	1.00	1	1	1	0.5	2.5	3.7		
	1.50	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.27	1.00	1.00	1	1	1	0.5	2.5	4.1		
	2.00	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.20	1.00	1.00	1	1	1	0.5	2.5	3.9		
	2.50	2.00	0	1.6	1.60	0	0.00	1.77	5.14	1.00	0.00	1.00	1.00	1.00	1.16	1.00	1.00	1	1	1	0.5	2.5	3.8		

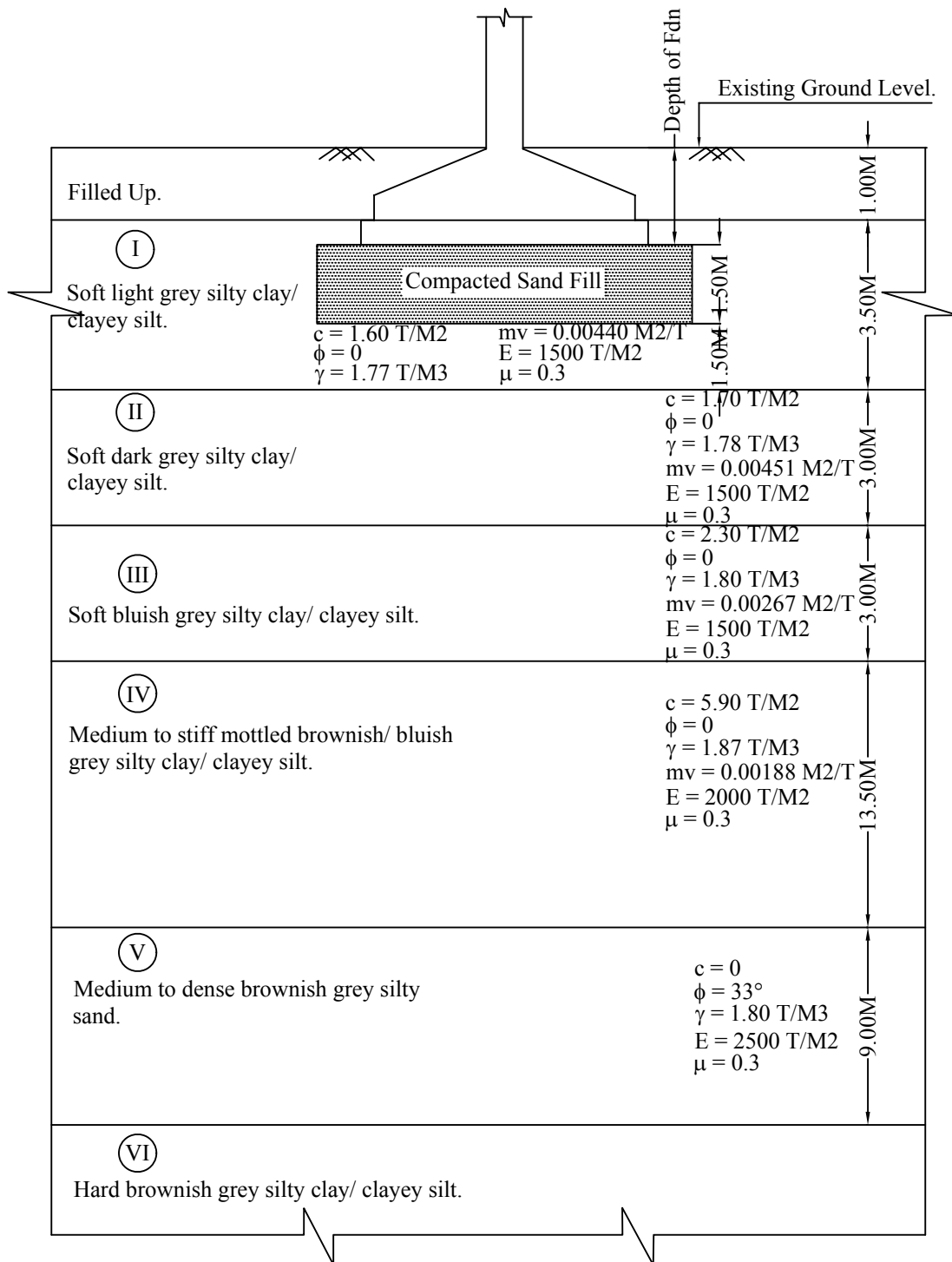
CALCULATION OF FOUNDATION SETTLEMENT

	FOOTING DIMENSIONS			Foundation pressure, p	Poisson's Ratio μ	Young's Modulus, E	Coefficient of consolidation, m_v	pressure increment, Δp	Layer thickness H	Influence Factor I	Elastic settlement $S_i = pB\{(1-\mu^2)/E\}$	Consolidation Settlement $S_c = m_v \Delta p H$	total settlement, $S_t = S_i + S_c$	Depth Factor Dfact	Rigidity factor Rfact	total corrected settlement, $S_{t(\text{correct})} = S_t * D\text{Fact} * R\text{fact}$
	L	B	Df													
	Meter	Meter	Meter	T/m ²		T/M ²	m ² /T	T/m ²	Meter		mm	mm	mm			mm
ISOLATED SQUARE FOOTINGS	2.00	2.00	1.50	4.9	0.3	1500	0.004	1.23	4.00	0.95	5.65	21.56	27.21	0.794	0.8	17.28
	2.50	2.50	1.50	4.7	0.3	1500	0.004	1.18	5.00	0.95	6.77	25.85	32.62	0.835	0.8	21.79
	3.00	3.00	1.50	4.7	0.3	1500	0.004	1.18	6.00	0.95	8.13	31.02	39.15	0.863	0.8	27.01
	2.00	2.00	1.75	5.0	0.3	1500	0.004	1.25	4.00	0.95	5.76	22.00	27.76	0.759	0.8	16.87
	2.50	2.50	1.75	4.8	0.3	1500	0.004	1.20	5.00	0.95	6.92	26.40	33.32	0.808	0.8	21.52
	3.00	3.00	1.75	4.7	0.3	1500	0.004	1.18	6.00	0.95	8.13	31.02	39.15	0.84	0.8	26.29
	2.00	2.00	2.00	5.1	0.3	1500	0.004	1.28	4.00	0.95	5.88	22.44	28.32	0.725	0.8	16.42
	2.50	2.50	2.00	4.9	0.3	1500	0.004	1.23	5.00	0.95	7.06	26.95	34.01	0.78	0.8	21.22
ISOLATED RECTANGULAR FOOTINGS	3.00	2.00	1.50	4.2	0.3	1500	0.004	1.26	4.00	1.2	6.12	22.18	28.29	0.832	0.8	18.82
	3.75	2.50	1.50	4.1	0.3	1500	0.004	1.23	5.00	1.2	7.46	27.06	34.52	0.865	0.8	23.90
	4.50	3.00	1.50	4.1	0.3	1500	0.004	1.23	6.00	1.2	8.95	32.47	41.43	0.888	0.8	29.42
	3.00	2.00	1.75	4.3	0.3	1500	0.004	1.29	4.00	1.2	6.26	22.70	28.96	0.804	0.8	18.62
	3.75	2.50	1.75	4.2	0.3	1500	0.004	1.26	5.00	1.2	7.64	27.72	35.36	0.843	0.8	23.84
	4.50	3.00	1.75	4.1	0.3	1500	0.004	1.23	6.00	1.2	8.95	32.47	41.43	0.869	0.8	28.80
	3.00	2.00	2.00	4.4	0.3	1500	0.004	1.32	4.00	1.2	6.41	23.23	29.64	0.775	0.8	18.39
	3.75	2.50	2.00	4.3	0.3	1500	0.004	1.29	5.00	1.2	7.83	28.38	36.21	0.82	0.8	23.76
CONTINUOUS STRIP FOOTINGS	4.50	3.00	2.00	4.2	0.3	1500	0.004	1.26	6.00	1.2	9.17	33.26	42.44	0.85	0.8	28.87
	1.50	1.50	3.9	3.9	0.3	1500	0.004	1.83	3.00	2.289	8.13	24.13	32.26	0.929	0.8	23.97
	2.00	1.50	3.7	3.7	0.3	1500	0.004	1.73	4.00	2.289	10.28	30.53	40.80	0.947	0.8	30.90
	2.50	1.50	3.6	3.6	0.3	1500	0.004	1.69	5.00	2.289	12.50	37.13	49.63	0.957	0.8	38.01
	1.50	1.75	4.0	4.0	0.3	1500	0.004	1.88	3.00	2.289	8.33	24.75	33.08	0.917	0.8	24.27
	2.00	1.75	3.8	3.8	0.3	1500	0.004	1.78	4.00	2.289	10.56	31.35	41.91	0.938	0.8	31.44
	2.50	1.75	3.7	3.7	0.3	1500	0.004	1.73	5.00	2.289	12.85	38.16	51.00	0.95	0.8	38.78
	1.50	2.00	4.1	4.1	0.3	1500	0.004	1.92	3.00	2.289	8.54	25.37	33.91	0.905	0.8	24.56
	2.00	2.00	3.9	3.9	0.3	1500	0.004	1.83	4.00	2.289	10.83	32.18	43.01	0.929	0.8	31.96
2.50	2.00	3.8	3.8	0.3	1500	0.004	1.78	5.00	2.289	13.19	39.19	52.38	0.943	0.8	39.53	

ALLOWABLE BEARING CAPACITY FROM SHEAR AND SETTLEMENT CRITERIA

FOUNDATION TYPE	FOOTING DIMENSIONS			NET SAFE BEARING CAPACITY	total corrected settlement, $S_{correct}$	ALLOWABLE BEARING CAPACITY		
	L	B	Df			For allowable settlement 25 mm	For allowable settlement 40 mm	For allowable settlement 75 mm
	Meter	Meter	Meter	Qnet safe in T/sqm	mm	T/Sqm	T/Sqm	T/Sqm
ISOLATED SQUARE FOOTINGS	2.00	2.00	1.50	4.9	17.28	4	4	4
	2.50	2.50	1.50	4.7	21.79	4	4	4
	3.00	3.00	1.50	4.7	27.01	4	4	4
	2.00	2.00	1.75	5.0	16.87	5	5	5
	2.50	2.50	1.75	4.8	21.52	4	4	4
	3.00	3.00	1.75	4.7	26.29	4	4	4
	2.00	2.00	2.00	5.1	16.42	5	5	5
	2.50	2.50	2.00	4.9	21.22	4	4	4
	3.00	3.00	2.00	4.8	26.12	4	4	4
ISOLATED RECTANGULAR FOOTINGS	3.00	2.00	1.50	4.2	18.82	4	4	4
	3.75	2.50	1.50	4.1	23.90	4	4	4
	4.50	3.00	1.50	4.1	29.42	3	4	4
	3.00	2.00	1.75	4.3	18.62	4	4	4
	3.75	2.50	1.75	4.2	23.84	4	4	4
	4.50	3.00	1.75	4.1	28.80	3	4	4
	3.00	2.00	2.00	4.4	18.39	4	4	4
	3.75	2.50	2.00	4.3	23.76	4	4	4
CONTINUOUS STRIP FOOTINGS		1.50	1.50	3.9	23.97	3	3	3
		2.00	1.50	3.7	30.90	2	3	3
		2.50	1.50	3.6	38.01	2	3	3
		1.50	1.75	4.0	24.27	4	4	4
		2.00	1.75	3.8	31.44	3	3	3
		2.50	1.75	3.7	38.78	2	3	3
		1.50	2.00	4.1	24.56	4	4	4
		2.00	2.00	3.9	31.96	3	3	3
		2.50	2.00	3.8	39.53	2	3	3

**SAMPLE CALCULATION
FOR SHALLOW
FOUNDATION ON
IMPROVED SOIL BY
SAND REPLACEMENT**



Foundation Model on Improved Soil

Scale :- N.T.S.

Sketch No.-SK/PDIL	DANKUNI	1638	04	2 of 2
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COMPUTATION OF BEARING CAPACITY WITH SAND BACK FILL

Square Footing

Size (m x m)	2.00 x 2.00	2.50 x 2.50	3.00 x 3.00
B (m)	2.00	2.50	3.00
D _f (m)	1.50	1.50	1.50
C (T/M ²)	0.00	0.00	0.00
φ (degree)	33	33	33
φ' (degree)	29.82	29.82	29.82
γ (T/M ³)	1.80	1.80	1.80
q (T/M ²)	1.20	1.20	1.20
α (Degree)	0.00	0.00	0.00
<u>Bearing Capacity Factor</u>			
N _c	29.71	29.71	29.71
N _q	18.03	18.03	18.03
N _γ	21.81	21.81	21.81
<u>Shape Factor</u>			
S _c	1.30	1.30	1.30
S _q	1.20	1.20	1.20
S _γ	0.80	0.80	0.80
<u>Depth Factor</u>			
d _c	1.26	1.21	1.17
d _q	1.13	1.10	1.09
d _γ	1.13	1.10	1.09
<u>Inclination</u>			
i _c	1.00	1.00	1.00
i _q	1.00	1.00	1.00
i _γ	1.00	1.00	1.00
W'	0.50	0.50	0.50
<hr/>			
0.67cN _c S _c d _c i _c	0.00	0.00	0.00
q(N _q -1)S _q d _q i _q	27.69	27.06	26.64
0.5B _γ N _γ s _γ d _γ i _γ W'	17.74	21.66	25.59
<hr/>			
N.U.B.C	45.43	48.72	52.23
F.O.S	2.50	2.50	2.50
<hr/>			
N.S.B.C	18.17	19.49	20.89
<hr/>			

