Hiranmaye Energy Limited

(Formerly known as India Power Corporation (Haldia) Limited)

Ref: HMEL/WBERC/2021-22/021 13th July, 2021

The Secretary,
West Bengal Electricity Regulatory Commission,
Plot No. –AH/5 (2nd& 4th Floor) , Premises No. MAR 16-1111,
Action Area – 1A, New Town,
Rajarhat, Kolkata- 700163

Sub: Petition seeking in-principal approval for installation of FGD (Flue Gas Desulphurization) in its 3X150 MW thermal power station of Hiranmaye Energy Limited in compliance to the notification for the new environment norms issued by the Ministry of Environment Forest and Climate Change vide notification dated 7th December 2015 and 28th June 2018 as events of Change in Law.

Respected Madam,

Hiranmaye Energy Limited (HMEL) is hereby submitting a petition for seeking in-principal approval for installation of FGD (Flue Gas Desulphurization) in its 3X150 MW thermal power station at Haldia.

The Petitioner undertakes to deposit the requisite filing fee, as soon as the Hon'ble Commission informs the filing fee amount .

The Hon'ble Commission is humbly requested to acknowledge the receipt of the same.

Thanking You

Yours Sincerely
For Hiranmaye Energy Limited

Authorized Signatory

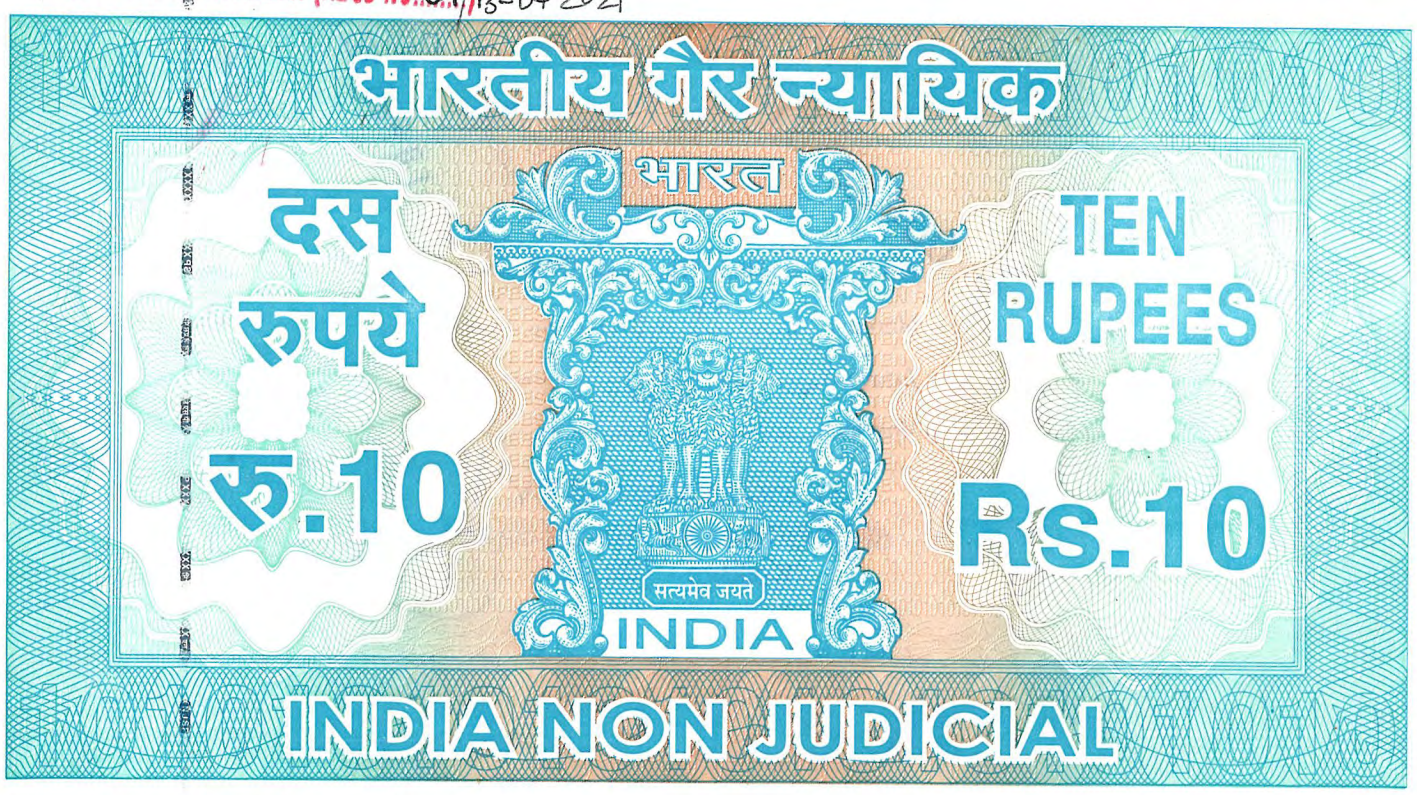
Encl.: 1 original + 3 photocopies of the petition + 1 CD

WEST BENGAL ELECTRICITY REGULATORY COMMISSION
RECEIVED
13 JUL 2021
CONTENT NOT VERIFIED
KOLKATA

CIN - U40105WB2008PLC125220
Registered Office : Plot No. X1 - 2 & 3, Block - EP, Sector - V, Salt Lake City, Kolkata - 700091
Ph : +91 33 6609 4314 / 15 / 16, Fax : +91 33 6609 4320
Project Office : Vill - Kasbere, P.O. - Shibramnagar, Haldia, Purba Medinipur, West Bengal, Pin - 721635
Ph : +91 3224 660910 / 925 / 926, Fax : +91 3224 660935
E-mail : pr@hiranmayeenergy.com, Web : www.hiranmayeenergy.com

Registration No 13759/2018 (REGD NO. 01/13-07-2021

13 JUL 2021



पश्चिमबङ्ग पश्चिम बंगाल WEST BENGAL

53AB 151266

Before the Notary Public (Seal)

FORM-1

BEFORE THE HON'BLE WEST BENGAL ELECTRICITY REGULATORY COMMISSION, KOLKATA

File No.

Case No.

(To be filled by the Office)

IN THE MATTER OF:

Petition seeking in-principal approval for installation of FGD (Flue Gas Desulphurization) in its 3X150 MW thermal power station of Hiranmaye Energy Limited in compliance to the notification for the new environment norms issued by the Ministry of Environment Forest and Climate Change vide notification dated 7th December 2015 and 28th June 2018 as events of Change in Law.

AND

IN THE MATTER OF:

M/s Hiranmaye Energy Limited [HMEL],
Plot No. X1-2&3, Block – EP,
Sector V, Salt Lake City, Kolkata- 700091 (West Bengal) ... Applicant

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

13 JUL 2021

FORM-2

BEFORE THE HON'BLE WEST BENGAL ELECTRICITY REGULATORY COMMISSION, KOLKATA

File No.

Case No.

(To be filled by the Office)

IN THE MATTER OF:

Petition seeking in-principal approval for installation of FGD (Flue Gas Desulphurization) in its 3X150 MW thermal power station of Hiranmaye Energy Limited in compliance to the notification for the new environment norms issued by the Ministry of Environment Forest and Climate Change vide notification dated 7th December 2015 and 28th June 2018 as events of Change in Law.

AND

IN THE MATTER OF:

M/s Hiranmaye Energy Limited [HMEL],
Plot No. X1-2&3, Block – EP,
Sector V, Salt Lake City, Kolkata- 700091 (West Bengal) **... Applicant**

AFFIDAVIT VERIFYING THE PETITION/APPLICATION

I, Jyotirmay Bhaumik, son of of Shri Jitendra Nath Bhaumik aged 64 years residing at B-101,Greenwood Housing Complex,Kaikhali Main Road ,Kolkata -700052 do solemnly affirm and say as follows:

I am the Whole Time Director of Hiranmaye Energy Limited, the petitioner/applicant in the above matter and am duly authorised by the said petitioner/applicant to make this affidavit for and on behalf of the petitioner.

The statements made in the petition herein now shown to me and marked with the letter 'A' are true to my knowledge and are based on information received and are true to my belief and nothing material has been concealed from the statements so made or documents or supporting data etc. attached.

Solemnly affirmed at Kolkata on this **12th day of July 2021** that the contents of this affidavit are true to my knowledge, no part of it is false or nothing material has been concealed therefrom and misleading material included therein.