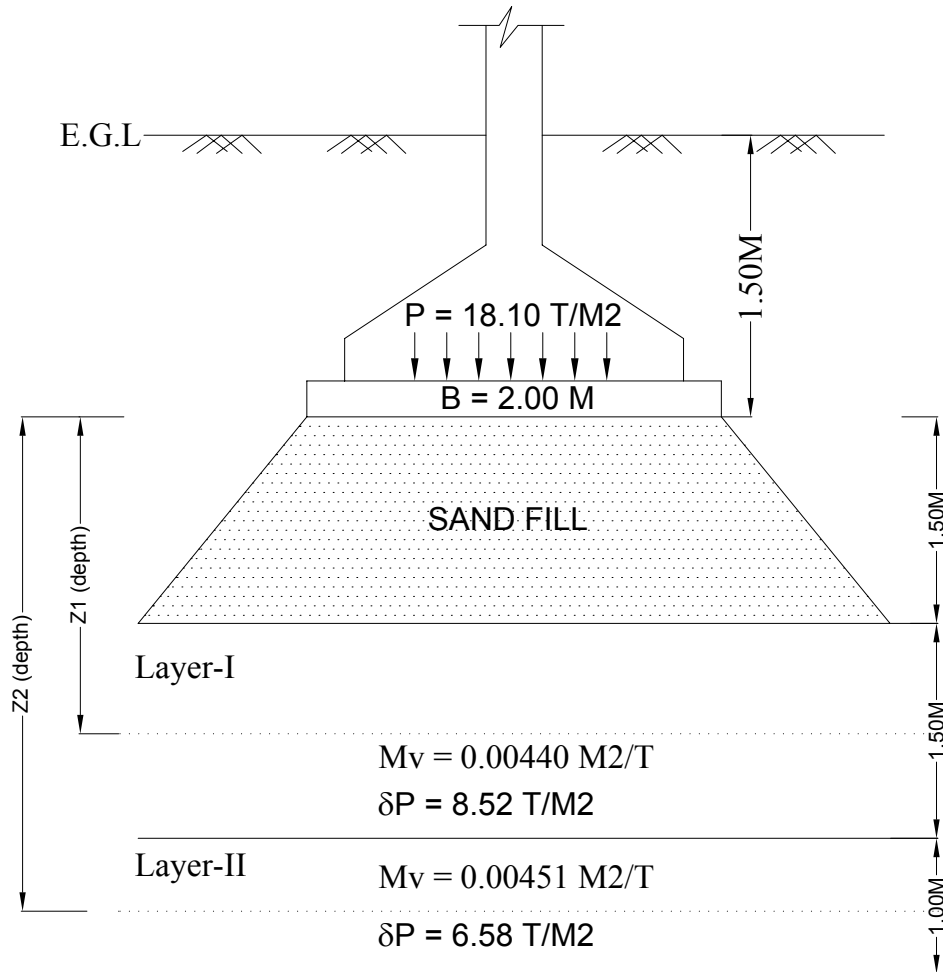
Rectangular Footing

Size (m x m)	2.00 x 3.00	2.50 x 3.75	3.00 x 4.50
L (m)	3.00	3.75	4.50
B (m)	2.00	2.50	3.00
D _f (m)	1.50	1.50	1.50
C (T/M ²)	0.00	0.00	0.00
φ (degree)	33	33	33
φ' (degree)	29.82	29.82	29.82
γ (T/M ³)	1.80	1.80	1.80
q (T/M ²)	1.20	1.20	1.20
α (Degree)	0.00	0.00	0.00
<u>Bearing Capacity Factor</u>			
N _c	29.71	29.71	29.71
N _q	18.03	18.03	18.03
N _γ	21.81	21.81	21.81
<u>Shape Factor</u>			
S _c	1.13	1.13	1.13
S _q	1.13	1.13	1.13
S _γ	0.73	0.73	0.73
<u>Depth Factor</u>			
d _c	1.26	1.21	1.17
d _q	1.13	1.10	1.09
d _γ	1.13	1.10	1.09
<u>Inclination</u>			
i _c	1.00	1.00	1.00
i _q	1.00	1.00	1.00
i _γ	1.00	1.00	1.00
W'	0.50	0.50	0.50
0.67cN _c S _c d _c i _c	0.00	0.00	0.00
q(N _q -1)S _q d _q i _q	26.16	25.56	25.16
0.5B _γ N _γ s _γ d _γ i _γ W'	16.26	19.86	23.46
N.U.B.C	42.42	45.41	48.61
F.O.S	2.50	2.50	2.50
N.S.B.C	16.97	18.17	19.45

Strip Footing

Size (m x m)	1.50	2.00	2.50
B (m)	1.50	2.00	2.50
D _f (m)	1.50	1.50	1.50
C (T/M ²)	0.00	0.00	0.00
φ (degree)	33	33	33
φ' (degree)	29.82	29.82	29.82
γ (T/M ³)	1.80	1.80	1.80
q (T/M ²)	1.20	1.20	1.20
α (Degree)	0.00	0.00	0.00
<u>Bearing Capacity Factor</u>			
N _c	29.71	29.71	29.71
N _q	18.03	18.03	18.03
N _γ	21.81	21.81	21.81
<u>Shape Factor</u>			
S _c	1.00	1.00	1.00
S _q	1.00	1.00	1.00
S _γ	1.00	1.00	1.00
<u>Depth Factor</u>			
d _c	1.35	1.26	1.21
d _q	1.17	1.13	1.10
d _γ	1.17	1.13	1.10
<u>Inclination</u>			
i _c	1.00	1.00	1.00
i _q	1.00	1.00	1.00
i _γ	1.00	1.00	1.00
W'	0.50	0.50	0.50
0.67cN _c S _c d _c i _c	0.00	0.00	0.00
q(N _q -1)S _q d _q i _q	23.96	23.08	22.55
0.5B _γ N _γ s _γ d _γ i _γ W'	17.26	22.17	27.08
N.U.B.C	41.22	45.25	49.63
F.O.S	2.50	2.50	2.50
N.S.B.C	16.49	18.10	19.85

Settlement Calculation for Strip Footing



Layer-I

$$\begin{aligned} \delta P \text{ at the centre of the compressible layer} &= P \times B / (B + Z_1) \\ &= 18.10 \times 2 / (2 + 2.25) \text{ T/M}^2 \\ &= 8.52 \text{ T/M}^2 \end{aligned}$$

Layer-II

$$\begin{aligned} \delta P \text{ at the centre of the compressible layer} &= P \times B / (B + Z_2) \\ &= 18.10 \times 2 / (2 + 3.50) \text{ T/M}^2 \\ &= 6.58 \text{ T/M}^2 \end{aligned}$$

Layer-I

$$\begin{aligned} \text{So, } S &= M_v \times \delta P \times H \\ &= 0.00440 \times 8.52 \times 1.50 \times 1000 \\ &= 56.23 \text{ mm} \end{aligned}$$

Layer-II

$$\begin{aligned} \text{So, } S &= M_v \times \delta P \times H \\ &= 0.00451 \times 6.58 \times 1.00 \times 1000 \\ &= 29.68 \text{ mm} \end{aligned}$$

$$\text{Corrected Settlement} = (56.23 + 29.68) \times 0.80 = 68.73 \text{ mm} < 75 \text{ mm}$$

$$\text{Bearing Capacity of 2.00M wide strip} = 18.10 \text{ T/M}^2$$

$$\text{Similar Settlement of 2.50M wide strip} = 99.21 \text{ mm} > 75 \text{ mm}$$

$$\text{Hence, Bearing Capacity of 2.50M wide strip for 75mm settlement} = 15.00 \text{ T/M}^2$$

Bearing Capacity of Soil after Ground Improvement with Compacted Sand Fill

TYPE OF FOOTINGS	SIZE OF FOUNDATION (m)			THICKNESS OF COMPACTED SAND FILL BELOW FOUNDATION (m)	SAFE BEARING CAPACITY OF COMPACTED SAND FILL AT FOUNDATION DEPTH (m)	ESTIMATED SETTLEMENT (mm)	PRESSURE ON VERGINE SOIL AT A LEVEL BELOW COMPACTED SAND FILL (t/m ²)	ALLOWABLE BEARING CAPACITY OF VERGINE SOIL (t/m ²)	ADOPTED PRESSURE AT TOP OF VERGINE SOIL (t/m ²) (LOWER OF THE VALUES OF vii & viii)	DESIGN SBC OF FOUNDATION ON TOP OF SAND FILL (t/m ²)
	B	L	Df							
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)
ISOLATED SQUARE FOOTINGS	2.00	2.00	1.50	1.50	18.17	31.71	5.93	4.00	4.00	12.25
	2.50	2.50	1.50	1.50	19.49	52.42	7.61	4.00	4.00	10.24
	3.00	3.00	1.50	1.50	20.89	77.24	9.28	4.00	4.00	9.00
ISOLATED RECTANGULAR FOOTINGS	2.00	3.00	1.50	1.50	16.97	38.45	6.46	4.00	4.00	10.50
	2.50	3.75	1.50	1.50	18.17	65.76	8.11	4.00	4.00	8.96
	3.00	4.50	1.50	1.50	19.45	90.24	9.72	4.00	4.00	8.00
CONTINUOUS STRIP FOOTINGS	1.50		1.50	1.50	16.49	43.56	8.24	3.00	3.00	6.00
	2.00		1.50	1.50	18.10	68.73	10.34	3.00	3.00	5.25
	2.50		1.50	1.50	19.85	99.21	12.41	3.00	3.00	4.80

CHEMICAL TEST ON SOIL AND WATER SAMPLE

Chemical Test on Soil Samples

PROJECT: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location	Description of Soil	Type of Chemical Test	Result
BH-1 Depth: 1.50-1.95M	Soft brownish grey silty clay/ clayey silt with traces of sand.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.032%
BH-1 Depth: 3.00-3.45M	Soft brownish grey silty clay/ clayey silt with traces of sand.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.031%
BH-2 Depth: 1.50-1.95M	Soft light grey silty clay/ clayey silt with traces of sand.	pH Value	6.7
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.033%
BH-2 Depth: 3.00-3.45M	Soft light grey silty clay/ clayey silt with traces of sand.	pH Value	6.8
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.035%
BH-3 Depth: 1.50-1.95M	Soft light/ dark grey silty clay/ clayey silt with traces of concretion.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-3 Depth: 3.00-3.45M	Soft light/ dark grey silty clay/ clayey silt with traces of concretion.	pH Value	6.8
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.034%
BH-4 Depth: 4.50-4.95M	Medium brownish grey silty clay/ clayey silt with traces of sand and rusty brown spots.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-4 Depth: 6.00-6.45M	Medium brownish grey silty clay/ clayey silt with traces of sand and rusty brown spots.	pH Value	6.7
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.034%
BH-5 Depth: 1.50-1.95M	Soft to medium brownish/ bluish grey silty clay/ clayey silt with traces of sand and silt stone.	pH Value	6.7
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.036%
BH-5 Depth: 3.00-3.45M	Soft to medium brownish/ bluish grey silty clay/ clayey silt with traces of sand and silt stone.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%

Location	Description of Soil	Type of Chemical Test	Result
BH-6 Depth: 1.50-1.95M	Soft light/ bluish grey silty clay/ clayey silt with traces of sand.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-6 Depth: 3.00-3.45M	Soft light/ bluish grey silty clay/ clayey silt with traces of sand.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-7 Depth: 1.50-1.95M	Soft brownish grey silty clay/ clayey silt with traces of sand.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-7 Depth: 3.00-3.45M	Soft brownish grey silty clay/ clayey silt with traces of sand.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-8 Depth: 5.50-5.95M	Soft brownish grey silty clay/ clayey silt with traces of rusty brown spots.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-8 Depth: 8.00-8.45M	Soft brownish grey silty clay/ clayey silt with traces of rusty brown spots.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-9 Depth: 6.00-6.45M	Soft to medium brownish grey silty clay/ clayey silt.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.036%
BH-9 Depth: 7.50-7.95M	Soft to medium brownish grey silty clay/ clayey silt.	pH Value	6.8
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-10 Depth: 1.50-1.95M	Soft light grey silty clay/ clayey silt with traces of kankar.	pH Value	6.8
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-10 Depth: 3.00-3.45M	Soft light grey silty clay/ clayey silt with traces of kankar.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-11 Depth: 1.50-1.95M	Soft to medium brownish grey silty clay/ clayey silt with traces of sea shell, sand and silt stone.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-11 Depth: 3.00-3.45M	Soft to medium brownish grey silty clay/ clayey silt with traces of sea shell, sand and silt stone.	pH Value	6.7
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%

Location	Description of Soil	Type of Chemical Test	Result
BH-11 Depth: 4.50-4.95M	Soft to medium brownish grey silty clay/ clayey silt with traces of sea shell, sand and silt stone.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.037%
BH-12 Depth: 1.50-1.95M	Soft dark grey silty clay/ clayey silt with traces of vegetative organic matter.	pH Value	6.7
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-12 Depth: 3.00-3.45M	Soft dark grey silty clay/ clayey silt with traces of vegetative organic matter.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.034%
BH-13 Depth: 1.50-1.95M	Soft to medium bluish/ dark grey silty clay/ clayey silt with traces of vegetative organic matter. Calcareous nodules found occasionally.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%
BH-13 Depth: 3.00-3.45M	Soft to medium bluish/ dark grey silty clay/ clayey silt with traces of vegetative organic matter. Calcareous nodules found occasionally.	pH Value	6.8
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.033%
BH-13 Depth: 1.50-1.95M	Soft light brownish grey silty clay/ clayey silt.	pH Value	7.0
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.035%
BH-13 Depth: 3.00-3.45M	Soft light brownish grey silty clay/ clayey silt.	pH Value	6.9
		Sulphite Content as SO ₃	Absent
		Chloride Content as Cl	0.038%

Chemical Test on Water Samples

PROJECT: Geotechnical Investigation Work for Proposed Coal to Methanol Project at Dankuni Coal Complex, Dankuni (WB)

Location	Description	Type of Chemical Test	Result
BH-1	Water Collected from Borehole Marked BH-1	pH value	7.1
		Sulphate SO ₃	12.8
		Chloride as Cl	17.5
BH-2	Water Collected from Borehole Marked BH-2	pH value	7.4
		Sulphate SO ₃	13.2
		Chloride as Cl	17.5
BH-3	Water Collected from Borehole Marked BH-3	pH value	7.4
		Sulphate SO ₃	13.8
		Chloride as Cl	17.7
BH-4	Water Collected from Borehole Marked BH-4	pH value	7.4
		Sulphate SO ₃	13.5
		Chloride as Cl	17.6
BH-5	Water Collected from Borehole Marked BH-5	pH value	6.9
		Sulphate SO ₃	12.9
		Chloride as Cl	17.4
BH-6	Water Collected from Borehole Marked BH-6	pH value	7
		Sulphate SO ₃	13.1
		Chloride as Cl	17.3
BH-7	Water Collected from Borehole Marked BH-7	pH value	7.2
		Sulphate SO ₃	13.5
		Chloride as Cl	17.3
BH-8	Water Collected from Borehole Marked BH-8	pH value	7.6
		Sulphate SO ₃	13.3
		Chloride as Cl	17.5
BH-9	Water Collected from Borehole Marked BH-9	pH value	7.6
		Sulphate SO ₃	13.3
		Chloride as Cl	17.4
BH-10	Water Collected from Borehole Marked BH-10	pH value	7.5
		Sulphate SO ₃	13.4
		Chloride as Cl	17.4
BH-11	Water Collected from Borehole Marked BH-11	pH value	7.4
		Sulphate SO ₃	13.2
		Chloride as Cl	17.7

Location	Description	Type of Chemical Test	Result
BH-12	Water Collected from Borehole Marked BH-12	pH value	7.8
		Sulphate SO ₃	13.1
		Chloride as Cl	17.1
BH-13	Water Collected from Borehole Marked BH-13	pH value	7.3
		Sulphate SO ₃	13.5
		Chloride as Cl	17.6
BH-14	Water Collected from Borehole Marked BH-14	pH value	7.2
		Sulphate SO ₃	13.4
		Chloride as Cl	17.6

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PART II: TECHNICAL



SECTION –1.13

ENGINEERING SPECIFICATIONS FOR COAL/FLUXANT AND ASH HANDLING SYSTEM

PLANT: INTEGRATED COAL BASED METHANOL PLANT,
AT DANKUNI, KOLKATA (INDIA)



PROJECT: SUPPLY OF COAL TO METHANOL (C2M)
PROJECT THROUGH COAL GASIFICATION
ROUTE AT DANKUNI COAL COMPLEX
WESTBENGALINDIA ON BUILD-OWN-OPERATE
(BOO) BASIS.

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REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

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1.0 SCOPE



This document lays down for scope of Coal/Fluxant and Ash Handling System of Coal Gasification based Methanol Plant of **M/s Coal India Limited** for Coal based methanol Plant on Build-Own-Operate (BOO) basis.

- i) Required Raw Coal shall be supplied by the Owner at the unloading hopper from Wagon Tippler / BOBRN type wagon. For fluxant, the procurement, transportation, handling, storage, conveying etc. will be in the scope of BOO Operator.
 - ii) Raw material received by BOO Operator shall be transferred to storage yard with series of belt conveyor. In storage yard stacker cum reclaimers shall be used to stack and reclaim the raw material and transferred to crusher house for crushing and then transfer to bunkers of CMD system or transfer as recommended by licensor.
 - iii) Blended Coal milling, drying and feeding to burners of the gasifier via the “Coal Pressurisation and Feeding” system or as recommended by process licensor.
 - iv) Conveying Ash / slag produced from gasifier to overhead bunkers or ash/slag disposal pond shall be carried out with the help of conveyors/dumpers etc or as recommended by process licensor.
- IV) BOO operator shall adhere to these specifications for engineering. However BOO operator may follow material specification as recommended by Process Licensor.**

2.0 CODES AND STANDARDS

The design, manufacture, inspection and testing of Coal and Ash Handling System for Coal based Methanol Plant shall comply with all the currently applicable statues, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall confirm to the latest edition of the following standards & codes. Other internationally acceptable standards/codes, which ensure equal or higher performance, shall also be accepted.

Conveyor System	“Conveyor Equipment Manufacturer’s Association” (CEMA) or IS : 11592 latest edition
Conveyor Belting	IS : 1891 latest edition or equivalent / ISO
Flat Belt/Slat Conveyors	IS : 8597 latest edition or equivalent / ISO
Conveyor Pulleys	IS : 8531 latest edition or equivalent / ISO
Conveyor Idlers	IS : 8598 latest edition or equivalent / ISO
Conveyor safety	IS : 7155 latest edition or equivalent / ISO
Troughed Belt Conveyors	IS : 4776 latest edition or equivalent / ISO
Use & Selection of Bucket Elevator	IS : 7167 latest edition or equivalent / ISO

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Code of practices for selection of belt feeder	IS : 12215 latest edition or equivalent / ISO
Design criteria for pneumatic conveying systems	IS : 8647 latest edition or equivalent / ISO
Mobile Continuous Bulk Handling Equipment	ISO : 5049/1 latest edition or equivalent / IS
Dust Extraction system	ACGIH (American Conference of Governmental Industrial Hygienists) latest edition or equivalent /ISO
Belt conveyors - Travelling tripper - Motorised-for belt widths 650 mm to 1600 mm - Dimensions	IS : 14386 latest edition or equivalent / ISO
Federation Europeenne De La Manutention Section-I-Rules for Design of Hoisting Appliances.	FEM

3.0 RAW MATERIAL HANDLING SYSTEM

3.1 COAL/FLUXANT HANDLING

ROM Coal (-200mm) /Limestone (-200mm) received from railway siding with help of BOBRN type wagon through Track Hopper and shall be transferred to storage yard with the help of stacker/reclaimer, belt conveyors, rack & pinion gate / rod gate, vibrating feeder etc. Scope of bidder shall be started from Track hopper. The analysis design and detailed drawing for the structures like track hopper including machinery hatches, tunnels, underground TP, s etc. coming below the railway track shall be got approval by the contractor from concerned railways authority before taking up construction.



Suspended magnets shall be provided above head pulleys of conveyors at transfer points for removal of tramp Iron pieces. Metal detectors are also provided to detect non-ferrous materials present in the coal/fluxant before crusher.

Emergency reclaim hopper (ERH) shall be provided to reclaim coal/fluxant by dozers when stacker/ reclaimer are not in operation. Emergency reclaim hopper shall also be used for coal feeding by dozers / pay loader etc.



Bidder to consider unloading ground hopper for truck unloading when ROM coal/Fluxant received from trucks.

4.0 TECHNICAL SPECIFICATION



4.1 BELT CONVEYORS

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1. Conveyor capacity shall be such that it shall be adequate to handle raw material for Steam Generation Plant capacity. Design capacity shall be considered as min. 20% more than the rated capacity.
2. All conveyors shall include adequate structural supports, transfer towers, all drives, pulleys, idlers, chutes, belting, skirt boards, belt cleaners, hold backs(for inclined conveyors), emergency switches, protective devices etc.
3. Conveyor supporting structure should be closed gallery with walkway on both sides.
4. All the equipment of coal handling system shall be designed to operate on continuous duty i.e., 24 hours per day and 365 days in a year.
5. All belt conveyors shall have suitable gravity take-up unit, except material weigh feeder which have short length and wherever agreed by owner/ consultant.
6. Continuous belt weigher shall be installed on conveyor at suitable locations. Display of this weigher would be connected through control panel.
7. Electro Magnetic separator arrangement of adequate capacity to be provided at suitable location to separate any unwanted particle from the feed coal and fluxant.
8. All the conveyors shall be provided with identical designed frame size, roller size, pulley size etc. as far as possible to have better interchangeability and reducing the inventory spare parts.
9. The belting shall be of either synthetic fabric such as Nylon-Nylon / Polyester Polyamide, Steel Cord etc. with rubber covers of adequate flexibility. For all the conveyors the number of plies, cover thickness, factor of safety etc. shall be as per the recommendation of belt manufacturer of adequate strength.
10. Conveyor drive shall be directly coupled through suitable helical gear box.
11. Minimum service factor for coupling shall be taken as 2.0 on the absorbed power.
12. Minimum service factor on gear boxes shall be taken as 1.5 over the absorbed power.
13. All conveyor belts shall be fitted with belt cleaners/scrapers which will be located between the head and snub drums, on the return belt side. All conveyors' belts shall be fitted with multi-blade sprung type external belt scraper below head pulley and V-type internal belt scraper. All cleaned material from the belt shall fall within the head chute.
14. The skirt boards and sealing with overlapping block design shall be provided with labyrinth seals.
15. All equipment's / assemblies shall use antifriction bearing fitted in Plummer block.

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16. All discharge Chutes shall be lined with material Tiscral /Sailhard(Adequate thickness minimum 12 mm).
17. In Belt conveyor system, Deck plate shall be provided minimum thickness 3.15mm with 4 m length (min.) at receiving end and 2 m length (min.) at discharge end.
18. In Double stream conveyors central walk way width shall be minimum 1100mm and side walkway 750mm.
19. Self-aligning training idler spacing to be considered as maximum 15m for carrying side & maximum 30m for return side.
20. Return idler shall be with rubber rings or rubber lined. Vertical guide rollers shall also be rubber lagged type.
21. Impact idlers (minimum 5 nos.) shall be provided at loading points at spacing of 300 mm. Impact idlers shall be of rubber lagged type.
22. All pulleys shall be lagged in herring-bone pattern. Head/Drive pulleys shall be lagged with 12 mm thickness Neoprene and Tail & Snub pulleys shall be lagged with 12 mm thickness Neoprene.
23. All diverter & gate shall be electrically or pneumatically operated.
24. For safety of conveyors and personnel, all conveyors shall be provided with safety switches like zero speed switch, belt sway switch and pull cord. In addition to these there shall be provision of audible warning (Hooter) of starting of conveyor.
25. Suitable hold back devices for preventing running back of the conveyor belt in case of conveyor being stopped in loaded conditions due to power failure or during normal operational delays shall be provided to give positive protection. The hold back shall instantaneously engage without shock and be capable of protecting equipment and personnel. It shall be released instantly when 'power' resumes or the 'delay' is removed. The holdback devices shall be integral with gearbox.
26. All Conveyor galleries shall be provided with dust sweeping chutes covered with removal chequered plates. There shall be one dust hopper for each walkway of gallery and the same shall be provided at the middle of walkway near trestle location.
27. All over ground conveyors are provided with covered galleries. Crossover shall be provided at 100 m intervals (no cross over for conveyors less than 100 m). Gallery shall be designed to accommodate cable & pipes including fire water, Dust Suppression pipelines.

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28. Walkway shall be of chequered plate construction with anti skid arrangement. Both sides of the central and side walkway shall be provided with pipe hand rail with kerb plate using pipe of 'medium' class as per IS: 1239 having 32mm nominal size. Handrail shall not be connected to conveyor supporting stringer.
29. Bidder to consider redundancy / stand-by for belt conveying system (1W+1S) from battery limit to bunkers for boilers feeding.
30. The inclination of conveyors inside the tunnel shall be limited to 10 degree. The inclination of conveyors above the ground level shall be as per CEMA / IS11592. The conveyor shall be horizontal at the feed point as far as possible. In case the same is not possible, the inclination at the feed point shall be limited to 6 degree. Conveyor system shall be designed with zero leakage of coal.
31. Wherever the conveyor crosses the road, a minimum clearance of 8 M shall be provided below the structure.
32. Minimum 3.15 mm thick seal plate shall be provided at all locations wherever conveyor crosses the road / building / any other facilities.
33. For over ground conveyors take-up shall not be provided in the pits. Sand pit shall be provided at the ground level.

4.2 HOPPERS

The hoppers shall be fabricated from Carbon steel plates (min. 10 mm thickness.) conforming to IS : 2062 or equivalent / ISO and to lined with Tiscral /Sailhard (Adequate thickness minimum 12 mm) from inside not only on bottom portion but also on vertical portion for free flow of material.

4.3 FEEDERS

1. The design of the feeder shall be sturdy and robust in construction to withstand worst duty conditions and given uninterrupted flow of material. The unit shall have unbalanced motors with vibration control and variable control mechanism for controlling the rate of flow. The design shall be such that it consumes less power per ton of material handled, with less maintenance.
2. The feeder shall be able to start at full load quickly, stop smoothly and shall operate at an extremely low noise level. With the empty tray the noise level shall be less than 85db within one meter radius of the unit.
3. The width of the deck and height of skirts shall be sufficient to suit the duty conditions. The length of the deck shall be suitable for arresting the flow from hopper efficiently when the feeder is stopped or not in working condition.

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4. The deck and skirts shall be provided with abrasion resistant liners. The through shall be suitably stiffened to avoid bending.
5. Adequate capacity feeder shall be selected by bidder at all locations. Design capacity shall be considered as min. 20% more than the rated capacity.

4.4 BUCKET ELEVATORS

1. The bucket elevator shall be designed for continuous duty at full load as specified under operating conditions and the various components shall conform to relevant codes.
2. Top cover shall be in pieces for easy to disassemble for the maintenance and inspection of complete drive assembly. The housing shall be provided with inspection opening at appropriate location.
3. Dust proof labyrinth metallic seal for the drive & return shaft shall be provided.
4. Bucket chain shall be of heavy duty and the chain specification with manufactures designated type/ number shall be specified in the bid.
5. Elevator shall be provided with Heavy duty positive holdback in order to prevent it from rotating backwards.
6. Hoods & safety guard shall be provided for the coupling and any other exposed rotating components. All safety switches shall be provided.
7. Adequate capacity bucket elevator shall be selected by bidder at all locations. Design capacity shall be considered as min. 20% more than the rated capacity.

4.5 VIBRATING SCREENS

1. The solid deck section shall be provided with replaceable Tiscral /Sailhard(Adequate thickness minimum 12 mm). The perforated deck shall be wear resistant and shall be rigidly fixed with main frame along the length of grizzly deck.
2. The vibrating screening feeders shall be mounted on the floor with the help of helical springs made of alloy steel. No rubber/synthetic material for the support shall be acceptable.
3. Vibrator bearings shall be grease lubricated, double spherical roller type suitable for vibrating equipment. The bearings shall be sized for minimum 8,000 hours of operation.
4. Suitable sealing arrangement shall be provided between the vibrating structure and chute work to avoid dust nuisance in the surrounding area.
5. Proper arrangement to avoid dust ingress into lubricant of eccentric shafts shall be

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provided.



- Necessary arrangements shall be provided for maintaining / replacing the complete vibrator assembly.

4.6 CRUSHER AND VIBRATION MONITORING SYSTEM(VMS)

- Crusher shall be provided for sizing the input coal and fluxant. Crusher shall be supplied complete with accessories and subsystems.
- The crusher design should be such that the crushing action is accompanied by the minimum of attrition.
- Uniform crushing impact shall be assured.
- The crusher shall be capable of delivering the normal rated output even when handling damp sticky coal having maximum moisture content. No clogging or building up of material on the crushing element shall develop.
- Temperature sensing devices shall be installed on both bearings of each of the crusher to trip the crusher in case temperature goes beyond limit.
- The entire inside surface of crusher coming in contact with coal shall be provided with abrasion resistant steel liners.
- The Plummer block shall be of 'Split Type' design and shall be fixed with minimum four numbers of high tensile steel bolt studs of adequate size complete with adequate locking device and locating arrangement. In addition, the jacking screw shall be provided for easy lifting of top part of the plummer block. The same shall be of solid base with flat machined bottom surface all around having maximum contact on the foundation plate.
- Maximum accessibility shall be provided for routine inspection and replacement of parts. For these purposes, the doors shall be of hinge connection with effective dust sealing arrangement. Hydraulically operated top cover of crushers shall be provided for quick inspection.
- Crusher shall be mounted on independent foundation with vibration damping device like GERB springs and dampers.

4.7 VERTICAL ROLLER MILL

- Vertical Roller mills shall be supplied complete with accessories and subsystems.
- Design capacity shall be considered as min. 10% more than the rated capacity. The vertical roller mill shall be used for grinding, drying, separation and transportation.

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3. Vertical roller mill shall have following features like better utilisation of grinding area, even distribution of load on the table, comparative less dynamic forces on table due to lesser mass of single moving part, variable speed mill drives and “hydraulic loading system” for maximum flexibility to vary grinding pressure.
4. Roller swing-out device for quick and easy changing of grinding components shall be provided or other facilities shall be used for quick and easy maintenance.
5. Bevel Planetary gearbox with full lubrication and gear system shall be used.
6. High efficiency dynamic classifier shall be used.
7. There shall be no metallic contact between the grinding rollers and grinding tracks.
8. Mill feed shall be sealed through rotary air lock



4.8 TRANSFER CHUTES

1. Chutes transferring Coal from one conveyor to another shall be designed in such a way that material fall height is minimum and the change in direction is achieved as smoothly as possible.
2. All the chutes shall be provided with IS: 2062 material of construction of 8 mm thickness and lined with material Tiscral /Sailhard(Adequate thickness minimum 12 mm).
3. Inspection holes / window with covers shall be provided at all convenient locations.
4. Speed of the material falling on conveyor belt in the direction of belt travel should be almost the same as that of the conveyor.
5. The angle of chutes shall be 55⁰ as far as possible but in no case less than 50⁰ for proper flow of material.

4.9 BUNKERS

1. The bunkers shall be of round shape/rectangular shape and fabricated from Carbon steel plates (min. 10 mm thickness) conforming to IS : 2062 or equivalent / ISO and to lined with Tiscral /Sailhard (Adequate thickness minimum 12 mm) from inside not only on bottom conical portion but also on vertical portion for free flow of material.
2. Bunkers shall be provided with load cells, vibrators/poking hole, radar type level indicator etc. The angle of conical portion of bunkers shall be kept as 55° with the horizontal.
3. Feeding to bunkers shall be automatic with the help of series of conveyors system.