Deponent

Place: Kolkata

Date: 12th July, 2021

Solemnly Affirmed & Declered before me on Identification

Dr. R. N Kundu, Notary
Alipore Judges/police Court, Cal-27
Regd No 13759/2018 Govt. of Ind

Identified By Me
Basundhara Kundu
Advocate
BASUNDHARA KUNDU
Advocate F/1880/19
Alipore Judges Court

PETITION SEEKING IN-PRINCIPAL APPROVAL FOR INSTALLATION OF FLUE GAS DESULPHURISATION (FGD) IN 3X150 MW THERMAL POWER PLANT OF HIRANMAYE ENERGY LIMITED

"A"

MOST RESPECTFULLY SHOWETH

Hiranmaye Energy Limited has filed the subject petition seeking in-principal approval for installation of FGD (Flue Gas Desulphurisation) in its 3X150 MW Thermal power station at Haldia in compliance to the notification for the new environment norms issued by the Ministry of Environment Forest and Climate Change vide notification dated 7th December 2015 and 28th June 2018 as events of Change in Law. The subject petition is filed under Regulations 2.8.4.1 (iii) , 5.2.2 (iii),(iv),(vi) & (vii) of WBERC (Terms and Conditions of Tariff) Regulations, 2011 and Article 9 of the Power Purchase Agreement dated 28.12.2010 entered into between the petitioner and West Bengal State Electricity Distribution Company Limited.

BACKGROUND

1. Hiranmaye Energy Limited (hereinafter referred to as "HMEL" or, "Petitioner") is setting up a 3x150 MW Coal based Thermal Power Project at Haldia. Out of the three units, Unit-1 & 2 have achieved COD on 13.08.2017 and 31.12.2017 respectively.

2. The Petitioner had entered into a Long Term PPA for 300 MW capacity with West Bengal State Electricity Distribution Company Limited ("WBSEDCL") on 28.12.2010.

3. Ministry of Environment, Forest and Climate Change, Government of India (hereinafter referred to as MoEF&CC) issued Gazette notification on 7th December 2015 amending Environment (Protection) Rules, 1986. Amended rules are called Environment (Protection) Amendment Rule, 2015. Gazette notification of Amendment on the water consumption limits and stack height was issued on dated 28th June 2018. The revised standards are mandatory in nature and are to be complied with within a stipulated time frame. (Copy of MOEF&CC Notification dated 07 Dec, 15 and 28 June,18 is enclosed as **Annexure-A.**)

4. Ministry of Power (GoI), vide its letter dated 30.05.2018 addressed to Central Electricity Regulatory Commission (CERC) has issued directions **for smooth implementation of the revised emission standards and mechanism**. The said letter is enclosed as **Annexure-B**. Emission Standards as per MOEF&CC for TPPs (units) installed from 1st January, 2017 is indicated in the table below:

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Sr. No.	Industry	Parameter	Standards
1	Thermal Power Plants	Particulate	30 mg/Nm^3
2		Sulphur Dioxide (SO_2)	100 mg/Nm^3
3		Oxides of Nitrogen (NO_X)	100 mg/Nm^3
4		Mercury (Hg)	0.03 mg/Nm^3
5		Water Consumption	Maximum 3.0 m^3/MWh
6		Zero Liquid Discharge	To be adopted.

5. The Petitioner has appointed M/s Fichtner Consulting Engineers (India) Private Limited "hereafter called as M/s FCEIPL" to prepare Feasibility Report after carrying out the evaluation and assessment for implementation of the revised emission norms for existing/and under construction units of 3x150 MW power plant of the Petitioner at Haldia. M/s FCEIPL team visited the power plant site to study the technical parameters of plant. M/s FCEIPL team collected the plant design data, specifically with regard to coal analysis, Plant water consumption, designed/actual emissions levels of SOx, NOx. Based on the site visit and the data collected there, a feasibility study was carried out by M/s FCEIPL and a Detailed Project Report (DPR) was prepared. (Copy of the DPR FOR INSTALLATION OF EMISSION REDUCTION PLANT TO MEET LATEST MOEF & CC NORMS is enclosed as **Annexure-C**.)

6. The feasibility report provided a technical and techno-economic analysis of various technologies for control of SOx, NOx, particulate matter and specific water consumption. The details for the various technologies are as under:
   a. **SOx Control:** As per the study, SOx is to be reduced by 94.5% from the present levels to meet the December, 2015 norms of MoEFCC. After analyzing various technologies,it was concluded that Wet Limestone based technology emerged as the most suitable one in order to economically achieve the prescribed reduction of SOx. This technology is well proven and majority of the plants across the world utilize this technology in order to control SOx emissions.

   b. **NOx Control:** As per the study, it was concluded that NOx emission needed to be curtailed by 77% from the present levels in order to achieve the norms prescribed by MoEFCC. As per the feasibility report, Selective Catalytic Reduction (SCR) emerged as the most suitable technology in which ammonia would be used as a Reagent.

   c. **Particulate Matter Control:** There are various pollution control devices which can be installed in the power plant such as Electrostatic precipitators (ESP), Filters and dust collectors Wet scrubbers etc. One ESP is already installed in the power plant which deals with pollution control. The study suggested that installation of additional ESP would be

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the best option , however there is no space in the existing power plant for an additional ESP. Hence, it was suggested that feasibility of Ammonia dosing at ESP along with upgrading of ESP with latest technology may be considered in order to meet the desired norms. Further, the exsiting Ash handling system also needs to be augmented to cater to the disposal of additional ash generated.

d. **Specific Water consumption:** The specific water consumption of HMEL during normal operation is 3.5m3/MWh. However, when there is high chloride content in the water and multiple start-ups and shutdown occur, it increases in the range between 3.27 to 3.92 m3/MWh. Addition of FGD system will further increase the water consumption by 105m3/hour. Considering an average specific water consumption as 3.59 m3/MWh combined with additional 105m3/hr of clarified water would increase the specific water consumption to 3.82 m3/MWh. As per the MoEFCC norms, the specific water consumption must be 3.0 m3/MWh. In order to limit the specific water consumption, it has been recommended in the study that HMEL must adopt **UF-RO based waste water treatment system** of capacity 300 m3/hr for 2 units and extension of the same by additional 150 m3/hr to be done when the third unit is in operation.

7. Vide letter no. WTD/HMEL/ENV/CEA/2021-22/007/38 dated 10.06.2021, the Petitioner had submitted the aforesaid DPR before CEA to accord its approval on submitted DPR for onward transmission to Appropriate Commission. However, CEA vide its reply dated 15.06.2021, advised that the Petitioner to directly approach concerned Regulator for future course of action and any plant specific requirement for FGD installation. A copy of CEA reply dated 15.06.2021 is enclosed as **Annexure-D.**

8. MOEF & CC has categorised thermal power plants in three categories as specified in the Table below on the basis of their location to comply with the emission norms within the time limit as specified in column (4) of the said Table, namely: -

Sl. No.	Category	Location/area	Timelines for compliance	
			Non retiring units	Retiring units
(1)	(2)	(3)	(4)	(5)
1	Category A	Within 10 km radius of National Capital Region or cities having million plus population[1].	Upto 31st December 2022	Upto 31st December 2022
2	Category B	Within 10 km radius of Critically Polluted Areas[2] or Non-attainment cities[2]	Upto 31st December 2023	Upto 31st December 2025
3	Category C	Other than those included in category A and B	Upto 31st December 2024	Upto 31st December 2025

[1] As per **2011** census of India.

[2] As defined by CPCB.

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A copy of the latest MOEF & CC notification dated 31.03.2021 regarding the extended target timelines for installation of FGD system by the thermal power plants across the country is enclosed as **Annexure-E**.

9. The Petitioner humbly submits that as per the DPR being submitted herein, the completion period for implementation of abatement methods for the Petitioner's plant on EPC basis would be 26-30 months. The downtime for flue gas duct modification in the existing plant will be 4 weeks/boiler in addition to the above mentioned timeline. The said timeline for the Petitioner's project is within the target date specified by the MOEF&CC for Category-B Power Plants.