4.10 FLAP GATES

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1. The motor operated 2 position flap gates shall be provided in transfer chutes as specified and shall be complete with electrically operated actuators. The gates shall be of robust construction and suitable for trouble free operation.
2. The motor rating for the actuator shall be so selected as to provide sufficient thrust for operation of the flap gates against the moving weight of coal and/or flap gate. The flap gate travel shall be 60 deg. The motor shall be completely dust proof.
3. The actuators shall be capable of preventing any over travel. These shall be placed internal to the drive unit and shall be completely dust-proof. The limit switches shall be capable of adjustments to vary the total length of travel of the gates.
4. Provision for alternative manual operation shall also be made using de-clutch able hand wheel. The diameter of hand wheel shall be selected considering convenient force to be applied by a single operator. However, minimum diameter of hand wheel shall be 500 mm. Limit switch for safety of person operating the hand wheel shall be provided. Manual effort required to operation the flap gate shall not exceed 25 kg.

4.11 RACK & PINION GATES / ROD GATE

1. Rotary actuator operated rack and pinion gates shall be provided at various locations as required. The gate shall be mounted such that coal load does not act vertically on gate.
2. Suitable manually operated rod gates shall be provided over rack and pinion gates for their easy operation and maintenance. The rack and pinion gate shall be guided properly and suitable rollers with bearings sealed for life and dust proof shall be provided.
3. Provision for alternative manual operation of motorized rack and pinion gates shall also be made. Limit switch for safety of person operating the hand wheel shall be provided. Manual effort required to operate the rack and pinion gate shall not exceed 25 kg.

4.12 BELT SCALE

1. Belt weigh scale for measurement of coal flow rate and quantity shall be provided at specified locations. System shall be complete with flow rate indicator, totaliser, control panel etc. The weigh scale shall be automatic and electronic type. It should be designed for continuous automatic weighing, metering and printing of coal flow.
2. Each belt weigh scale shall comprise of a belt weigh scale platform with minimum 4 nos. weighing idlers. It shall have unitized construction for ease of installation and shall be fully floating type (without pivot points). Minimum 4 nos. hermetically sealed load cells of precision strain gauge type shall be applied in tension to support the weigh bridge. The load cells shall have 100% overload protection and shall be structurally safe upto to 250% of rated belt scale capacity.

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3. Belt scale shall be electronic microprocessor based with its program stored in non-volatile memory. It shall be provided with self-diagnostic features for trouble shooting of the entire belt scale system. Fully automatic zero and span calibration facility shall be provided.
4. The electronic systems offered by the Contractor shall include all signal conditioning, power amplifiers and printed circuits etc. The printed circuits shall be encapsulated against dust and moisture.
5. The flow rate indicator shall have minimum 4 digits. The flow totalizer should have 8 digits display scale with reset facility.

4.13 INLINE MAGNETIC SEPARATOR / SUSPENDED MAGNET

Inline Magnetic Separators shall be provided for continuous and automatic extraction and discharge of tramp magnetic pieces from coal being discharged from conveyors as specified. The sets shall be complete in all respects with drives, magnets, inline belts, hoppers, chutes, tramp-iron boxes and all electrical ancillaries like control panels etc. Suspended Magnetic Separator shall be provided for picking up tramp magnetic pieces buried under coal from moving coal over Conveyor as specified.

4.14 TRAVELLING TRIPPER UNIT / SHUTTLE CONVEYOR & BUNKER SEALING ARRANGEMENT

1. Rail mounted movable travelling Tripper / shuttle conveyor shall be provided to feed coal to overhead bunkers of Boilers.
2. Mobile Trippers on bunker conveyors along with belt sealing arrangement shall be furnished and erected complete with rails, including necessary supporting structures, approach/maintenance platforms with ladders and hand railings, trailing cables, all electrical including machine mounted local control panel & control panel on one end of bunker, location of which shall be decided during detail engineering.
3. The Mobile tripper conveyors shall be motor driven type. It shall consist of structures, supports, walkways, rails, belt scrapper with adjustable rubber strip, rubber lagged head and bend pulleys complete with shaft bearings, chutes, stops, limit switches, brakes etc. The rating of tripper travel motor shall be adequate to move the tripper smoothly either in same or opposite direction to belt direction under fully loaded conditions. Minimum two drive axles shall be provided for tripper travel. Arrangement shall be provided at the starting point of the tripper to avoid folding of belt.
4. Supply of adequate length of rails to cover the runway length for the motor driven tripper shall be included. Suitable belt hold down guide pulley shall be provided over the concave curve of belt over tripper.
5. The travelling trippers shall be provided with fail safe A.C. thruster operated brake of



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totally enclosed type which shall engage as soon as tripper travel motor stops. A.C. thruster operated rail clamps along with manual Rail clamps on both side of the tripper shall also be provided.

6. Monorail & electric hoist shall be provided for lifting conveyor drum to floors. Monorail all along the tripper travel length to facilitate maintenance of tripper shall be provided.
7. Suitable dust cover shall be provided over tripper head pulley. Serrated rubber seal shall be provided at open side to prevent dust nuisance. Suitable dust tight access doors shall be provided. Spring loaded scraper type belt cleaner shall be provided below the tripper head pulley for cleaning the carrying side of the belt.
8. The tripper shall run on rails with double flanged wheels. Rails for tripper travel shall be mounted on supporting structure of respective conveyors.
9. Suitable access platform of chequered plate with ladders, hand railing and walkways on both sides shall be provided for access/maintenance of equipment on tripper. In addition, crossover platform shall be provided with tripper so that operator can cross the belt through the same.
10. Suitable rail cleaners shall be provided on leading and trailing edge of tripper for either track.

4.15 UNIDIRECTIONAL TRAVELLING STACKER CUM RECLAIMER

- 4.15.1 Unidirectional travelling stacker cum reclaimer operating in conjunction with yard conveyor shall be provided as specified. Stacker-cum-Reclaimers shall be capable of both stacking and reclaiming complete with adequate length of rail track, and its foundation, cantilever boom conveyor, boom hoist, reclaimer bucket wheel, control panel, operators cabin, electrical power distribution system, motorised cable reeling drum, adequate length of trailing cables etc.
- 4.15.2 The design average capacities shall not be less than 110% of rated (guaranteed) capacities as specified elsewhere for both stacking & reclaiming. The continuous motor rating at 50 degree celcius of the drive motor to be provided on each side of the yard conveyor shall be 120% of the actual power requirement at motor output shaft.
- 4.15.3 Stacker/Reclaimer shall be capable of operating at high wind velocities upto 65 km/hr. It shall also be able to withstand maximum wind velocity as indicated in Project Synopsis, when it is not operating. A suitable anemometer shall be provided which shall indicate the wind velocity in the control cabin. Electro-hydraulic thruster operated rail clamp and manual rail clamp shall be provided for holding the stacker-cum-reclaimer. Suitable arrangement shall be provided for keeping the stacker-reclaimer in fixed stable position when the weather is stormy.
- 4.15.4 Stacker-cum-reclaimer shall operate on rail track running for adequate length to cover the entire coal stockyard. The wheel load of stacker-reclaimer shall not exceed 27.0 tonnes. The

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ratio of boom length (as specified) to the rail track gauge shall not exceed 5. Top of rail level shall be maintained at 0.7 m above the ground level, i.e., coal pile base level unless specified otherwise. Suitable number of rail scrappers shall be provided.

5.0 DUST EXTRACTION SYSTEM

Dust control system shall be of dry / wet / extraction type and as well as dust suppression type to suit at the application point.

The Contractor shall require providing suitable dust control system at suitable location for Coal/Fluxant screening, crushing, coal/Fluxantcrushing and feeding system etc.

The dust control system to be furnished under this specification is required for control of fugitive dust emissions from dust generation points such as transfer points, feeders, crushers etc. Dust control is achieved by dust suppression/extraction system.

Dust control system which shall not allow a dust concentration in the ambient air inside the buildings more than acceptable limits as per the approved guidelines or any internationally recognized hygienic Standards/Codes.

6.0 ASH HANDLING SYSTEM

Conveying Ash / slag produced from gasifier to overhead bunkers or ash/slag disposal pond shall be carried out with the help of conveyors/dumpers etc or as recommended by process licensor.

7.0 ACCESS TO MACHINERY

1. Special attention shall be given in providing adequate access to all machinery for safe operation / maintenance and cleaning purpose.
2. Gravity take-up of conveyor shall be provided with the platform and access ladder for maintenance.
3. Provision shall be made for lifting out and replacing equipment's such as motors, gearboxes, conveyor pulleys, idlers parts and other heavy machinery in each Transfer Towers with the help of electric hoist. Capacity of the hoist would be based on the weight of the heaviest part to be lifted.

NOTE: - Bidder to strictly follow licensor's specification for the mentioned items of Coal Gasification Plant.



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SAFETY, HEALTH AND ENVIRONMENT

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THROUGH COAL GASIFICATION ROUTE AT
DANKUNI COAL COMPLEX WEST BENGAL,
INDIA ON BUILD-OWN-OPERATE (BOO) BASIS**

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BOO OPERATOR shall abide by all Safety, Health and Environment rules applicable for CIL Complex during construction and subsequent operation of the Methanol plants. BOO OPERATOR shall also ensure compliance to all Safety, Health and Environment rules including (but not limited to) following points.



1.0 FIRE AND SECURITY REGULATIONS:

1.1 No Smoking:

- 1.1.1 BOO OPERATOR shall instruct his personnel/ employees NOT TO SMOKE except at the prescribed smoking booths as provided by the CIL. BOO OPERATOR shall be responsible for all defaults of his workers in this regard.
- 1.1.2 Carrying of matchboxes, lighters or any other means of ignition is strictly prohibited inside the Dankuni premises.
- 1.1.3 Any BOO OPERATOR's employee who is found smoking or in the possession of match box or lighter or any other means of ignition in a prohibited area will be turned out from the premises of the Dankuni. Suitable action as decided by the management will also be taken.

1.2 Dankuni Area:

- 1.2.1 BOO OPERATOR and his employee shall observe all fire & safety regulations of the Dankuni and shall so organize his work as not to interfere with the running of the Dankuni in any manner whatsoever. BOO OPERATOR shall ensure that their staff/ workmen carry with them valid passes for proper identification inside the battery area.
- 1.2.2 The complete job is to be carried out within the unit of CIL Dankuni Coal complex. BOO OPERATOR shall take all necessary safety precautions and obtain required certificates/ fire permits / safety/ work permits etc. from the competent authority before carrying out any hot works during the execution of the entire works covered by this tender. Safety barricade wherever necessary are to be put up at his own cost.
- 1.2.3 BOO OPERATOR's employees shall abide by the Fire & Safety rules and regulations of the Dankuni.
- 1.2.4 BOO OPERATOR shall make his own arrangements of Gate Pass with photo for his employees as prescribed and instructed by the Security dept. i.e. CISF, CIL at his own cost, each gate pass has to be endorsed by the Security Officer of the Dankuni before the pass be used by any employee. In case of termination of the service of any of his employee during the contractual period, BOO OPERATOR shall have to surrender the Gate Pass issued to the employees to the Security Dept. At the end of the project all the gate passes endorsed by the Security Dept. for use of BOO OPERATOR's employees shall have to be returned.
- 1.2.5 For any damage done by BOO OPERATOR's employees to the existing facilities of the Dankuni, BOO OPERATOR shall be solely responsible to make good as per the instruction of the Engineer-in-Charge or full satisfaction of the Dankuni belt for his workman at his own cost.
- 1.2.6 For any hazardous/ overhead work BOO OPERATOR has to arrange necessary safety belt for his workman at his own cost.

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2.0 SAFETY REGULATIONS:



The following is a list of Rules and Regulations which must be observed by BOO OPERATOR working in the Dankuni.

2.1 Safety:

- 2.1.1 BOO OPERATOR shall ensure that all labourers/ supervisor engaged by him will carry Card/ Photo Pass displayed on their person during working hours at the work place in/ outside Dankuni for their easy identification.
- 2.1.2 BOO OPERATOR shall ensure that their supervisors must undergo Fire & Safety Training & subsequent Test at Fire Station before starting the job. BOO OPERATOR must disclose to CISF the name of supervisors and arrange safety training at GR Fire Station, before obtaining a gate pass. CISF will issue the gate pass meant for supervisor, only after getting the confirmation from Fire & Safety. It is the duty of supervisor to train his work force in Fire & Safety on regular basis. The violation of this will be viewed seriously.
- 2.1.3 BOO OPERATOR shall ensure that their workmen/ supervisors shall not move to other places other than their work premises without proper permission/ authorization.
- 2.1.4 BOO OPERATOR shall ensure verification of antecedents of the labourers/ supervisors from Polices / Sarpanch/ other officials before they are engaged by him. No person having adverse antecedent shall be employed by BOO OPERATOR. BOO OPERATOR shall be held responsible for all the acts carried out by his workmen.
- 2.1.5 BOO OPERATOR shall ensure that the workmen working with him are given do's and don'ts for strict adherence.
- 2.1.6 BOO OPERATOR/ his workmen/ supervisor shall fully adhere to the security instructions issued by Management from time to time.
- 2.1.7 Persons below the age of 18 (Eighteen) will not be employed in any part of the Dankuni.
- 2.1.8. The weekly safety report should be submitted in the prescribed format without fail.

2.2 Work Permit:

- 2.2.1 Any work carried out within the Dankuni must be covered by a work permit issued by the concerned department or area-in-charge. In addition, a clearance must be obtained from the concerned department's officer or supervisor prior to commencement of any job. A fire permit is required for all the hot jobs.
- 2.2.2. Any work involving open flames and spark such as welding, gas cutting, soldering, grinding, concrete breaking, use of hurricane lamps and internal combustion driven vehicles/equipment.
- 2.2.3. Sand blasting, trucks, Jeeps, Cranes, Lifts, Cars or any kind of vehicle/equipment driven by an internal combustion engine or by batteries.
- 2.2.4. Use of gasoline, diesel or electrical power engines or tools.
- 2.2.5. Entry of vehicles inside battery limits of process area, within tank dykes and adjacent to pump houses / API separator and loading gantries.
- 2.2.6. Open fire such as burning of wood, coal etc. is strictly prohibited inside the Battery area.

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2.2.7. While carrying out the hot job, BOO OPERATOR and his workmen must ensure the following safety measures and job should not be carried out without these:

- Valid hot job permit.
- Availability of Tested and proper Fire Extinguisher at the work places.
- Provision of running fire water hose at the work place.

2.2.8. All Flammable / combustible materials should either be removed from the work place or should be properly protected.

2.3 Safety Permits:

2.3.1 BOO OPERATOR must obtain the safety permit from the area Incharge of the concerned department, prior to the starting of the job as stated below.

2.3.2. Entry of personnel into any process area of storage facilities that has been in service etc. Entry into hazardous areas, Dosing area or any other area where chemicals and hazardous materials are either in use or kept as store.

2.4 Vessels Entry Permit:

2.4.1 BOO OPERATOR must obtain this permit prior to the start up of the job, column, vessels, tanks or any enclosed area where the chemicals and hazardous materials is either used or stores into it. It is BOO OPERATOR's duty to ensure daily that the above permits are obtained from the area-in-charge till the completion of the job. All precautionary points stipulated in the permit and instruction of the Area In charge/Engineer In charge must be strictly complied with.

2.4.2 BOO OPERATOR shall ensure the following at the time of entry into the vessels:

- Standby persons
- Provision of exhaust fan
- Use of breathing apparatus

2.5 Excavation:



2.5.1 All the areas where the existing grading is disturbed in the course of work by BOO OPERATOR shall be made good by him to the full satisfaction of the Engineer-in-Charge.

2.5.2. This job must be executed only after obtaining a valid excavation permit for the particular area where the excavation is required to be done. The permit shall be considered valid only when it is signed by the authorized person of CIL in addition to other signatories like F&S officer, Civil Engineer, the electrical section and supervising Engineer-in-Charge of the particular area where the excavation is to be carried out.

2.5.3. The company reserves the right to cancel a permit without assigning any reasons. When called upon to stop the work by any personnel of the company, BOO OPERATOR shall immediately cease to continue the work. Before re-commencement, a fresh permit must be obtained.

2.5.4. If any excavation job is being done at the depth, then following precaution needs to be taken up.

- BOO OPERATOR has to obtain the permit "Working at Depth" duly authorized by

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competent authorities.

- Proper barricading shall be provided at all sides of the opening.
- Excavation shall be done with adequate slop instead of vertical to avoid collapse of wall.
- Proper shoring / strutting shall be provided without fail.
- At least two no. of escape ladders shall be provided at two sides.
- Adequate illumination shall be provided as per site requirement.
- Minimum person shall be kept inside the pit. All idle workers should be removed from there.
- Heavy machinery like crane etc. should not be used near the pit.

2.6 Working at Heights:

2.6.1 While working at height, more than 2 meters from floor level, following safety precautions has to be followed.



- BOO OPERATOR has to obtain the permit for working at height duly approved by competent authority.
- Proper type of scaffolding / platform /ladder should be made to facilitate the job at height. Minimum 2 nos. of ladders should be provided at opposite sides.
- Use of bamboo scaffolding is strictly prohibited inside the Battery area. Only steel scaffolding shall be used for work inside the Dankuni. The steel scaffolding material and its erection shall be done as per relevant IS specification.
- BOO OPERATOR shall ensure the use of safety belts by the person who is working at heights. Safety belt to be used should be of good quality (IS marked) and shall be hooked up with firm support.
- Safety nets also to be used as per site conditions.
- Before starting the job, scaffolding shall be inspected by competent person and a record of the same shall be kept at site.

2.7 Working with Electrical System:

2.7.1 BOO OPERATOR should have valid electrical license for working in the state of Orissa. BOO OPERATOR shall furnish a copy of the same to Engineer-in-Charge before commencement of any work pertaining to Electrical System. In any case, no work shall be permitted to be executed at site without a valid Electrical License, and the decision of the Engineer-in-charge in this regard shall be final and binding and no claim / compensation whatsoever shall entertain on this account.

2.7.2 While working on electrical system, BOO OPERATOR and his workmen shall ensure that the following safety measures are in place:

- Proper & valid Electrical line clearance is obtained for the equipment.
- The cables are properly insulated and are without any temporary joint.
- All Flammable / combustible materials should either be removed from the work place or should be properly protected.

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- Suitable Earth leakage Circuit Breaker (ELCB) is provided for incoming and all outgoing feeders.
- Proper earthing is provided to distribution board and other electrical equipments like welding machines & grinding machines etc.
- Pipe sleeves are provided for road crossings of temporary cables laid by BOO OPERATOR for his work.
- The power connection should not be overloaded and suitable overload protection should be provided.
- The tools used by BOO OPERATOR personnel should be properly insulated and in good condition
- The grinding machine & other power tools should have proper guard.

2.8 Electrical Apparatus:



- 2.8.1 BOO OPERATOR should ensure that the portable electrical equipment like grinding machine, drilling machine etc. is in healthy condition. BOO OPERATOR should take all precautionary safety action, as providing of earth leakage circuit breakers for their portable electric machines. In lieu of the above, double insulated portable equipment may be used.
- 2.8.2 All portable electrical apparatus shall be regularly examined, tested and maintained to ensure the apparatus and leads are in good order.
- 2.8.3 Ensure that all portable appliances are provided with 3 pin plug and socket connections and that all the metallic parts of the apparatus are effectively earthed. All loose wiring such as flexible cables for portable lamps, tools and trailing cables and other portable and transportable apparatus shall be tested regularly at frequent intervals to ensure safety.
- 2.8.4 No dry battery or accumulator, type of electric hand lamp or torch which is not of flameproof safety type shall be taken inside the Dankuni.

2.9 Use of Company Facilities:

Under no condition shall any BOO OPERATOR personnel temper with or use any property belonging to the Dankuni without obtaining prior sanction from the supervisor of area concerned.

2.10 Radiography:

- 2.10.1 The radiography agency employed by BOO OPERATOR shall be duly approved by BARC.
- 2.10.2 Specific approval from the Engineer-in-charge for the radiography agency shall be obtained by BOO OPERATOR prior to any radiography work.
- 2.10.3 BOO OPERATOR shall ensure the following safety precautions for the work to be done by the radiography agency.
- The radiography work shall be carried out under the supervision & guidelines of their site in-charge duly approved by BARC.
 - As far as possible, field radiography should be done only during night time when there

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is little or no occupancy around.

- Field radiography during day time may be permitted with due permission of EIC when the occupancy around is minimum i.e. during lunch interval or on holidays.
- A suitable area around the radiography job should necessarily be cordoned off, so that the radiation level outside the area does not exceed the permissible radiation level. The radiation level along the cordon should be monitored by suitable & calibrated survey meter.
- Radiation warning symbol during day time & red warning light during the night to be prominently displayed while carrying the radiography work.
- The concerned radiographer shall remain physically present outside the cordoned area during exposure.

2.11 Temporary Structure/ Fixtures:

2.11.1 Before erecting temporary shelters like sheds or tents anywhere within the Dankuni premises, written permission of the concerned authorities must be obtained.

2.11.2 Temporary fixtures like sheds, tents, etc. shall be erected in conformity with normal safety standards. Thatched roof to such fixtures will not be permitted.

2.11.3 Temporary piping, hose connections and electrical wiring must be laid in such manner that they do not cause tripping or hitting hazard.

2.11.4 Temporary sheds can be constructed only for the storing of the material / site office. It should not be used for any other purpose.

2.11.5 Following information shall be clearly written on the shed.

- Name of BOO OPERATOR
- Work Order No.
- Working under the Department
- Name of the Engineer-in-charge.
- Permit No. & it's validity period.

The shed shall be made of safe construction material and good aesthetic view. The shed shall be made strictly at the authorized location and size.



2.11.6 All windows shall be either of wire mesh or glass.

2.11.7 After completion of the job, shed must be demolished within 10 days and area must be cleaned.

2.11.8 All precautions should be taken to ensure that any temporary electrical wiring used within the Dankuni will not cause spark or shock.

2.12 Compressed Gas Cylinders:

2.12.1 Compressed gas cylinders should be used in upright position. They must be firmly located on the ground or to a sturdy stand and the cylinder should be chained to prevent accidental fall.

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2.12.2 Rolling or throwing of cylinders is strictly prohibited. Cylinders shall be handled carefully and transported through hand trolleys.

2.12.3 Cylinders shall be stacked properly. Empty cylinders shall be stacked separately and filled cylinders separately. After completion of job, all cylinders must be removed.

2.13 House Keeping:

2.13.1 Good House keeping must be practiced by BOO OPERATOR personnel at all times while within the plant. During and after completion of the work, they are to ensure that their work area is kept clean and tidy. Materials and equipment should be stored in a safe and orderly manner so that they will not block exits to roads, buildings, aisles, passage and approach to firefighting equipment such as fire hydrants, fire hose and fire extinguishers or area where emergency safety showers, electrical switch panels and switch rooms are located.

2.13.2 The work / construction sites are to be cleaned daily and all debris / scrap generated is to be kept at the designated place only every day by BOO OPERATOR as directed by the Engineer-In-charge. The scrap / debris so generated shall be disposed off to the designated places once a week as per the direction of Engineer-in-charge.

2.13.3 A job will not be considered completed until all surplus material, scrape and debris / rubbish are removed from the job site.

2.13.4 In case BOO OPERATOR does not clear the area within 5 days of completion of work, the same shall be got done by CIL and recoveries shall be made from the bills of BOO OPERATOR at double the rate at which CIL has got it done.



2.13.5 Any failure by BOO OPERATOR in maintaining good house-keeping / clearing the site as above shall be recorded in the performance report of BOO OPERATOR.

2.13.6 At all work sites, BOO OPERATOR has to display a board containing following information:

- Name of BOO OPERATOR
- Name of the work
- Work Order No.
- Job site warning instruction
- Emergency Telephone Number
- Do's and don'ts on safety and security
- Working under the Department
- CIL site in-charge name
- Permit No. & Validity period.

2.13.7 BOO OPERATOR has to maintain the following at job site:

- First Aid Box with required medicines
- Safety Register
- Injury record
- Records of Weekly Staff safety meeting.
- Record for Safety briefing / Training at site by BOO OPERATOR.

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2.14 Personal Protective Equipment:

2.14.1 For the safe conduct of any job, BOO OPERATOR has to arrange personnel protective equipments for his personnel as per requirement. The equipment's shall be approved type, good condition and adequate numbers. Use of PPE such as helmets, safety shoes, safety belt., hearing aids, hand gloves, aprons, safety goggles, etc, is a must. CIL shall not provide any personal protective equipment. However, in certain cases, personal protective equipment maintained by the Dankuni will be made available for this purpose in which event such equipments shall be returned to the authorities in good condition.

2.14.2 BOO OPERATOR shall arrange all Non-Respiratory Type of Personal Protective Equipment (PPE) (e.g. Safety Goggles, Welding Helmets, Belts etc.) at their own cost and shall ensure use of these PPE by their workmen/ personnel during execution of the job as per Fire & Safety Rules and Regulations of the Dankuni and as directed by the Site Engineer-in-Charge. Fire & Safety Dept. may be contacted for any clarification on Safety Regulations.

2.14.3 Special precautions and personal protection shall be taken as per Dankuni Safety Regulation during the following jobs:

- (i) Handling of Hazardous Chemicals, gases and Materials etc. (e.g. TEL, Acids, Chlorine, Ammonia, Pyrophoric Iron etc.)
- (ii) Working in presence of Suspended Solids (e.g. Catalyst, Refractory, Sand, Dust etc.)
- (iii) Cleaning / Maintenance of equipments in Lead/ Sulphur/ Phenol rich Hydrocarbon service.
- (iv) Cleaning/ handling of oily sludge.
- (v) Welding/ Grinding/ Gas cutting jobs.
- (vi) Radiography of Mechanical jobs.

2.15 Clothing & Personal Protection:

BOO OPERATOR Personnel shall not wear loose clothing while working around moving or rotating machinery and equipment, and must wear helmets and safety shoes while working in Dankuni area.

2.16 Unsafe Practices:



Any unsafe practices in disregard of normal safe working practices by BOO OPERATOR personnel when pointed out by company personnel shall be immediately corrected.

2.17 Personal Conduct:

2.17.1 Working under influence of alcohol/ narcotics and entering Dankuni premises while in the influence of alcohol/ narcotics is strictly forbidden. BOO OPERATOR should ensure compliance of above by him and all his workmen.

2.17.2 Horseplay:

- (i) Fooling on the job, mock fighting within the Dankuni premises will not be tolerated.
- (ii) Gambling within the Dankuni premises is strictly forbidden.



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- (iii) Entering the Dankuni while in possession of weapons such as knives etc. is prohibited.
- (iv) BOO OPERATOR personnel shall not pick up quarrel or get into arguments with Dankuni personnel or act in any manner, which is in violation of plant discipline. In case of any misunderstanding, such problems should be referred to appropriate Dankuni personnel.

2.18 Driving of Motor Vehicles:

2.18.1 BOO OPERATOR shall ensure that all State traffic rules and regulations are complied with while motor vehicles are driven inside the Dankuni premises. In addition, the following points are also outlined for compliance:

- (i) Speed Limit: Speed limit within the Dankuni is 25 kmph except around the process area where the speed limit is 20 kmph. In any case, vehicle drivers should take cognizance of road, weather and vehicle condition and adjust their driving accordingly. All vehicles must be mechanically sound and have an efficient exhaust with approved spark / flame arrestor, silencer, horn, breakers and fuel cap.
- (ii) Parking: Park vehicles only in approved area. Vehicles must be parked in such manner that they will not move while unattended. As a general rule, vehicles should not be parked at road bends; in front of fire equipment sheds and firefighting equipment thereby blocking access to them.
- (iii) No vehicles should enter into any operating area without valid fire permit followed by a safety clearance from the area-in-charge (this includes process areas, tank farms and loading racks).
- (iv) Vehicles driven inside the Dankuni premises should have effective brakes horns, lights, mufflers, flame arrestors etc.
- (v) Vehicles shall carry only the number of passengers or weight of load it is authorized to carry as per law. Loads carried in trucks shall be properly secured so that they will not accidentally fall off while vehicle is in motion.
- (vi) Tractors and trucks should not be used for transporting personnel.
- (vii) Vehicle drivers shall always check overhead and side clearance while driving vehicles.
- (viii) Any kind of repair work on BOO OPERATOR's vehicle is not allowed inside the Battery area.
- (ix) BOO OPERATORS shall prominently display the name of their company on all the vehicles including tractor trolleys, trucks, open jeeps, cranes which are allowed by the Engineer-in-charge to enter inside the Dankuni for carrying out the job. The display board shall be put on front and rear side of each of the vehicle.
- (x) Hand cart, tractor-trolley etc should also bear the name of BOO OPERATOR clearly.
- (xi) Only open type of vehicles like jeep etc are allowed inside the Dankuni having fitted with approved spark arrestor.

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2.19 Use of Heavy Equipment:

2.19.1 If hoists, cranes, derrick, mixer machine, pumps etc. are used by BOO OPERATOR, the following are to be ensured by BOO OPERATOR and his workmen:

- Testing of crane for its capacity.
- Inspection & maintenance logs
- Crane operation logs
- Safety latch is provided on the hooks.
- The area is notified through display of Sign boards/ barricades
- Over head power cables is removed or kept at a safe distance.
- The exhaust of machines should have a proper flame arrester
- Carrying material by hydra inside Dankuni.
- No change of boom length beyond permissible limit.

2.20 Fire Protection Equipment:

2.20.1 The Dankuni will provide fire protection equipment wherever it is required. BOO OPERATOR personnel who are working on such jobs will be instructed by the concerned department about the operation of such standby fire protection equipment. In the event of an accidental fire, it is expected of such personnel to make efforts to extinguish the fire with the standby equipment made available and BOO OPERATOR personnel should immediately get in touch with any the Dankuni personnel available or break the nearest fire alarm point glass. In all cases, accidental fires shall be reported to the supervisor of the area concerned.

2.20.2 A work permit must be obtained prior to BOO OPERATOR personnel drawing water from the Dankuni fire water loop.

2.20.3 All efforts should be made by BOO OPERATOR personnel to prevent occurrence of any unwanted fire, Gasoline driven engines, trucks, tractors etc. shall not be filled with fuel while the motor is still running.

2.20.4 Gasoline, naphtha, benzene or toluene must not be used as a cleaning agency or solvent.



2.21 Report on Accidents:

2.21.1 All accidents such as personal injuries sustained by BOO OPERATOR personnel and damages to vehicle and property, no matter how slight they are, shall be immediately reported to the engineer-in-charge / RSM & Fire & Safety in writing. It is the responsibility of BOO OPERATOR to fulfill all legal formalities.

2.21.2 Medical treatment for injured BOO OPERATOR personnel will be entirely the responsibility of BOO OPERATORs. However, if required, emergency first aid treatment may be given by Dankuni hospital.