SUMMARY OF ESTIMATED PROJECT COST FOR INSTALLATION OF EMISSION REDUCTION PLANT

10. It is estimated that the total project cost for installation of Emission Reduction Plant for the Petitioner will be to the tune of Rs 61140.40 Lakhs (incl. Taxes and IDC) as indicated in the table below:

Particulars	Unit	Amount
Plant & Equipment (incl. Taxes and Duties)	Rs Lakhs	45884.30
Erection, Testing and Commissioning	Rs Lakhs	5506.10
Overheads& Pre Operative Expenses	Rs Lakhs	2055.60
Interest During Construction	Rs Lakhs	7480.40
Financing Charges	Rs Lakhs	214.00
TOTAL PROJECT COST	**Rs Lakhs**	**61140.40**

11. The project financing is expected to be in the following ratio of Equity & Debt:

Equity	30% of 61140.4	Rs Lakhs	18342.10
Debt	70% of 61140.4	Rs Lakhs	42798.30

EXPECTED FINANCIAL IMPACT ON VARIOUS PARAMETERS OF THE THERMAL POWER STATION DUE TO INSTALLATION OF FLUE GAS DE-SULPHURISATION (FGD) AND OTHER ASSOCIATED SYSTEM

12. M/s FCEIPL has also undertaken a financial analysis by computing the impact of installation of FGD and other associated system on the Fixed and Energy Charges. The balance useful life of (2*150 MW) plant has been considered as 18 years. The various assumptions considered in the study and impact on key parameters is discussed as under:
    a. The target availability has been considered as 80%. The auxiliary power consumption for FGD in case of each unit will be 150 kW, whereas in case of SCR, the auxiliary consumption for each unit will be 58 kW. Further, auxiliary consumption for the proposed UF-RO based waste water treatment system for two units is estimated to be 450 kW. This will translate into an increase in Auxiliary Consumption by 1.5%

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b. The Loan repayment period has been assumed as 7 years with 1 year as moratorium period whereas the Interest on Loan has been considered as 13.19%.

c. It has been estimated in the study that with the installation of FGD there will be an increase in O&M expenses of about Rs.3.56 Lakhs /MW in addition to the present O&M expenses in the first year after the installation of FGD. The O&M costs have been escalated at 3.50% p.a in the financial analysis.

d. The Water consumption has been considered as 70 m^3/h. Considering Water charges as Rs.20/kL, the annual water cost comes out to be Rs.98.10 Lakhs.

e. The Limestone consumption has been assumed as 1.728 tonnes/hr. This translates into an annual consumption of 12,109.82 Tonnes per annum. Considering the price of limestone as Rs.5000/tonne, the annual cost of Limestone will be Rs.605.5 Lakhs. Similarly, considering ammonia consumption for SCR and ESP as 0.08 tonnes/hr , the annual cost of ammonia comes out to be Rs.153.10 Lakhs.

Considering the abovementioned assumptions, the levelised impact of FGD system and its auxiliaries on Tariff comes out to be Rs.0.68/kWh. The detailed computation has been done in the attached DPR.

13. There will be a separate expense on account of Gypsum disposal, apart from the normal coal & ash handling expenses as well as there may be some income on account of gypsum sale.

14. The Petitioner humbly submits that the aforesaid expected changes in various parameters of the Thermal Power Plant will be required to be considered while APR / tariff determination for ensuing years.

15. The Petitioner further humbly submits that there will be disruption in generation of power during the installation phase of various emission control systems. This will lead to loss of fixed cost recovery during the shutdown period.

16. The Petitioner humbly submits that the Regulation 5.8.5 of the WBERC (Terms and Conditions of Tariff)(Third Amendment) Regulations, 2020 has also specified about the principle for determination of landed cost of reagent used during operation of emission control system for meeting revised emission standards. However, the normative consumption of specific reagent for the various technologies installed for meeting revised emission standards shall be notified separately. Till such time, actual consumption of specific reagent shall be considered.

GROUNDS OF PETITION

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17. As part of the compliance to the notification for the new environment norms issued by the Ministry of Environment Forest and Climate Change vide notification dated 7th December 2015 and 28th June 2018 the Petitioner is liable to undertake the installation of FGD & other associated emission reduction system.

18. The aforesaid FGD system & other associated emission reduction system were not envisaged to be installed during conception of the petitioner's thermal power project and therefore cost of such installation was not considered in the original project cost submission & Investment approval proceedings.

19. Hon'ble APTEL in the Order dated 28.08.2020 in Appeal Nos. 21 & 73 of 2019 and Appeal no. 153 of 2019 has allowed Capital Cost of the FGD project; wherein it is held that the MoEF&CC notification dated 07.12.2015 is a ***"Change in Law event"*** and directed Punjab State Electricity Regulatory Commission to devise mechanism for its recovery i.e. to formulate tariff determination principles for recovery of FGD project cost. The same principle is applicable to this capex proposal of the Petitioner.

20. Article 9 of the PPA dated 28.12.2010 between WBSEDCL and the Petitioner, deals with the Change in Law scenario and states as follows:

*" **9.1 Change in Law***

Due to any change in law after Investment Approval under the applicable regulations from the Appropriate Commission, if there is any price and/or cost implication on the Seller, either upward or downward, then the same will be mitigated by the Appropriate Commission in terms of applicable regulations including through the application of Annual Performance Review (APR)/Fuel Cost Adjustment (FCA) , as the case may be."

21. Regulation 2.8.4.1 (iii) of the WBERC (Terms and Conditions of Tariff) Regulations, 2011 as amended from time to time deals with the prior approval of capex schemes above 300 Rs Crores:

"2.8.4.1 A licensee or a generating company may undertake capital expenditure in small schemes, which do not fall within the capital expenditure programme approved by the Commission in pursuance of regulations 2.8.1.4, 2.8.2.3 and 2.8.3, provided the aggregate expenditure on such schemes does not exceed Rs. 300 crore or 5% of gross fixed assets of the generation business of the generating company or distribution business of the distribution licensee or transmission business of the transmission licensee, whichever is lower during the concerned year, subject to the following conditions:-

i. ....

ii. ....

*iii. **If the Capital Expenditure**, other than those mentioned in Sl.No.(ii) **exceeds 300 Crores** or 5% of the gross fixed assets of the concerned business whichever is lower as*

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mentioned above, ***prior approval is required to be taken for Capital Expenditure*** *for such small schemes and which are undertaken beyond the above limit* ***prior to incurring such expenditure." (Emphasis added)***

22. Regulation 5.2.2 (iii), (iv), (vi) & (vii) of the WBERC (Terms and Conditions of Tariff) Regulations, 2011 and amendments thereof deals with the Additional Capitalization as stated below:

"5.2.2 The capital expenditure of the following nature actually incurred after the cut-off date may be allowed by the Commission for inclusion in the original cost of project, subject to prudence check:
(i) ...
(ii) ...
(iii) Liabilities on account of change in law;
(iv) Any additional works / services which have become necessary for efficient and successful operation of the generating station or licensed business, but not included in the original project cost;
(v) ...
(vi) Works related to Pollution Control Measures; and
(vii)Works related to compliance of any statutory requirements."

23. The Petitioner has relied upon the aforesaid MOEF&CC notification, regulations and provision under PPA for filing this petition. The Petitioner humbly prays before the Hon'ble Commission that although the WBERC Tariff Regulations are silent on the issue of FGD installation parameters and investment approval, this may be considered under the Change in Law scenario and investment approval be granted.

PRAYERS BEFORE THE HON'BLE COMMISSION

24. In view of the above facts and circumstances, the Petitioner prays the Hon'ble Commission may be pleased to:
    a. Admit the Petition as submitted herewith;
    b. Grant 'in-principle clearance' for Rs 61140.4 Lakhs towards capital cost for installation of FGD and other associated system system in compliance of MoEFCC notification dated 07.12.2015;
    c. Allow the Petitioner to file such additional information, explanation and documents as may be required under the guidelines of the Hon'ble Commission;

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d. Consider the revised parameters(such as increase in Auxiliary consumption, O&M expenses ,water charges etc.) expected due to installation of FGD system while APR / Tariff determination for ensuing years;

e. Allow procurement cost of limestone and ammonia for operation of FGD System as part of Energy charges;

f. Allow normative availability(85%) for the period of installation and commissioning of FGD as deemed availability for payment of capacity charges during shutdown period;

g. Allow any other relief, order or direction, which the Hon'ble Commission deems fit to be issued;

h. Condone any inadvertent errors / inconsistencies / omissions / rounding off differences, etc. as may be there in the Petition.