2.21.3 Any questions or doubts on the safety regulations enumerated in this tender or the generally accepted safety working practices may be clarified with the concerned department of safety section.

2.22 The following actions shall be taken by BOO OPERATOR and his employees/ workmen about bombs, unattended baggages / objects lining in secluded places in the plant:

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- 2.22.1 On noticing any bomb/ unattended baggage or object lying in the plant area, they should immediately inform the CISF control room.
- 2.22.2 They should not touch the object or try to open the baggage or fiddle with the wires or battery if found attached to the object.
- 2.22.3 They should move away to a safety distance of approximate 100 m without creating any panic.
- 2.22.4 In case of unattended baggage, they should help CISF personnel in identifying the claimant.
- 2.22.5 They should not move to the area unless clearance is given by security personnel.

2.23 Do's and Don'ts – Safety:

Do's and Don'ts in case of Bomb/ Unattended baggage's lying in secluded places in the plant:

Do's

- Do's on noticing any bomb or CISF unattended baggage, inform control room by quickest possible means. Move away from the bomb/ unattended baggage.
- Help security personnel in identifying unattended baggage.
- Move back to your place of work after clearance has been given.

Don'ts



- Do not touch the bomb/ unattended baggage.
- Do not lift any attended baggage.
- Do not go very close to the object.
- Do not create panic.
- Do not fiddle with wires or battery if found attached with any object.
- Do not open any unattended baggage.
- Do not try to defuse any bomb of explosive material.

3.0 PENALTIES IN CASE OF NON-COMPLIANCE TO SAFETY RULES AND REGULATIONS:

- 3.1 BOO OPERATOR has to follow all Safety, Health and Environment rules & regulations of the Dankuni. In case of non-compliance of any of these rules and regulations by BOO OPERATOR or his employees, BOO OPERATOR shall be held responsible. If any violation or non-fulfillment of these Safety, Health and Environment rules and regulation is observed by Dankuni authorities during checking at any time, a penalty of Rs. 5000.00 (Rs. Five Thousand Only) shall be imposed on BOO OPERATOR for each occasion of non-compliance to these rules and regulations by him or his employees. The decision of Dankuni authorities shall be final and binding on to BOO OPERATOR in this regard. The amount of penalties so imposed shall be recovered from the next R.A. Bill of the work or any other dues payable to BOO OPERATOR by Dankuni.

4.0 COMPENSATION IN CASE OF ACCIDENTS:

In case of any accidents/injury of a BOO OPERATOR's workmen, BOO OPERATOR shall pay a suitable compensation (subjected to the minimum compensation as mentioned below) to the affected person / his family members in the presence of Engineer-in-charge and in

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consultation with Chief Medical Officer of the Dankuni. The said compensation shall depend on the seriousness of injury, etc, and shall be in addition to the hospitalization /treatment charges and Group Insurance Amount payable to the effected person. The following are the minimum compensation shall be paid to the affected person / his family as stated above:



- 4.1 In case of fatal accidents: Rs. One Lakh within 5 days of accident.
- 4.2 In case of loss of both the limbs (hand/legs/eyes/ears): Rs.50,000/- (Rs. Fifty Thousand) within 1 week.
- 4.3 In case of loss of one limb (hand / legs/eyes/ ears): Rs.25,000/- (Rs. Twenty Five Thousand) within 1 week.
- 4.4 In case of any injury not specified above, Rs.1000/- (Rs. One Thousand) to Rs.5000/- (Rs. Five Thousand) as directed by Engineer-in-charge within 1week

5.0 EMERGENCY RESPONSE PLAN:

- 5.1 BOO OPERATOR has to adhere and respond to the on-site emergency plan and co-ordinate with the site main controller of Pardip Dankuni.
- 5.2 BOO OPERATOR personnel shall stop their work and proceed to a safe area in the event an emergency arises in the area where they are working like, in case of fire, oil spillage, power failure etc. Before re-commencement of the job they should obtain clearance of supervisor of area involved.
- 5.3 In view of the hazards associated with Hydrocarbon processing, on site emergency plan has been prepared in the event of major accident occurring on site. The plan envisages handling emergency situation, which shall be communicated through siren, based on nature of emergency as mentioned below.
- 5.4 In case of major emergency, it is the responsibility of BOO OPERATOR to headcount his personnel and take them out with the help of concerned CIL Co-ordinator. BOO OPERATOR must confirm the safe evacuation of his personnel to CIL Coordinator. In case of any missing person, it must be brought into the notice of CIL Dankuni authorities immediately.

TYPES OF COMMUNICATION, IN CASE OF EMERGENCY

TYPE OF EMERGENCY	SIREN
Air Raid Warning	Siren for two minutes on a wailing note or intermittent blasts each for 4 sec. duration followed by 4 sec. silence.
All clear or Raiders Passed Warning	Continuous siren for 2 min. at steady pitch
Small fire	No siren
Major fire	Wailing type siren: 3 min. for 30 sec. with an interval of 15 sec. in between (Total Duration: 2 min.)
Disaster	Same type of siren as in the case of major fire except that it will be sounded three times at an interval of two minutes.
All clear	Straight siren for two minutes.
Siren testing	Straight siren for two minutes (daily at

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	0815 hrs). First Monday of every month, all sirens will be tested in all the modes.
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5.5 Evacuation and Sheltering:

In case of emergency/major accident or disaster, Muster points shall be identified for assembling of people for head counting /transportation to a safe place. BOO OPERATOR site-in-charge shall co-ordinate with Site Main Controller for sheltering and evacuation and advise his workmen to rush to the identified locations of muster points.

6.0 ENVIRONMENTAL MANAGEMENT SYSTEM:

- 6.1** BOO OPERATOR shall inculcate environmental awareness among their workmen/personnel and strive for enhancement of systems and skills for minimizing the environmental impact out of their activities/ services.
- 6.2** BOO OPERATOR shall avoid wastage of water, compressed Air and Steam supplied to them from owner's source of supply for execution of the job and closes the supply valves properly while not in a use.
- 6.3** BOO OPERATOR shall ensure that while carrying out Modification/ Repair/ Replacement jobs of any equipment of pipeline, the spillage of Hydrocarbon Oily sludge etc. are cleaned and routed to nearby OWS, at regular interval as well as after completion of jobs. BOO OPERATOR must ensure that the spillage of hydro-carbon oily sludge etc. is not drained in Storm water channel or open channel.
- 6.4** Before attending any blinding/ de-blinding jobs, all tools, tackles and spares shall be kept ready at site in order to minimize Hydrocarbon spillage.
- 6.5** BOO OPERATOR shall clear and level the job-site and remove all metallic and non-metallic surplus materials, scrap and other waste materials generated out of his job, from time to time as well as after completion of job to a specific location as per Engineer-in-charge.
- 6.6** BOO OPERATOR shall ensure to avoid idle running of all electrical equipments e.g. welding machines etc. used for execution of the job.
- 6.7** BOO OPERATOR's vehicles, trucks, tractor, cranes and other portable equipments. Air Compressor, DG Set, Dewatering pumps etc. used inside Dankuni premises (where Hydrocarbon is used as fuel) for execution of the job must be mechanically sound and have an approved spark arrester and have exhaust complying pollution norms. Idle running of those vehicles and equipments shall be avoided.



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SECTION – 1.15

QUALITY ASSURANCE PLAN

**PROJECT: COAL TO METHANOL (C2M) PROJECT
THROUGH COAL GASIFICATION ROUTE AT
DANKUNI COAL COMPLEX WEST BENGAL,
INDIA ON BUILD-OWN-OPERATE (BOO) BASIS**

	QUALITY ASSURANCE PLAN COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO)	PC176/E/4001/P- II/ SEC-1.15	0	
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	QUALITY ASSURANCE PLAN COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA ON BUILD-OWN-OPERATE (BOO)	PC176/E/4001/P- II/ SEC-1.15	0	
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All work/services to be performed by BOO OPERATOR under this contract shall be of specified/approved quality and BOO OPERATOR shall have a QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) system during the performance of various activities such as engineering, procurement, tendering, construction etc. Review of the activities by CIL/PMC shall not however, dilute the responsibility of BOO OPERATOR for maintaining quality.

1.1 QA/QC Procedure:

BOO OPERATOR shall submit the QA/QC Procedure to be adopted for the engineering procurement and construction activities of the PLANT for review to CIL/PMC. The QA/QC procedure shall cover all activities to be performed by BOO OPERATOR/Contract/Vendors. Some of the important activities & procedures to be evolved are listed below:

- a) General Document control:
 - Coordination
 - Non-conformance report of sub-Bidders.
 - Output identification and traceability
 - QA system review
- b) Residual Basic Engineering:
 - Residual Basic Engineering & detail engineering performing, checking, review and approval.
 - Drafting - performing, checking, review & approval.
 - Engineering for procurement.
- c) Procurement / Inspection; Incoming material control Welding qualification and repair:
 - Manufacturing/fabrication process control.
 - Applicable non-destructive examination.
 - Coating/lining.
 - Preservation.
 - Post-weld heat treatment wherever applicable Packaging and dispatch control
 - Transportation
 - Inspection/Test plans for all specific and mandatory tests (as per drawings and codes) with clear indication of Witness, Verification and Hold points.
- d) Construction Pre-construction activities viz., incoming material all control receipt control etc. Job construction, Welding qualification and repair Inspection/Test Plans for all specified and tests (as per drawing & codes).with clear indication of witness, Verification and Hold points.

BOO OPERATOR shall prepare Construction QA Plans for review of the PMC/CIL & the same shall cover as minimum the areas as under, and shall confirm their compliance to approved codes/standards/specifications, etc. Site preparation Tie-ins Buildings and structures Incorporation of all witness tests/hold points of the construction work Clean-up testing Instrumentation installation and construction. As a part of Construction & Quality Assurance BOO OPERATOR shall also comply with the following activities:

- Stage wise inspection of quality of work as per approved QA plan and contract specifications.

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- Develop welding procedures and welders qualification procedures for their work.
- Ensure compliance of various statutory rules, regulations and safety measures and to arrange and co-ordinate site inspection, testing etc. as required under local- statutory rules and regulations prevalent in India.
- Take all necessary precautions to protect construction work and material from damage by climate, outside elements and construction activities.
- Ensure that materials used are in accordance with the drawings and Project specification.
- Review safety procedures prepared by BOO OPERATOR for compliance with applicable codes, regulations and CIL requirements.
- Prepare schemes for heavy/critical equipment's erection/lifts/rigging before and submit the same for PMC review.
- Ensure alignment (hot/cold) of all critical rotary equipment/machinery and their up-keep/ maintenance as per supplier's recommendations.
- Perform house-keeping activities which include maintaining sanitary facilities, sweeping clean-up, removal of excess materials/temporary facilities, scaffolding, as necessary.
- Conduct periodic Quality/Technical Audits for ensuring quality and conformance with the Contract.
- To take immediate appropriate corrective actions as & when such discrepancy arises to fulfill quality, safety obligations. i) All inspection and Test Plans are required to be submitted for finalization and approval' to PMC immediately after award of contract.

The QA/QC Procedure shall also include Quality Plans, mostly in tabular formats defining the specific quality practices and flow of every identifiable activity of a discipline. All disciplines concerned with the performance of work are to be covered. These quality Plans should indicate the following

1.2 For Design and Engineering:

Activity description Preparation, checking, review and approval requirements Code of conformance (applicable standard specification number) Applicable procedure number Q A. data/records produced.

1.2 For Procurement & Construction:

- Activity description Procedure number/Inspection and Test Plan number Conformance Code Testing and Inspection Code.

The QA/QC Procedure together with Quality Plans will be discussed during kick-off meeting and Hold, Witness and Verification points and PMC / CIL / Licensor review/audit requirements will be finalized between BOO OPERATOR and PMC / CIL.

2.0 IMPLEMENTATION:

During the performance of the contract, BOO OPERATOR shall:

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Implement approved Quality Assurance programme including but not limited to:

- 2.1** Performance of internal quality audits, preparation of audit reports and submission for review of PMC. BOO OPERATOR shall evolve a comprehensive system of planned and documented audit to verify whether various performed activities comply with detailed procedures, specifications, guidelines etc. and to determine the effectiveness of QUALITY SYSTEM. Scope of such internal audits shall be furnished to PMC for review. Verification documents shall be generated during audit and submitted periodically to PMC for review. Throughout all stages of the scope of contract, BOO OPERATORs procedures, documents, activities, products & services and those of his sub-bidder's shall be subject to CIL/PMC Review / approval. Such surveillance and audit are optional and shall not relieve BOO OPERATOR of his contractual obligations and liabilities.
- Generation of Q. A. records (mostly inspection and test plans) as per Quality Plan and submission for review by PMC/CIL. BOO OPERATOR shall submit all quality records (generated during activity execution) and audit results on well laid formats/performance for CIL/PMC- review. The rights of such review are reserved by CIL/PMC. CIL/PMC may review it in full, parts or selectively. However, complete correctness of the Q. A. records shall be the sole responsibility of BOO OPERATOR irrespective of its review by CIL/PMC.
- 2.2** Facilitate CIL/PMC in the quality audit at works.
- 2.3** Certify "QA Programme" documents of BOO OPERATORs and submit to CIL/PMC- for review.
- 2.4** Carry out audits/inspection at BOO OPERATORs works as per approved Q. A. programme and submit the reports for review by CIL/PMC.
- 2.5** Get similar Q. A. System implemented at his Sub-Bidder's works/office. Q .A. records from BOO OPERATOR shall be reviewed and certified for compliance by BOO OPERATOR before submitting to CIL/PMC for information.
- 2.6** Carry-out audits at BOO OPERATORs' office/works and submit the report to CIL/PMC for information.
- 2.7** Ensure that all personnel shall be assigned tasks commensurate with their qualification. Specialized workmen shall be qualified and certified.
- 2.8** Handle non-conformance brought out by internal and external sources as follows:
- Non Conformance Handling (Internal sources):
Non-conformance brought out by BOO OPERATOR's own review/audit shall be resolved by BOO OPERATOR himself. One level higher than those responsible to carry-out the activity shall resolve the non-conformance. Such resolution shall be in full knowledge of Departmental Manager. Corrective action shall be initiated at the earliest. Report of such resolution shall be submitted to CIL/PMC for information.
 - Non Conformance Handling (External sources):
Non-conformance brought out by CIL/PMC through any of the following shall be resolved by BOO OPERATOR. Such corrective actions shall be submitted to CIL/PMC for review. However, corrective action shall be initiated at the earliest.
 - Technical Reviews
 - Q. A. Review & Surveillance

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- Inspection
- External Audit (CIL/PMC)

2.9 Glossary of Terms used in the Section:

i) Hold Point:

A Point designed by CIL/PMC/BOO OPERATOR in the approved Quality Plan submitted by BOO OPERATOR in the kick-off meeting which requires inspection/verification and acceptance by CIL/PMC before any further progressing is permitted. BOO OPERATOR shall not process the activity/ item beyond a hold point without written approval by CIL/PMC/BOO OPERATOR except where prior written permission for further processing is available.

ii) Witness Point:

An activity designated by CIL/PMC/BOO OPERATOR which requires witnessing by CIL/PMC/Licensors as the activity is performed. After proper notification has been provided (notification modalities and period shall be finalized in kick-off meeting) BOO OPERATOR is not obliged to hold further processing if CIL/PMC/Licensors is not available to witness the activity or does not provide comments before the date notified. Basis of acceptance shall be as per relevant technical specification.

iii) Verification Point:

Point where CIL/PMC/Licensors Plans to audit, monitor or witness in-process activity. BOO OPERATOR is not obliged to provide any advance written notification of these points. Basis of acceptance shall be as per relevant technical specification.

iv) Quality Surveillance:

Monitoring or making observations to verify whether or not material/items or services conform to specified requirements. Surveillance activities may include audit, inspections, witness of testing, review of Quality documentation, personnel qualifications etc.

v) Q. A. Records Documents which demonstrate achievement of required quality and verify effective operation of Quality System, viz.

- Inspection reports
- Test data/Inspection
- Test Plans
- Qualification reports
- Validation reports
- Audit report
- Material review reports
- Calibration data

vi) Quality Audit:

A systematic examination of the acts and decisions by people with respect to quality in order to independently verify or evaluate and report degree of compliance to the operational requirement of the quality programme, or the specifications or contract requirements of the product or service.

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3.0 CONSTRUCTION EQUIPMENT:

BOO OPERATOR is required to organize and mobilize the construction equipment and other tools tackles in a sequential manner to ensure that plant installation is carried out in a mechanized manner and its mechanical completion is achieved within targeted time schedule. BOO OPERATOR shall without prejudice to his responsibility to execute and complete the work strictly as per the specifications and other laid down procedures by mechanizing the construction activities to the maximum extent by deploying all necessary construction equipment/ machinery of adequate capacities and numbers. For this purpose, BOO OPERATOR shall deploy a Rigging team headed by a Rigging foreman reporting to Area Engineer responsible for equipment erection. Area Engineer should be well conversant with various erection techniques and shall be responsible for preparing erection schemes in accordance with the approved procedures and based on crane manuals suiting to plan layout. Area Engineer will have to foresee various other constructive activities in the surroundings while planning erection schedules including safety aspects of man and machinery also. BOO OPERATOR will prepare erection schedule based on the overall project schedule of the Plant in phased manner with erection schemes of various equipments, vessels and submit to CIL/PMC for approval, Monitoring and control of erection schedule and erection activities will be carried out as per the approved construction procedures. or efficient working and maintenance of construction aids, BOO OPERATOR shall establish and maintain crane Yard/workshop equipped with regular maintenance facility for various construction aids for carrying out routine field maintenance during performance for the contract. Temporary approach road, wherever required for the movement of the Crane and other vehicles for equipment erection and transportation of material shall be properly planned and be made by BOO OPERATOR for quick mobilization of the transportation system. The proper padding for the crane movement shall be done to avoid any delays of erection schedule. Weekly/fortnightly maintenances shall be planned in such a way that it should not hamper the erection schedule BOO OPERATOR shall ensure the timely augmentation of the Plant, equipment and machinery depend upon the exigencies of the requirement to meet the overall project schedule. During performances of the work, BOO OPERATOR to ensure to keep structures, materials or equipment is adequately braced by Guys, Struts or otherwise approved means which shall be supplied and installed by BOO OPERATORS as required till the erection works is satisfactorily completed. Such guys, shoring, bracing, strutting, planking supports etc. shall not interfere with the work of other agencies and shall not damage or cause distortion to other works executed by him or other agencies. BOO OPERATOR to submit the construction equipment schedule along with the bid. A specimen of the same is enclosed herewith.

SI.No	ACTIVITY DESCRIPTION	DURATION IN MONTHS													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
A.	TEMPORARY WORKS														
1	SITE OFFICE & MOBILISATION														
2	CONSTRUCTION POWER-DG SET														
B	CIVIL WORKS														

1																				
2																				
3																				
C	MECHNICAL EQUIPMENT																			
1																				
2																				
3																				
D	PIPING																			
1																				
2																				
3																				
E	ELECTRICAL/ INSTRUMENTATION																			
1																				
2																				
3																				
F	INSULATION/ PAINTING																			
1																				
2																				
3																				
G	MISC																			
1																				
2																				
3																				

Note: May be corrected suiting to job requirement.

4.0 CONSTRUCTION MAN POWER:

BOO OPERATOR is required to organize and mobilize construction staff in a sequential manner to ensure that Plant installation is carried out in accordance with the S curve defined

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with other chapter of the Bid package. Mobilization of construction staff should be such that "S" curve based on the time schedule and progress achieved in the phased manner should match with the overall project time schedule. For this purpose, BOO OPERATOR shall clearly indicate in his construction methodology that work shall be done departmentally or by engaging such sub-bidder or the combination of both. BOO OPERATOR will prepare detailed methodology for the work to be carried out departmental as well as by Sub-Bidder clearly defining the scope and responsibility of main BOO OPERATOR and Sub-Bidder.

BOO OPERATOR proposes to engage Sub-Bidder for the erection of various activities, he must enter into an agreement of Memorandum of Understanding and same shall be furnished along with their credential with the bid. Sub-Bidder's credential will be evaluated along with the offer. BOO OPERATOR shall not be permitted to change the Sub-Bidder after the award of work under any circumstances. Non-compliances of the above will be strictly dealt with relevant provision(s) of the contract. During the execution of works at site, if the principal BOO OPERATOR engages Sub-Bidders for execution of works at site as per approval obtained from CIL/PMC in line with contract provision(s) and in the event Sub-Bidder complains in writing to CIL with regard to the non-payment of their dues from the principal BOO OPERATOR for the works executed by them and site (excluding final payments and payments due after termination of Sub-Bidders' services by the main BOO OPERATOR), CIL reserves their right to make such payment to the Sub-Bidders based on approved measurement with due notice to the principal BOO OPERATOR. CIL shall release such payments to Sub-Bidder at the cost and risk of the main BOO OPERATOR in order to ensure smart execution of work at site. The above such payment made by CIL to the Sub-Bidder shall be adjusted in the running account bills or any other payment due to the concerned principal BOO OPERATOR. BOO OPERATOR to submit the construction manpower schedule as per the specimen enclosed. All Sub-Bidders will be managed by the main BOO OPERATOR construction staff who will perform the duties of construction management and will administer, co-ordinate, and inspect the work of the sub-Bidder and be responsible for the Quality. BOO OPERATOR will establish the pre-requisite for successful construction of sub-Bidder work. However, by deploying the sub-Bidder(s) as approved by CIL/PMC for any discipline does not absolve the principal BOO OPERATOR for his total responsibility under the subject contract. BOO OPERATOR to ensure that in case of Sub-contract failure to execute the works as per standards/specifications/drawings and negligence & disobedience in carrying out any order or instruction of CIL/PMC will be viewed very seriously & dealt with appropriately in accordance with provision(s) of the contract. BOO OPERATOR to submit the construction manpower schedule along with the bid.

5.0 QUALITY ASSURANCE SYSTEM AND INSPECTION REQUIREMENTS FOR BOUGHT OUT ITEMS & DURING CONSTRUCTION:

5.1 Quality Assurance System:

Contractors are required to follow a well-documented quality assurance and quality control system covering all phases of project viz. design/engineering, procurement, installation, testing and commissioning. TEIL typical specification "Specification for Turnkey BOO OPERATOR's Quality Assurance System" is attached with the bid package to provide necessary guidelines to contractors in this respect and contractor shall have to demonstrate that the project shall be executed by following an acceptable QA/QC system.

5.2 Inspection Co-ordination Methodology:

Contractors are required to develop their own resources for inspection of all bought-out items supported by third party inspection services for specific cases. A typical inspection co-ordination write-up defining PMC's involvement during inspection of various equipment is enclosed herewith.

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5.3 Inspection Requirement during construction:

Considering that the day to day supervision of construction activities is the responsibility of the turnkey contractor, CIL/PMC's role during construction phase is for quality surveillance. Typical write-up on inspection requirements during construction phase is attached herewith. The contractor is required to follow and comply with the above requirements during the bidding and contract execution stage.

5.4 Specification for BOO OPERATOR's Quality Assurance System:

5.4.1 Introduction:

This specification establishes the Quality Assurance requirements to be met by BOO OPERATOR during execution of CONTRACTED SERVICES. In case of any conflict between the requirements of this specification and other documents such as technical specifications, contract conditions etc. the Contractor shall notify PMC/CIL of all such conflicts for final resolution.

5.4.2 Scope of Work by BOO OPERATOR:

Prior to the award of contract: The following documents shall be submitted along with the bid for evaluation:

5.4.3 Quality Policy, Quality Objective & Company Quality Manual (Apex Document) Project Quality Plans (Tentative). After the award of contract: Within 4 weeks after the award of the Contract the Contractor shall participate in the pre-start meeting with PMC /CIL to finalize "Project Quality Plans" as regards to the following:

- Standard practices specified by the contractor.
- Hold, Witness and Verification point.
- PMC/ CIL's review/ audit requirements.

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VOLUME-II: TECHNICAL

SECTION – 1.16

DRAWINGS AND DOCUMENTS

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA

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	DRAWINGS AND DOCUMENTS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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1.0	Drawings And Documents	3
2.0	Category Of Documents	4

	DRAWINGS AND DOCUMENTS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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1.0 DRAWINGS AND DOCUMENTS

This chapter details out various drawings and documents to be generated at various stages during the course of execution of the Project by BOO OPERATOR for different project activities. Categorization of the documents / drawings for review / information / records of PMC and the review requirements of CIL/ PMC along with routing of the documents / drawings will be conveyed separately as a philosophy.

Drawings and documents to be prepared by BOO OPERATOR under the contract is the key to the timely completion of the plant. BOO OPERATOR to ensure that all drawings and documents to be submitted by him to CIL and/or PMC shall be of professional quality and conforming to the contractual requirements. BOO OPERATOR also undertakes to institute a formal drawing control system which will be documented and submitted to CIL/PMC for review or approval.

The drawings / documents are generated by BOO OPERATOR at various stages of the project covering different activities. The drawings / documents generated will be in the category of Approval/review/information. The drawings and documents required with bid and after order are given below. The categorisation for the Drawings/docs will be informed separately. However, this will in no way relieve BOO OPERATOR of responsibility to conform to drawings, standards, specification, codes and contractual requirements / obligations.

BOO OPERATOR shall prepare the drawing numbering procedure and submit to CIL/PMC for review. Each Drawing submitted by BOO OPERATOR shall be clearly marked with the name of CIL, PMC with revision number & date. It should contain the minimum following details:

1. Size of Drawing.
2. Discipline of Engineering for which the drawing is issued.
3. Discipline wise segregation of numbering sequence.

BOO OPERATOR to note that the number corresponds to Methanol plant and shall be prefixed to all related documents/deliverables which shall be indicated to successful BOO OPERATOR. For drafting of Drawings Computer aided design and drafting, AutoCAD shall be used. Further, standard, approved and well established P.C. based computer programmes/software packages, available in market shall only be used by BOO OPERATOR/his sub-bidders/vendors etc. BOO OPERATOR shall bring out the list of all such packages in the offer for each discipline for evaluation of bid. Every time a computer aided design is submitted for review/ approval to CIL/PMC, it shall accompany with input/output data on Compact disc (CD) along with the name of the software package and operable on any system along with the requisite No. of Hard Copies.

For drawing, data sheet and all graphic works AUTOCAD release 14 and for all texts, MS Word Package 2013 or above shall only be used. Soft Copies of all calculations & Drawings shall be made available by BOO OPERATOR for PMC review/records. Line List, Data Sheet & spread sheets shall be provided in MS Excel & all text items shall be in MS Word.

The review by the PMC/CIL shall not be construed by BOO OPERATOR, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and drawings.

Each drawing submitted by BOO OPERATOR shall be clearly marked with the name of the OWNER, the unit designation, the specifications, title, the specification number and the

	DRAWINGS AND DOCUMENTS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INDA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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name of the Project with revision No. and date. If standards catalogue pages are submitted the applicable items shall be indicated therein. All titles, noting, -markings and writings on the drawings shall be in English. All the dimensions should be in metric units. Upon receiving comments on Drawings and Documents by BOO OPERATOR, the subsequent submission should give compliance report, separately on each of the comments, document-wise. Comments given by PMC/CIL to be discussed and finalized within agreed schedule.

The schedule of submission of the Drawings and Documents shall be in accordance with project plans only. The detailed list under different category, document-wise, shall be prepared by BOO OPERATOR for approval of CIL/PMC. This activity is to be completed within one month of Fax of Intent.

Sequence of submission of drawing is essential for proper review of documents and timely completion of the project is to be adhered. In case sequence is not maintained, the documents submitted will not be reviewed by CIL/PMC and responsibility of timely execution of plant shall be to BOO OPERATOR's accounts.

2.0 CATEGORY OF DOCUMENTS:

Sl.No	Category	Action by CIL/PMC
1	Records/ Information	BOO OPERATOR can continue to progress with the work. This drawings or documents will be retained with CIL/PMC for information only. CIL/PMC reserves the right to advise BOO OPERATOR of any comments at any time and BOO OPERATOR is liable to respond to satisfy that the work being done is in accordance with the contract; deviations, if any will be BOO OPERATOR's risk and cost.
2.0	Review	CIL/ PMC will review and advise BOO OPERATOR of any comments on BOO OPERATOR's Drawings/ Documents within specified schedule (i.e, 2 weeks), from date of receipt in PMC office. The review period is defined as date of receipt of documents by PMC, to date of issue of comments by PMC. This review period shall be valid only if submission of drawings is done by BOO OPERATOR in accordance with approved drawings/ documents schedule as indicated in ITB. In case of any non-conformity to the above by BOO OPERATOR due to which the period of review extends beyond 2 weeks by PMC, Schedule delay, if any will have to be absorbed by BOO OPERATOR.

The documents falling under Review category will be returned with comments within specified time schedules subject to fulfilling other conditions enumerated. The information category document will be retained for information only but however CIL/PMC reserves the right to comment at any stage of the Project, but not later than two weeks of receipt.

2.1 As-Built Drawings:

BOO OPERATOR will furnish reproducible and electronic files of all the drawings under their scope to CIL / PMC, certified as "As-Built Issue" by Third Party Inspection Agency (TPIA) for Vendor Items coming under Third Party Inspection / BOO OPERATOR for all other drawings.

Upon completion of identifiable units or components of the fabrication, construction and installation phase of the project BOO OPERATOR will complete all the related plans to the "as built" stage including all Vendor drawings and furnish CIL/PMC with the following:

	DRAWINGS AND DOCUMENTS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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One complete set of all original tracings/ copies.

- a) One complete set of reduced size (A3-297x420 mm) reproducible copies of all drawings.
- b) One set of floppies for all documents/drawings/data.
- c) All the as built drawings duly certified should be scanned and converted into electronic files made on magnetic/discs/optical long storage. All other project documents such as operating and maintenance manuals, manufacturers' Catalogues etc. shall also be scanned on magnetic/optical discs for safe storage and retrievals by CIL when needed. 15 complete sets of full size prints of the drawings and 4 sets of reduced size prints.
- d) 6 complete bound sets of Manufacturer's specifications .
- e) 6 complete sets in hard binders of the Manufacturers data book including certified prints and data for all items including test reports. Data Books shall be complete with index as tag numbers associated with Manufacturer's data shown. Equipment data shall include as a minimum requirement the principal and description of operation, drawings and dimensions, spare parts lists and unpriced purchase orders and bill of material.
- f) 6 bound copies each of the Spare Parts data books and the Lubricants inventory Schedule.
- g) 6 complete sets of field records shall be signed by both BOO OPERATOR's and CIL's Representative at the site.
- h) Original approvals and related drawings and documents from the statutory authority.
- i) Copies of correspondence with the statutory authorities.