HIRANMAYE ENERGY LIMITED
(Formerly Known as India Power Corporation (Haldia) Limited)
Kolkata
700 091

LIST OF ANNEXURES

ANNEXURE	PARTICULARS
ANNEXURE-A	Copy of MOEF&CC Notification dated 07 Dec, 15 and 28 June,18
ANNEXURE-B	Ministry of Power (GoI), letter dated 30.05.2018 addressed to Central Electricity Regulatory Commission (CERC)
ANNEXURE-C	DPR for installation of Emission Reduction Plant to meet latest MOEF & CC norms
ANNEXURE-D	CEA reply to HMEL dated 15.06.2021
ANNEXURE-E	Copy of the latest MOEF & CC notification dated 31.03.2021 regarding the extended target timelines for installation of FGD system by the thermal power plants across the country

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700 091

ANNEXURE-A

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (ii)
PART II—Section 3—Sub-section (ii)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 2620] नई दिल्ली, मंगलवार, दिसम्बर 8, 2015/अग्रहायण 17, 1937
No. 2620] NEW DELHI, TUESDAY, DECEMBER 8, 2015/AGRAHAYANA 17, 1937

पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 7 दिसम्बर, 2015

का.आ. 3305(अ).— केंद्रीय सरकार, पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6 और धारा 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए पर्यावरण (संरक्षण) नियम, 1986 का और संशोधन करने के लिए निम्नलिखित नियम बनाती है, अर्थात् :—

1.(1) इन नियमों का संक्षिप्त नाम पर्यावरण (संरक्षण) संशोधन नियम, 2015 है ।

(2) ये उनके राजपत्र में प्रकाशन की तारीख को प्रवृत्त होंगे ।

2. पर्यावरण (संरक्षण) नियम, 1986 की अनुसूची 1 में,—

(क) क्रम सं. 5 और उससे संबंधित प्रविष्टियों के स्थान पर निम्नलिखित क्रम सं. और प्रविष्टियां अंत:स्थापित की जाएंगी, अर्थात् :—

क्रम सं.	उद्योग	मापदंड	मानक
1	2	3	4
5क	ताप विद्युत संयंत्र (जल उपभोग सीमा)	जल उपभोग	I. एक बार शीतलन (ओटीसी) के माध्यम से सभी संयंत्र शीतलन टावरों (सीटी) को प्रतिष्ठापित करेंगे और अधिसूचना की तारीख से दो वर्ष की अवधि के भीतर अधिकतम 3.5m^3/MWh के विनिर्दिष्ट जल उपभोग को हासिल करेंगे ।

			II. सभी विद्यमान सीटी-आधारित संयंत्र 3.5m^3/MWh इस अधिसूचना के प्रकाशन की तारीख से दो वर्ष के भीतर अधिकतम 3.5m^3/MWh तक के विनिर्दिष्ट जल उपभोग को कम करेंगे । III. जनवरी, 2017 के पश्चात् प्रतिष्ठापित किए जाने वाले नए संयंत्र अधिकतम 2.5 m^3/MWh तक के विनिदिष्ट जल उपभोग को पूरा करेंगे और शून्य जल दुर्व्यय को हासिल करेंगे ।

(ख) क्रम सं. 25 और उससे संबंधित प्रविष्टियों के पश्चात् निम्नलिखित क्रम सं. और प्रविष्टियां रखी जाएंगी, अर्थात् :—

क्रम सं.	उद्योग	मापदंड	मानक
1	2	3	4
		विवक्त पदार्थ	100 mg/Nm^3
		सल्फर डायोक्साइड(SO_2)	600 mg/Nm^3 (500 मेगावाट से कम क्षमता की इकाईयों से लघु इकाईयां) 200 mg/Nm^3 (500 मेगावाट और उससे अधिक क्षमता की इकाईयां)
		नाइट्रोजन के आक्साइड (NOx)	300 mg/Nm^3
		पारा (Hg)	0.03 mg/Nm^3 (500 मेगावाट और उससे अधिक क्षमता की इकाईयां)
		1 जनवरी, 2003 के पश्चात् 31 दिसंबर, 2016* तक प्रतिष्ठापित टीपीपी (इकाईयां)	
		विवक्त पदार्थ	50 mg/Nm^3
		सल्फर डायोक्साइड (SO_2)	600 mg/Nm^3 (500 मेगावाट से कम क्षमता की इकाईयों से लघु इकाईयां) 200 mg/Nm^3 (500 मेगावाट और उससे अधिक क्षमता की इकाईयां)
		नाइट्रोजन के आक्साइड (NOx)	300 mg/Nm^3
		पारा (Hg)	0.03 mg/Nm^3
		1 जनवरी, 2017** से प्रतिष्ठापित टीपीपी (इकाईयां)	
		विवक्त पदार्थ	30 mg/Nm^3
		सल्फर डायोक्साइड (SO_2)	100 mg/Nm^3
		नाइट्रोजन के आक्साइड	100 mg/Nm^3

		(NOx)	
		पारा (Hg)	0.03 mg/Nm^3

* टीपीपी (इकाईयां) इस अधिसूचना के प्रकाशन की तारीख से दो वर्ष के भीतर परिसीमाओं को पूरा करेंगी ।

** इसके अंतर्गत सभी टीपीपी (इकाईयां) हैं, जिन्हें पर्यावरणीय निकासी प्रदान की गई है और संनिर्माण के अधीन है ।

[फा. सं. क्यू-15017/40/2007-सीपीडब्ल्यू]

डा. राशिद हसन, सलाहकार

टिप्पण :- मूल नियम भारत के राजपत्र, असाधारण, भाग II, खंड 3, उपखंड (ii) में सं. का.आ. 844(अ) 19 नवंबर, 1986 द्वारा प्रकाशित किए गए थे और उनका पश्चातवर्ती का.आ. 433(अ) तारीख 18 अप्रैल, 1987 ; सा.का.नि 176(अ) तारीख 2 अप्रैल, 1996; सा.का.नि. 97 (अ), तारीख 18 फ़रवरी, 2009 ; सा.का.नि 149(अ) तारीख 4 मार्च, 2009 ; सा.का.नि. 543(अ) तारीख 22 जुलाई, 2009 ; सा.का.नि. 739(अ) तारीख 9 सितम्बर, 2010 ; सा.का.नि. 809(अ) तारीख 4 अक्टूबर, 2010, सा.का.नि. 215(अ) तारीख 15 मार्च, 2011 ; सा.का.नि. 221(अ) तारीख 18 मार्च, 2011 ; सा.का.नि. 354(अ) तारीख 2 मई, 2011 ; सा.का.नि. 424(अ) तारीख 1 जून, 2011 ; सा.का.नि. 446(अ) तारीख 13 जून, 2011 ; सा.का.नि. 152(अ) तारीख 16 मार्च, 2012 ; सा.का.नि. 266(अ) तारीख 30 मार्च, 2012 ; सा.का.नि. 277(अ) तारीख 31 मार्च, 2012; सा.का.नि. 820(अ) तारीख 9 नवम्बर, 2012 ; सा.का.नि. 176(अ) तारीख 18 मार्च, 2013 ; सा.का.नि. 535(अ) तारीख 7 अगस्त, 2013 ; सा.का.नि. 771(अ) तारीख 11 दिसम्बर, 2013 ; सा.का.नि. 2(अ) तारीख 2 जनवरी, 2014 ; सा.का.नि. 229(अ) तारीख 28 मार्च, 2014 ; सा.का.नि. 232(अ) तारीख 31 मार्च, 2014 ; सा.का.नि. 325(अ) तारीख 7 मई, 2014, सा.का.नि. 612(अ) तारीख 25 अगस्त, 2014 और अन्तिम संशोधन सा.का.नि. 789(अ) तारीख 11 नवम्बर, 2014 किया गया था ।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 7th December, 2015

S.O. 3305(E).— In exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:–

1. (1) These rules may be called the Environment (Protection) Amendment Rules, 2015.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule – I, -

(a) after serial number 5 and entries relating thereto, the following serial number and entries shall be inserted, namely:–

Sr. No.	Industry	Parameter	Standards
1	2	3	4
"5A.	**Thermal Power Plant (Water consumption limit)**	**Water consumption**	I. All plants with Once Through Cooling (OTC) shall install Cooling Tower (CT) and achieve specific water consumption upto maximum of 3.5m^3/MWh within a period

			of two years from the date of publication of this notification. II. All existing CT-based plants reduce specific water consumption upto maximum of 3.5m^3/MWh within a period of two years from the date of publication of this notification. III. New plants to be installed after 1st January, 2017 shall have to meet specific water consumption upto maximum of 2.5 m^3/MWh and achieve zero waste water discharged";

(b) for serial number 25, and the entries related thereto, the following serial number and entries shall be substituted, namely:-

Sr. No.	Industry	Parameter	Standards
1	2	3	4
"25.	Thermal Power Plant	**TPPs (units) installed before 31st December, 2003***	
		Particulate Matter	100 mg/Nm^3
		Sulphur Dioxide (SO_2)	600 mg/Nm^3 (Units Smaller than 500MW capacity units) 200 mg/Nm^3 (for units having capacity of 500MW and above)
		Oxides of Nitrogen (NOx)	600 mg/Nm^3
		Mercury (Hg)	0.03 mg/Nm^3(for units having capacity of 500MW and above)
		TPPs (units) installed after 1st January,2003, upto 31st December, 2016*	
		Particulate Matter	50 mg/Nm^3
		Sulphur Dioxide (SO_2)	600 mg/Nm^3 (Units Smaller than 500MW capacity units) 200 mg/Nm^3 (for units having capacity of 500MW and above)
		Oxides of Nitrogen (NOx)	300 mg/Nm^3
		Mercury (Hg)	0.03 mg/Nm^3
		TPPs (units) to be installed from 1st January, 2017**	
		Particulate Matter	30 mg/Nm^3
		Sulphur Dioxide (SO_2)	100 mg/Nm^3
		Oxides of Nitrogen (NOx)	100 mg/Nm^3
		Mercury (Hg)	0.03 mg/Nm^3

*TPPs (units) shall meet the limits within two years from date of publication of this notification.