Sl. No	Description	With Bid	After Job Award			Remarks
			For Review	For Information	For Record	
1	Process Flow diagram with heat & material balance, identifying all equipment	√ *	√		√	*Without Material Balance
2	P & ID with interlock and logic diagram and write-up		√		√	
3	Equipment Specification	√ *		√	√	*Indicating Type, Broad dimensions, capacity, duty, MOC etc
4	A write-up explaining the configured plant and how various demands will be	√	√		√	

	DRAWINGS AND DOCUMENTS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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	met by BOO OPERATOR					
5	Data sheet for equipments		√		√	
6	Flare Load summary	√	√		√	
7	Confirmed utility (both normal and peak consumption figures)	√	√		√	
8	Interface Engineering Data		√		√	
9	Report on HAZOP study		√		√	
10	Instrument data sheets		√		√	
11	Control Philosophy		√		√	
12	Line Schedule		√		√	
13	Tie-In List	√	√		√	

Note:

BOO OPERATOR to note that all final drawings and documents including installation, operation and Maintenance manuals for all disciplines, viz., Process, Mechanical, Electrical, Instrumentation, General Civil, Structural, Architectural, Rotating, Static, Heat and Mass Transfer, Environmental etc covering all equipment/ item for the entire plant shall be furnished in triplicate in hard copy and also 3 sets of soft copies for CIL's record, after the commissioning of the plant or before. The above also includes all inspection and test records, FATs, Performance Test Records, Material test Certificates, Characteristic curves, Catalogues, Nomographs etc.

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SECTION – 1.17

INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA

0	24.09.2020	24.09.2020	Issued for Tender Purpose	SK	SKK	MN
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD



	INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INDIA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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8.0	List of On-Line Analyzers	9
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LIST OF ATTACHMENT

Attachment Number	Description	Number of Sheets

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1.0 PLANT DATA:

1.1 COAL GASSIFICATION PLANT:

1.1.1 PRODUCT METHANOL SYN GAS:



Sl. No.	Description	Units	At 100% capacity	At 110 % capacity	At 50% capacity
i	Capacity	Nm ³ /hr of Methanol Syn. Gas			
ii	Plant Turn-down ratio	%			
iii	Product Methanol Syn Gas				
	Hydrogen (H ₂) (66-67)	Vol. %, (min.),			
	Carbon Monoxide (CO) (31-32)	Vol % (min)			
	Argon (Ar), (0.5-0.75)	PPv(max)			
	Mercury (Hg), (Nil)	PPMv (max.)			
	N ₂ +Ar (<1.5)	PPMv			
	Pressure ____ (Min.)	Kg/Cm ² abs			
	Temperature ____ (Max.)	°C			
	Quantity of Methanol Syn. gas	Nm ³ /MT of Feed Coal			

1.1.2 CARBON DI-OXIDE GAS:

Sl. No.	Description	Units	At 100% capacity	At 110 % capacity	At 50% capacity
i	Capacity (Note:1)	Nm ³ /hr of CO ₂			
ii	Plant Turn-down ratio	%			
iii	Carbon di-oxide Gas (Dry)				
	Carbon dioxide (CO ₂),	Vol % (min).			
	Other Components,	Vol. %			
	Pressure ____ (min.)	Kg/Cm ² abs			
	Temperature ____ (max.)	°C			

1.1.3 BY-PRODUCT SULPHUR:



Sl. No.	Description	Value	Units	At 100% capacity	At 110% capacity	At 50 % capacity
i	Capacity		TPH of Sulphur (Solid)			
ii	Plant Turn-down ratio		%			
iii	Sulphur (Solid)	99.9	Wt. %(min, dry)			
	Hydrogen Sulphide	10	Wt.ppm(max, dry)			

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	(H2S)					
	Ash	200	Wt.ppm (max)			
	Colour	Bright Yellow	-			
	Physical Appearance		-			
	Pressure	Not Relevant	Kg/cm ² a			
	Temperature	Ambient	OC			

1.1.4 BY-PRODUCT FLYASH/ SLAG/SLAGFINES:



Sl. No.	Description	Value	Units	At 100% capacity	At 110% capacity	At 50 % capacity
i	Capacity	(To be specified by BOO OPERATOR)	TPH of Ash/ Slag			
ii	Flyash	(To be specified by BOO OPERATOR)	Wt. %			
	Moisture (H2O)	(To be specified by BOO OPERATOR)	Wt. %			
	Pressure	Atmospheric	Kg/Cm2abs			
	Temperature	<80	OC			
	Physical appearance	(To be specified by BOO OPERATOR)	Wt.%			
iii	Slag	(To be specified by BOO OPERATOR)				
	Moisture (H2O)	(To be specified by BOO OPERATOR)	Wt.%			
	Pressure	Atmospheric	Kg/Cm2abs			
	Temperature	<80	OC			
	Physical appearance	(To be specified by BOO OPERATOR)	Wt. %			
iv	Slagfines	(To be specified by BOO OPERATOR)				
	Moisture (H2O)	(To be specified by BOO OPERATOR)	Wt.%			
	Pressure	Atmospheric	Kg/Cm2abs			
	Temperature	<80	OC			
	Physical appearance	(To be specified by BOO OPERATOR)	Wt. %			

	INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INDIA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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1.2 METHANOL PLANT:

PRODUCT METHANOL (GRADE-AA):

Sl. No.	Description	Units	At 100% capacity	At 110 % capacity	At 50% capacity
i	Capacity	MT/hr of Methanol			
ii	Plant Turn-down ratio	%			
iii	Product Methanol				
	Methanol (99.85 / AA)	wt% (min.)			
	Water, (0.1)	wt% (max.)			
	Acetone & Aldehyds, (0.003)	wt% (max.)			
	Acetone, (0.002)	wt% (max.)			
	Acidity (as acetic acid), (0.003)	wt% (max.)			
	Appearance (Free of opalescence, suspended matter, and sediment)	----			
	Carbonizable impurities, colour.pt.co max. (No. 30 of ASTM D1209)				
	Colour, Pt-co maximum (No.5 of ASTM D1209)				
	Distillation ranges at 760mm Hg, max (10.0 °C (and shall include 64.6 °C ±0.1 °C)				
	Ethanol, (0.001)	wt% (max.)			
	Nonvolatile matter, (10)	mg per 100ml maxi.			
	Odor (Characteristic. Non-residual)				
	Permanganate time (No discharge of colour in 50 min.)				
	Specific gravity at 20 ^o / 20 ^o C, maximum (0.7928)				
	Alkalinity (as ammonal), (0.003)	wt% (max.)			
	Pressure @ B.L of Methanol Plant, (BOO Operator to decide)	kg/cm ² a (Min.)			
	Temperature, (41 Max.)	°C (max.)			
	Quantity of Methanol Syn. Gas ()	MT/MT of Feed Coal			

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2.0 RAW MATERIAL & UTILITY CONSUMPTION:

Gasification Plant

Sl. No.	Raw Material & Utility	Units	Plant Capacity		
			50%	100 %	110 %
1.	Coal	MT/hr			
2.	Fluxant	MT/hr			
3.	DM Water	M ³ /hr			
4.	Condensate (Steam/ Process) export	M ³ /hr			
5.	Condensate (Turbine) export	M ³ /hr			
6.	Net import of HP steam	MT/hr			
7.	HP/MP/LP Steam Export	MT/hr			
8.	Power Consumption	KW/hr			
9.	Cooling water circulation	M ³ /hr			
10.	Cooling water Make-up	M ³ /hr			
11.	Make-up water for Ash and slag(if any)	M ³ /hr			
12.	Service water requirement	M ³ /hr			
13.	Drinking Water	M ³ /hr			
14.	Fire water	M ³ /hr			
15.	Fuel gas	Nm ³ /hr			
16.	Instrument Air	Nm ³ /hr			
17.	Plant Air	Nm ³ /hr			

Methanol Plant

Sl. No.	Raw Material & Utility	Units	Plant Capacity		
			50%	100 %	110 %
1.	Methanol Syn. Gas	MT/hr			
2.	DM Water	M ³ /hr			
3.	Condensate (Steam/ Process) export	M ³ /hr			
4.	Condensate (Turbine) export	M ³ /hr			
5.	Net import of HP steam	MT/hr			
6.	HP/MP/LP Steam Export	MT/hr			
7.	Power Consumption	KW/hr			
8.	Cooling water circulation	M ³ /hr			
9.	Cooling water Make-up	M ³ /hr			
10.	Service water requirement	M ³ /hr			
11.	Drinking Water	M ³ /hr			
12.	Fire water	M ³ /hr			

	INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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13.	Fuel gas	Nm ³ /hr			
14.	Instrument Air	Nm ³ /hr			
15.	Plant Air	Nm ³ /hr			

Steam Generation Plant



Sl. No.	Raw Material & Utility	Units	Plant Capacity		
			50%	100 %	110 %
1.	Coal	MT/hr			
2.	Fluxant	MT/hr			
3.	DM Water	M ³ /hr			
4.	Power Consumption (Internal)	KW/hr			
5.	Steam Consumption (Internal)	MT/hr			
6.	Cooling water circulation (if any)	M ³ /hr			
7.	Cooling water Make-up (if any)	M ³ /hr			
8.	Service water requirement	M ³ /hr			
9.	Drinking Water	M ³ /hr			
10.	Fire water	M ³ /hr			
11.	Instrument Air	Nm ³ /hr			
12.	Plant Air	Nm ³ /hr			

Water Treatment Plant/ DMW Plant/ Condensate Polishing Unit

Sl. No.	Raw Material & Utility	Units	Plant Capacity		
			50%	100 %	110 %
1.	Raw Water	M ³ /hr			
2.	Power Consumption (Raw water/ DMW/ CPU)	KW/hr			
3.	Cooling water Make-up	M ³ /hr			
4.	Instrument Air	Nm ³ /hr			
5.	Plant Air	Nm ³ /hr			

Effluent Treatment Plant

Sl. No.	Raw Material & Utility	Units	Plant Capacity		
			50%	100 %	110 %
1.	Effluent	M ³ /hr			
2.	Power Consumption (Raw water/ DMW/ CPU)	KW/hr			
3.	LP Steam	Mt/hr			
4.	Cooling water Make-up	M ³ /hr			
5.	Instrument Air	Nm ³ /hr			
6.	Plant Air	Nm ³ /hr			

	INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INDIA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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Instrument Air Plant

Sl. No.	Raw Material & Utility	Units	Plant Capacity		
			50%	100 %	110 %
1.	Power Consumption	KWhr			
2.	Cooling water Make-up	M ³ /hr			

3.0 PLANT START UP REQUIREMENT:

Sl. No.	Item (Bidder to specify)	Units	
1.			Bidder to specify
2.	Normal		Item-wise quantity, quality at B.L.
3.	Peak, including duration		required for start-up
4.	B/L Pressure		
5.	B/L Temperature		
6.	Minimum purity required		
7.	Minimum acceptable limit of		

4.0 CATALYST REQUIREMENT :

Bidder to specify Item-wise information on catalysts used in their process as per pro-forma given below:

Type	Supplier	Loaded Volume	Expected Life
		m ³	Years

5.0 EFFLUENTS AND EMISSIONS:

5.1 Liquid Effluents:



- a) Continuous
- b) Intermittent

5.2 Gaseous Emissions:

- a) Continuous
- b) Intermittent

6.0 FLARE LOAD SUMMARY:

- a) HP Flare load

	INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INDIA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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b) LP Flare load

7.0 LIST OF EQUIPMENT

8.0 LIST OF ON-LINE ANALYZERS:

9.0 FLOW MEASURING INSTRUMENTS AT PLANT BATTERY LIMITS:



Description	Recommended Flow Meter	Unit	Limits of Accuracy (Instrument Accuracy)
Methanol Syn Gas	Suitable	Nm ³ / hr, Nm ³ /day	
Carbon di-oxide	Suitable	Nm ³ / hr, Nm ³ /day	
HP/MP/LP Steam Export	Orifice Plate/ Coriolis Flow meter	Kg/hr, Tonnes /day	+/- 0.5%
DM water/ Potable water/ Construction water	Orifice Plate	m ³ /hr, m ³ /day	+/- 0.5%
Circulating CW	Magnetic Flow meter Spool Type	m ³ /hr, m ³ /day	+/- 0.5%
CW Make-up	Magnetic Flow meter Spool Type	m ³ /hr, m ³ /day	+/- 0.5%
Instrument air/ Service air	Orifice Plate	Nm ³ /hr, Nm ³ /day	+/- 0.5%
HP Flare Header	Ultrasonic Flow-meter (Insertion Type)	Nm ³ /hr, Nm ³ /day Kg/hr, Tonnes/day	+/- 2-5 %
LP Flare Header	Ultrasonic Flow-meter (Insertion Type)	Nm ³ /hr, Nm ³ /day Kg/hr, Tonnes/day	+/- 2-5 %

10.0 OTHER TECHNICAL INFORMATION TO BE SUBMITTED ALONG WITH THE BID:

In addition to the requirements indicated in the earlier paragraphs, the following technical information in accordance with the offer is to be furnished (but not limited to) in the Technical proposal:

10.1 Salient features and description of process along with flow diagram indicating operating temperature and pressure conditions of all equipment used in the process.

- a) Process Flow Diagram including Heat & Material Balance
- b) Steam Balance Diagram
- c) Water Balance Diagram
- d) Process description indicating the functions of various sections.
- e) Turndown capability and operating range.
- f) System suggested for on-line product quality control.

	INFORMATION REQUIRED IN THE TECHNICAL PROPOSAL COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER: COAL INDIA LIMITED	PC176/E/4001/P-II/ SEC-1.16	0	
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- g) The details of effluent treatment facilities included in the battery limit and the quantities of gaseous, liquid and solid wastes released from the plant along with their specifications for normal operation and during regeneration, if any.
- h) Utility summary including the requirements of start-up / shutdown of Coal Gasification Plant, Methanol Plant, Offsite utilities
- i) Flare load summary for various failure cases (cooling water, reflux, power, blocked out, fire).
- j) Plant battery limit tie point details.

10.2 Equipment Layout plan:

Equipment Layout plan showing location of various equipment based on relevant appropriate norms

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SECTION – 1.18

SPARE PARTS

PLANT: INTEGRATED COAL BASED METHANOL PLANT, AT DANKUNI, KOLKATA (INDIA)

PROJECT: COAL TO METHANOL (C2M) PROJECT THROUGH COAL GASIFICATION ROUTE ON BUILD-OWN-OPERATE (BOO) BASIS AT DANKUNI COAL COMPLEX WEST BENGAL, INDIA

0	24.09.2020	24.09.2020	First Issue for Tender Purpose	SK	SKK	MN
REV	REV DATE	EFF DATE	PURPOSE	PREPD	REVWD	APPD

	SPARE PARTS COAL GASIFICATION BASED METHANOL PLANT ON BUILD-OWN-OPERATE (BOO) BASIS OWNER:COAL INIDA LIMITED	PC176/E/4001/P-II/ SEC-1.18	0	
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The list of spare parts to be supplied by BOO OPERATOR will be given during the technical clarification meeting.