**Includes all the TPPs (units) which have been accorded environmental clearance and are under construction".

[F. No. Q-15017/40/2007-CPW]

Dr. RASHID HASAN, Advisor

Note: - The principal rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i) *vide* number S.O. 844(E), dated the 19th November, 1986 and subsequently amended *vide* the following notifications:—

S.O. 433(E), dated 18th April 1987; G.S.R. 176(E) dated 2nd April, 1996; G.S.R. 97(E), dated the 18th February, 2009; G.S.R. 149(E), dated the 4th March , 2009; G.S.R. 543(E), dated 22nd July, 2009; G.S.R. 739(E), dated the 9th September, 2010; G.S.R. 809(E), dated, the 4th October, 2010, G.S.R. 215(E), dated the 15th March, 2011; G.S.R. 221(E), dated the 18th March, 2011; G.S.R. 354(E), dated the 2nd May, 2011; G.S.R. 424(E), dated the 1st June, 2011; G.S.R. 446(E), dated the 13th June, 2011; G.S.R. 152(E), dated the 16th March, 2012; G.S.R. 266(E), dated the 30th March, 2012; and G.S.R. 277(E), dated the 31st March, 2012; and G.S.R. 820(E), dated the 9th November, 2012; G.S.R. 176(E), dated the 18th March, 2013; G.S.R. 535(E), dated the 7th August, 2013; G.S.R. 771(E), dated the 11th December, 2013; G.S.R. 2(E), dated the 2nd January, 2014; G.S.R. 229(E), dated the 28th March, 2014; G.S.R. 232(E), dated the 31st March, 2014; G.S.R. 325(E), dated the 07th May, 2014, G.S.R. 612,(E), dated the 25th August, 2014 and lastly amended vide notification G.S.R. 789(E), dated 11th November, 2014.

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भारत का राजपत्र
The Gazette of India

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EXTRAORDINARY
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PART II—Section 3—Sub-section (i)
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PUBLISHED BY AUTHORITY

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पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 28 जून, 2018

सा.का.नि. 593 (अ).— भारत के राजपत्र, असाधारण में भारत सरकार, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय की दिनांक 16 अक्तूबर, 2017 की अधिसूचना संख्या सा.का.नि. 3337 (अ) के द्वारा एक प्रारूप अधिसूचना प्रकाशित की गई थी जिसमें उन सभी व्यक्तियों, जिनके उससे प्रभावित होने की संभावना थी, से उस तारीख से जिसकी उक्त अधिसूचना की राजपत्र की प्रतियां जन-साधारण को उपलब्ध कराई गई थीं, साठ दिन की अवधि के भीतर आपत्तियां और सुझाव मांगे गए थे।

और, राजपत्र की प्रतियां दिनांक 16 अक्तूबर, 2017 को जन-साधारण को उपलब्ध कराई गई थीं।

और, केंद्र सरकार द्वारा इस प्रारूप अधिसूचना के प्रत्युत्तर में सभी व्यक्तियों और पक्षों से प्राप्त सभी आपत्तियों और सुझावों पर विधिवत् रूप से विचार किया गया है।

अत: अब, पर्यावरण (संरक्षण) नियम, 1986 के नियम (5) के उप नियम (3) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6 और 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, केंद्र सरकार, एतद्द्वारा पर्यावरण (संरक्षण) नियम, 1986 में और संशोधन करने के लिए निम्नलिखित संशोधन करती है, अर्थात्:—

1. (1) इन नियमों का संक्षिप्त नाम पर्यावरण (संरक्षण) संशोधन नियम, 2018 है।

(2) ये राजपत्र में प्रकाशन की तारीख को प्रवृत्त होंगे।

2. पर्यावरण (संरक्षण) नियम, 1986 की अनुसूची 1 में,-

(क) स्तंभ 4 में क्रम संख्या 5क के सामने, मद 3 के स्थान पर निम्नलिखित मद रखी जाएगी, अर्थात:—

"III. विनिर्दिष्ट जल उपभोग, तारीख 1 जनवरी, 2017 के पश्चात् संस्थापित किए गए नए संयंत्र के लिए 3.0 मी^{3}/एमडब्ल्यूएच से अधिकतम नहीं होगा और ये संयंत्र शून्य अपशिष्ट जल बहाव को हासिल करेंगे।"

(ख) क्रम संख्या 5 क और उससे संबंधित प्रविष्टियों के पश्चात् निम्नलिखित क्रम संख्या और प्रविष्टियों को अंत:स्थापित किया जाएगा, अर्थात्:-

क्रम सं	उद्योग	पैरामीटर	मानक
1	2	3	4
"5ख	तापीय विद्युत संयंत्र (जल उपभोग सीमा समुद्री जल का प्रयोग)	जल उपभोग	उपरोक्त क्रम सं 5क में स्तंभ 4 में मद I से III समुद्री जल का प्रयोग करने वाले तापीय विद्युत संयंत्र पर लागू नहीं होगा";

(ग) क्रम सं 25 में, निम्नलिखित टिप्पण अंत:स्थापित किया जाएगा, अर्थात:—

"टिप्पण : सल्फर डाइआक्साइड, नाइट्रोजन और धूल-कण के लिए सभी मानीटर किए गए मान को शुष्क आधार पर 6% आक्सीजन के लिए संशोधित किया जाएगा।";

(घ) क्रम सं 33 और उससे संबंधित प्रविष्टियों के पश्चात् निम्निलिखित क्रम संख्या और प्रविष्टियों को अंत:स्थापित किया जाएगा:-

क्रम सं	उद्योग	पैरामीटर	मानक
1	2	3	4
"33क	आर्द्र-फ्लू गैस डीसल्फयुराईजेशन (एफजीडी) के साथ तापीय विद्युत संयंत्र	चिमनी की ऊंचाई/मीटर में सीमा	विद्युत उत्पादन क्षमता: 100 मेगावाट और अधिक एच= 6.902 (क्यू x 0.277)$^{0.555}$ अथवा 100 मीटर न्यूनतम 100 मेगावाट से कम एच= 6.902 (क्यू x 0.277)$^{0.555}$ अथवा 30 मीटर जो भी अधिक हो"; क्यू=सल्फर डाइआक्साइड की कि.ग्रा./उत्सर्जन दर* एच= मीटर में भैतिक स्टाक ऊंचाई।" *चिमनी से जुड़ी सभी यूनिटों का योग **टिप्पणी :** ये मानक कोयला/लिग्नाइट आधारित तापीय विद्युत संयंत्रों पर लागू होंगे।

[फा. सं. क्यू-15017/40/2007-सीपीडब्ल्यू)]

डॉ. ए. सेंथिल वेल, वैज्ञानिक 'जी'

टिप्पण : मूल नियम के राजपत्र असाधारण, भाग II, खंड 3, उपखंड (i) का.आ. 844 (अ) तारीख 19 नवम्बर, 1986 द्वारा प्रकाशित किया गया था और पिछली बार अधिसूचना सा.का.नि. 568 (अ) दिनांक 18 जून, 2018 के द्वारा संशोधित किया गया।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 28th June, 2018

G.S.R. 593 (E).—Whereas, a draft notification, for Thermal Power Plants was published in the Gazette of India, Extraordinary, vide notification of the Government of India in the erstwhile Ministry of Environment, Forest and Climate Change number G.S.R. 3337(E), dated the 16th October, 2017, inviting objections and suggestions from all persons likely to be affected thereby within a period of sixty days from the dated on which copies of the Gazette containing the said notification were made available to the public;

And Whereas, copies of the Gazette were made available to the public on the 16th October, 2017;

And Whereas, all objections and suggestions received from all persons and stakeholders in response to the draft notification have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by sections 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) read with sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:-

1. (1) These rules may be called the Environment (Protection) Amendment Rules, 2018.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule-I,-

(a) against serial number 5A, in column 4, for item III, the following item shall be substituted, namely:-
"III. Specific water consumption shall not exceed maximum of 3.0 m^3/MWh for new plants installed after the 1st January, 2017 and these plants shall also achieve zero waste water discharge.";

(b) after serial number 5A and the entries relating thereto, the following serial number and entries shall be inserted, namely:-

Sl. No.	Industry	Parameter	Standards
1	2	3	4
"5B.	Thermal Power Plant (water consumption limit) using sea water	Water consumption	Items I to III in column 4 in serial number 5A above shall not be applicable to the Thermal Power Plants using sea water";

(c) in serial number 25, the following Note shall be inserted, namely:—

"**Note:** All monitored values for SO_2, NOx and Particulate Matter shall be corrected to 6% Oxygen, on dry basis";

(d) after serial number 33 and the entries relating thereto, the following serial number and entries shall be inserted, namely:—

Sl. No.	Industry	Parameter	Standards
1	2	3	4

"33A.	Thermal Power Plants with wet Flue Gas Desulphurization (FGD)	Stack Height/Limit in Meters	Power generation capacity: - 100 MW and above $H=6.902(QX0.277)^{0.555}$ or 100 m minimum - Less than 100 MW $H=6.902(QX0.277)^{0.555}$ or 30 m whichever is more"; Q = Emission rate of SO_2 in kg/hr* H = Physical stack height in meter *total of the all Unit's connected to stack **Note:** These standards shall apply to coal / lignite based Thermal Power Plants.".

[F. No. Q-15017/40/2007-CPW]
DR. A. SENTHIL VEL, Scientist 'G'

Note: The principal rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i) *vide* number S.O. 844 (E), dated the 19th November, 1986 and last amended *vide* notification number G.S.R. 263(E), dated the 22nd March, 2018.

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ANNEXURE-B

No. 23/22/2018-R&R
Government of India
Ministry of Power
***

Shram Shakti Bhawan, Rafi Marg,
New Delhi, 30th May, 2018

To

The Chairperson,
Central Electricity Regulatory Commission,
Chanderlok Building,
Janpath, New Delhi-110001

Subject: Mechanism for Implementation of New Environmental Norms for Thermal Power Plants (TPP) supplying power to distribution licensees under concluded long term and medium term Power Purchase Agreement (PPA).

Sir,

Ministry of Environment, Forest and Climate Change (MoEFCC) has notified the Environment (Protection) Amendment Rules, 2015 on 7th December, 2015 thereby introducing revised emission standards for Thermal Power Plants (TPPs). The revised emission standards are applicable to existing as well as upcoming TPPs. To meet the revised emission standards, the TPPs would have to install or upgrade various emission control systems like Flue-Gas desulfurization (FGD) system, Electro-Static Precipitators (ESP) system etc.

2. As per implementation plan prepared by Central Electricity Authority (CEA), the existing TPPs are required to comply with the new emission standards by the year 2022.

3. Implementation of revised emission standards would face challenges relating to stringent timelines, availability of suppliers and technology, shut down for longer periods, and revenue loss during shutdown. It would also have significant implications on the tariff agreed under the long term and medium term power purchase agreement (PPA) due to additional infrastructure and operational cost on account of large scale installations, renovations & retrofitting of existing plant and machinery to meet revised emission norms.

4. In view of the nature of cost involved in implementation of revised standards of emission and the provisions of Power Purchase Agreement, there is a need to develop the appropriate regulatory framework specifying the mechanism or enabling guidelines for providing regulatory certainty to the TPPs about recovery of such additional costs through tariff. It is important to ensure implementation of the revised standards of emission for TPPs for controlling pollution level in the larger public interest.

HALDIA ENERGY LIMITED (Formerly known as India Power Corporation (Haldia) Limited) Kolkata 700 091

....2/-

5. After considering all aspects and with due regard to the need for safeguards against environmental hazards, and accordingly to ensure timely implementation of new environment norms, the Central Government has decided that –

5.1 The MoEFCC Notification requiring compliance of Environment (Protection) Amendment Rules, 2015 dated 7th December, 2015 is of the nature of Change in Law event except in following cases:

a) Power Purchase Agreements of such TPPs whose tariff is determined under Section 63 of the Electricity Act, 2003 having bid deadline on or after 7th December, 2015; or

b) TPPs where such requirement of pollutions control system was mandated under the environment clearance of the plant or envisaged otherwise before the notification of amendment rules;

5.2 The additional cost implication due to installation or up-gradation of various emission control systems and its operational cost to meet the new environment norms, after award of bid or signing of PPA as the case may be, shall be considered for being made pass through in tariff by Commission in accordance with the law.

5.3 The respective TPPs may approach the Appropriate Commission for approval of additional capital expenditure and compensation for additional cost on account of this Change in Law event in respect of the Power Purchase Agreement entered under Section 62 or Section 63 of the Electricity Act, 2003.

5.4 For the TPPs that are under the purview of the Central Commission, the Commission shall develop appropriate regulatory mechanism to address the impact on tariff, and certainty in cost recovery on account of additional capital and operational cost, under concluded long term and medium term PPAs for this purpose.

6. The Central Government, in exercise of the power conferred under section 107 of the Electricity Act 2003 issues directions to the Central Electricity Regulatory Commission to implement the above decision of the Government. This direction is being issued to facilitate the smooth implementation of revised emission standards of the Environment (Protection) Amendment Rules, 2015 dated 7th December, 2015 for Thermal Power Plants in the larger public interest.

7. This issues with the approval of Minister of State (IC) for Power and NRE.

Yours faithfully,

(Ghanshyam Prasad)
Chief Engineer
Tel: 2371 0389

Copy to:
i) Secretary (MoEFCC), Government of India
ii) Chief Secretaries of all State Governments and Union Territory Administrations
iii) The Principal Secretary/ Secretary (in charge of energy) of all State Governments and UT Administrations.

ANNEXURE-D

File No.CEA-TH-14-20/2/2021-TRM Division

सत्यमेव जयते

भारत सरकार

Government of India

विद्युत मंत्रालय

Ministry of Power

केन्द्रीय विद्युत प्राधिकरण

Central Electricity Authority

तापीय परियोजना नवीनीकरण एवं आधुनिकीकरण प्रभाग

Thermal Project Renovation & Modernization Division

Dated: 15-06-2021

To,

Sh. J. Bhaumik, whole time Director
Hiranmaye Energy Limited,
Salt Lake City, Kolkata -700091.

विषय:- ***Detail Project Report (DPR) for installation of FGD for 3x150MW Thermal Power Plant of Hiranmaye Energy Limited, Haldia, Purba Midnapur, West Bengal. -reg.***

Dear Sir,

This has reference to your letter no. WTD/HMEL/ENV/CEA/2021-22/007/38 dated 10.06.2021 received through e-mail enclosing therewith requesting Detail Project Report (DPR) for installation of FGD for 3x150MW Thermal Power Plant of Hiranmaye Energy Limited, Haldia, Purba Midnapur, West Bengal for CEA to accord it's approval to submitted DPR for onward transmission to concerned regulator.

2. In this regard, it is informed that guiding norms for installation of FGD systems for different size of units has already been uploaded on CEA's website under cea.nic.in>wings>Thermal>UMPP & TPE&CC. You are also advised to look in to the "Central Electricity Regulatory Commission (Terms and Conditions of Tariff) (First Amendment) Regulations, 2020 dated 25.08.2020 (**copy attached**) "related to emission control systems, if applicable, for further guidance. Final selection of feasible technology may be done considering "Techno-economic lifecycle cost analysis" of various SO2 removal technologies. In the absence of any order of concerned regulator for approaching CEA for technology approval, it is advised that Hiranmaye Energy Limited may directly approach concerned regulator for future course of action and any plant specific requirement for FGD installation. The feasibility report submitted in this regard is returned herewith in original (if hard copy submitted).

This issues with the approval of the competent authority.

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

(सुरेंद्र कुमार)
उप निदेशक (टीपीआरएम)

ANNEXURE-E

रजिस्ट्री सं. डी.एल.- 33004/99 REGD. No. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

सी.जी.-डी.एल.-अ.-01042021-226335
CG-DL-E-01042021-226335

असाधारण
EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (i)
PART II—Section 3—Sub-section (i)

प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 192] नई दिल्ली, बृहस्पतिवार, अप्रैल 1, 2021/चैत्र 11, 1943
No. 192] NEW DELHI, THURSDAY, APRIL 1, 2021/CHAITRA 11, 1943

पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 31 मार्च, 2021

सा.का.नि. 243(अ).—केन्द्रीय सरकार, पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3, धारा 6 और धारा 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, पर्यावरण (संरक्षण) नियम, 1986 का और संशोधन करने के लिए निम्नलिखित नियम बनाती है, अर्थात् :-

1. (1) इन नियमों का संक्षिप्त नाम पर्यावरण (संरक्षण) संशोधन नियम, 2021 है।

(2) ये नियम राजपत्र में प्रकाशन की तारीख को प्रवृत्त होंगे।

2. पर्यावरण (संरक्षण) नियम, 1986 की अनुसूची-1, के क्रम संख्यांक 25 में, "*टीपीपी (इकाईयां) इस अधिसूचना के प्रकाशन की तारीख से दो वर्ष के भीतर सीमाओं को पूरा करेंगी", अक्षरों, कोष्ठकों और शब्दों के स्थान पर, निम्नलिखित रखा जाएगा, अर्थात् :-

"*(i) पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, विद्युत मंत्रालय, केन्द्रीय विद्युत प्राधिकरण (सीईए) और केन्द्रीय प्रदूषण नियंत्रण बोर्ड के प्रतिनिधियों से मिलकर बने कार्य बल का गठन केन्द्रीय प्रदूषण नियंत्रण बोर्ड (सीपीसीबी) द्वारा सारणी-1 में यथाविनिर्दिष्ट तीन प्रवर्गों में सारणी-1 के स्तंभ (4) में यथाविनिर्दिष्ट समय सीमा के भीतर उत्सर्जन मानदंडों के अनुरुप होने के लिए उनकी अवस्थिति के आधार पर तापीय विद्युत संयत्रों के प्रवर्गीकरण हेतु किया जाएगा, अर्थात् :-

सारणी-1

क्र.सं.	प्रवर्ग	अवस्थिति/स्थान	अनुपालन के लिए समय सीमाएं	
			निवृत्त नहीं होने वाली इकाईयां	निवृत्त होने वाली इकाईयां
(1)	(2)	(3)	(4)	(5)
1	प्रवर्ग क	10 लाख से अधिक जनसंख्या वाले राष्ट्रीय राजधानी क्षेत्र या शहरों की 10 किलोमीटर की परिधि के भीतर 1	31 दिसम्बर, 2022 तक	31 दिसम्बर, 2022 तक
2	प्रवर्ग ख	गंभीर रूप से प्रदूषित क्षेत्रों या गैर प्राप्ति शहरों की 10 किलोमीटर की परिधि के भीतर 2	31 दिसम्बर, 2023 तक	31 दिसम्बर, 2025 तक
3	प्रवर्ग ग	प्रवर्ग क और ख में सम्मिलित से भिन्न	31 दिसम्बर, 2024 तक	31 दिसम्बर, 2025 तक

[1] भारत की 2011 की जनगणना के अनुसार ।

[2] सीपीसीबी द्वारा यथापरिभाषित ।

(ii) सारणी-1 के स्तंभ (5) में यथाविनिर्दिष्ट तारीख के पूर्व निवृत्त होने के लिए घोषित तापीय विद्युत संयत्र से, उस स्थिति में जहां ऐसे संयंत्र उनके निवृत्त होने के आधार पर छूट के लिए सीपीसीबी और सीईए को एक प्रतिज्ञान प्रस्तुत करते हैं, विनिर्दिष्ट मानदंडों को पूर्ण करने की अपेक्षा नहीं की जाएगी:

परन्तु ऐसे संयत्रों से, उस स्थिति में जहां उनका प्रचालन प्रतिज्ञान में यथाविनिर्दिष्ट तारीख से आगे जारी रहता है, जनित विद्युत के प्रति यूनिट पर 0.20 रुपए की दर से पर्यावरण प्रतिकर उद्ग्रहीत किया जाएगा;

(iii) निवृत्त नहीं होने वाले तापीय विद्युत संयंत्र से, सारणी-1 के स्तंभ (4) में यथाविनिर्दिष्ट तारीख के पश्चात्, सारणी-2 में विनिर्दिष्ट दरों के अनुसार पर्यावरण प्रतिकर उद्ग्रहीत किया जाएगा, अर्थात् :-

सारणी-2

समय-सीमा से आगे गैर अनुपालन प्रचालन	पर्यावरणीय प्रतिकर (रुपए प्रति यूनिट जनित विद्युत)		
	प्रवर्ग क	प्रवर्ग ख	प्रवर्ग ग
0-180 दिवस	0.10	0.07	0.05
181-365 दिवस	0.15	0.10	0.075
366 दिवस और अधिक	0.20	0.15	0.10"

[फा.सं. क्यू-15017/40/2007-सीपीडब्ल्यू]

नरेश पाल गंगवार, संयुक्त सचिव

टिप्पणः मूल नियम, भारत के राजपत्र, असाधारण, भाग II, खंड 3, उपखंड (i) में अधिसूचना संख्या का.आ. 844(अ), तारीख 19 नवम्बर, 1986 द्वारा प्रकाशित किए गए थे और उनका अंतिम संशोधन अधिसूचना संख्या सा.का.नि. 662(अ), तारीख 19 अक्तूबर, 2020 द्वारा किया गया ।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, the 31st March, 2021

G.S.R. 243(E).—In exercise of the powers conferred by sections 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Environment (Protection) Rules, 1986, namely:—

1. (1) These rules may be called the Environment (Protection) Amendment Rules, 2021.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Environment (Protection) Rules, 1986, in Schedule – I, in serial number 25 for letters, brackets and words "*TPPs (units) shall meet the limits within two years from date of publication of this notification", the following shall be substituted, namely: -

"* (i) A task force shall be constituted by Central Pollution Control Board (CPCB) comprising of representative from Ministry of Environment and Forest and Climate Change, Ministry of Power, Central Electricity Authority (CEA) and CPCB to categorise thermal power plants in three categories as specified in the Table-I on the basis of their location to comply with the emission norms within the time limit as specified in column (4) of the Table-I, namely: -

Table-I

Sl. No.	Category	Location/area	Timelines for compliance	
			Non retiring units	Retiring units
(1)	(2)	(3)	(4)	(5)
1	Category A	Within 10 km radius of National Capital Region or cities having million plus population[1].	Upto 31st December 2022	Upto 31st December 2022
2	Category B	Within 10 km radius of Critically Polluted Areas[2] or Non-attainment cities[2]	Upto 31st December 2023	Upto 31st December 2025
3	Category C	Other than those included in category A and B	Upto 31st December 2024	Upto 31st December 2025

[1] As per **2011** census of India.

[2] As defined by CPCB.

(ii) the thermal power plant declared to retire before the date as specified in column (**5**) of Table-I shall not be required to meet the specified norms in case such plants submit an undertaking to CPCB and CEA for exemption on ground of retirement of such plant:

Provided that such plants shall be levied environment compensation at the rate of rupees **0.20** per unit electricity generated in case their operation is continued beyond the date as specified in the Undertaking;

(iii) there shall be levied environment compensation on the non-retiring thermal power plant, after the date as specified in column (**4**) of Table-I, as per the rates specified in the Table-II, namely:-

Table-II

Non-Compliant operation beyond the Timeline	Environmental Compensation (Rs. per unit electricity generated)		
	Category A	**Category B**	**Category C**
0-180 days	0.10	0.07	0.05
181-365 days	0.15	0.10	0.075
366 days and beyond	0.20	0.15	0.10. "

[F. No. Q-15017/40/2007-CPW]

NARESH PAL GANGAWAR, Jt. Secy.

Note: The principle rules were published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i) vide number S.O. 844(E), dated the 19th November, 1986 and lastly amended vide notification G.S.R. 662(E), dated the 19th October, 2020.

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ANNEXURE-C

Hiranmaye Energy Limited

FINAL

DETAILED PROJECT REPORT FOR INSTALLATION OF EMISSION REDUCTION PLANT TO MEET LATEST MOEF & CC NORMS

3 x 150 MW THERMAL POWER PLANT

KASHBERIA –VILLAGE, SIBARAM NAGAR-P.O,
BHAVANIPORE-P.S, HALDIA, WEST BENGAL, INDIA-721635

Doc.No. FCE-3120152-ME-DOC-PFR-3000-001, Rev. R1

May 2021

FICHTNER **Consulting Engineers (India) Pvt Ltd**

Document Revision Record

Rev.	Date	Details of revision	Prepared by	Checked by	Approved by
R0	26.03.2021	For Approval	Madurai Veeran V Rajeev, Sakthivel, Anand	Sunita .N. Kelekar	
R1	12.05.2021	For Approval	Madurai Veeran V Rajeev, Sakthivel, Anand	Srinivasan.V	

Disclaimer

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List of Annexures

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Glossary

CEA	Central Electricity Authority
COD	Commercial Operation Date
DCS	Distributed Control System
DSI	Dry Sorbent Injection
ESP	Electro Static Precipitator
FGD	Flue Gas Desulphurization
GGH	Gas to Gas Heater
HEL	Hiranmaye Energy Limited
ID	Induced Draft
MOEF & CC	Ministry of Environment, Forest and Climate Change
NOx	Oxides of Nitrogen
NPV	Net present value
PM	Particulate Matter
RCC	Reinforced Cement Concrete
ReACT	Regenerative Activated Coke Technology
SCR	Selective Catalytic Reduction
WFGD	Wet Limestone based FGD

1. Executive Summary

1.1 Introduction

Hiranmaye Energy Limited (HEL) (formerly India Power Corporation (Haldia) Limited), operates a Coal based Thermal Power Plant of capacity 3 x 150 MW in Haldia, West Bengal, India.

HEL has appointed Fichtner Consulting Engineers (India) Private Limited (FI) to assess, evaluate and prepare a feasibility study report to reduce SOx , NOx, Particulate Matter, Specific water consumption and Mercury complying with the revised norms issued by Ministry of Environment & Forests and Climate Change (MoEF & CC) vide the Gazette notification dated 7th December 2015 & its amendment.

The scope of this report is to establish the feasibility for installation of emission reduction plant to meet MoEF& CC Norms for the following units of the Thermal Power Plant.

Thermal Power Plant Name	Unit Capacity	Date of COD
Hiranmaye Energy Limited	3x150 MW	Unit 1: February 2017 Unit 2 : April 2018 Unit 3: Yet to commission

Table 1-1 : List of units and its COD

1.2 Brief Details of the Plant

Owner	Hiranmaye Energy Limited
Location	Haldia, West Bengal
Nearest Railway station	Haldia
Site elevation	2.65 M above MSL
Nearest Airport	Netaji Subhas Chandra Bose International Airport (CCU)
Nearest Sea port	Haldia Port
Latitude of site	22.03°N
Longitude of site	88.06°E

Table 1-2 : Plant Details

1.3 Site Study and Input Data

FI team visited the power plant site for studying the existing plant set up and had discussions with HEL officials. FI team collected the plant design data, present recorded values of emission

measured at stack, particulars related to coal analysis and other plant design details. The list of input data received is indicated in **Annexure-1**.

The coal analysis listed in **Annexure-2** is considered to estimate baseline SO_x emission values.

1.4 Applicable Emission Standard

Units 1, 2 & Unit 3 come under the category "TPPs (units) installed after 01st January, 2017" and "Units smaller than 500 MW capacity units", as per MOEF & CC Gazette Notification dated 7th December 2015. In view of this following are the applicable emission limits.

Parameters	Unit	Standard
Sulphur Dioxide (SO_x)	mg/Nm^3	100
Oxides of Nitrogen (NO_x)	mg/Nm^3	100
Particulate Matter (PM)	mg/Nm^3	30

Table 1-3 : Applicable Emission Limits for Units 1 & 2

1.5 Estimated/Measured Emissions of Plant

Measured and estimated SOx emission level are compared with the limiting emission values mandated by December 2015 MOEF&CC norms in the below table.

Unit Capacity	SOx (mg/Nm^3)*		
	Estimated Emission base line Data with 0.4% S@ 6% O2	Measured Emission base line Data @ 6% O2	Dec 2015 MOEF&CC Norms
150 MW (Unit 1)	1850*	946	100
150 MW (Unit 2)	1850*	946	100
150 MW (Unit 3)		Yet to commission	100

Table 1-4 : SOx Present emissions and MOEF&CC norms

Measured SOx emission level is less than the estimated value of SOx emission with 0.4% Sulphur. Sulphur content in Indian coal varies from 0.35 to 0.5%, as a conservative and practical approach, Estimated SOx emission values with 0.4% Sulphur is considered in this report.

*The base emission values computed above considering coal GCV of 3000 kcal/kg with 0.4% S at 6% O2 are considered for further study on selection of technology and equipment for SO2 control to limit the emission level to 100 mg/Nm^3.

Measured NOx emission level is compared with the limiting emission values mandated by December 2015 MOEF&CC norms in the below table.

Unit Capacity	NOx (mg/Nm^3)	
	Measured Emission base line Data	Dec 2015 MOEF&CC Norms
150 MW (Unit 1)	435	100
150 MW (Unit 2)	435	100
150 MW (Unit 3)	Yet to commission	100

Table 1-5 : NOx Present emissions and MOEF&CC norms

Measured particulate emission level is compared with the limiting emission values mandated by December 2015 MOEF&CC norms in the below table

Unit Capacity	Particulate matter (mg/Nm^3)	
	Measured Emission base line Data	Dec 2015 MOEF&CC Norms
150 MW (Unit 1)	50	30
150 MW (Unit 2)	50	30
150 MW (Unit 3)	Yet to commission	30

Table 1-6 : Particulate Matter Present emissions and MOEF&CC norm

Measured Specific Water Consumption level is compared with the limiting values mandated by December 2015 MOEF&CC norms in the below table

Unit Capacity	Specific Water Consumption (m^3/MWh)	
	Measured specific water consumption Data	Dec 2015 MOEF&CC Norms
150 MW (Unit 1)	3.27 to 3.92**	3.0
150 MW (Unit 2)	3.27 to 3.92**	3.0
150 MW (Unit 3)	Yet to commission	3.0

Table 1-7 : Specific water consumption Present levels and MOEF&CC norm

** The specific water consumption varies from 3.27 to 3.92 m^3/MWh during, multiple start-ups and shutdown of plant, operating with high chloride content in intake water.

From the data furnished and detailed assessment of the same, it is observed that the estimated SOx, NOx, PM emission values and Specific water consumption for both the units are exceeding the stipulated limit. Hence, measures to reduce SOx, NOx, PM emission and Specific water consumption need to be implemented.

1.6 Technology Selection for SOx, NOx and PM Control

Many technologies are available for SOx, NOx and PM control in flue gas from power plants and these technologies are operational in plants worldwide. An overview of available technologies for SOx, NOx and PM control in thermal power plants is presented in Chapter- 3.

The selection of appropriate technology and equipment depends on many factors such as type of boiler, coal analysis, required removal efficiency, operational requirement, environmental regulation, layout feasibility, land availability, whether technology is well established, estimated auxiliary power and utility requirement, capital expenditure and operating cost.

Based on the detailed study presented in this report, FI recommends the following:

1.6.1 SOx Control

- The present SOx emission level needs to be reduced by around 94.5% to meet the Dec 2015 MoEF & CC norms for Unit-1 and 2.

- Limestone based FGD with dedicated absorber for each unit without GGH and a common auxiliary (limestone storage and handling, gypsum handling and storage, Process water) system is recommended as the suitable technology to limit the SOx emission level within December2015 MoEF & CC norms.

- Typical Limestone Analysis is enclosed as **Annexure-4**

1.6.2 NOx Control

- The present NOx emission level needs to be reduced by around 77 % to meet the Dec 2015 MoEF& CC norms for Unit-1 and 2.

- Primary control measures and Secondary control measure of Selective catalytic Reduction (SCR) with common Ammonia storage system is recommended.

1.6.3 Particulate Matter Control

- The present PM emission level needs to be reduced by around 40 % to meet the Dec 2015 MoEF& CC norms for Unit-1 and 2.
- Upgrading of existing ESP with advanced electrical and control system (Replacement of existing ESP transformer sets with low frequency three phase transformer set or with Low ripple high frequency IGBT controlled power supply instead of conventional thyristor) and dosing of Ammonia at ESP inlet are recommended.
- Capacity of the existing ash handling system will have to be augmented to cater to disposal of additional ash generated.

1.6.4 Specific Water Consumption

- As per site data , the specific water consumption is about 3.05 m^3/MWh , of During ,multiple start-ups and shutdown of plant, operating with high chloride content in intake water, Specific water consumption varies from 3.27 m^3/MWh to 3.92 m^3/MWh. Additionally 105 m^3/h of clarified water will be required for FGD operation of 3 x150 MW units. Considering, average plant specific water consumption as 3.59 m^3/MWh and with additional FGD water requirement of 105 m^3/h, the specific water consumption works out to 3.82 m^3/MWh. This exceeds the specific water consumption norm of 3.0 m^3/MWh.

- To limit the specific water consumption, it is recommended to adopt UF-RO based waste water treatment system of capacity 300 m^3/hr for 2 units and extension of the same by additional 150 m^3/hr when the third unit is in operation.

1.6.5 Mercury Control

The permissible mercury emission as per MoEF norms is 0.03 mg/Nm^3. As per the flue gas analysis the mercury emitted is 0.0006 mg/Nm^3. This is within the MoEF permissible limits.

1.7 Stack Height

Ministry of Environment, Forest and Climate Change, Government of India issued Gazette notification on 28th June 2018 amending the Environment (Protection) Rules, 1986.
As per this Gazette the recommended stack height for Thermal Power Plants with wet flue gas desulphurization has to be worked out using the formula given below:

Sl.No	Industry	Parameter	Standard
1.	Thermal Power Plants with wet Flue Gas Desulphurization (FGD)	Stack Height/Limit in Meters	Power generation capacity: **100 MW and above** H=6.902(Qx0.277)0.555 (Or) 100 m minimum **Less than 100 MW** $H=6.902(Qx0.277)^{0.555}$ (Or) 30 m whichever is more Q = Emission rate of SO2 in Kg/hr* H= Physical stack height in meter *Total of the all Unit's Connected to stack

Table 1-8 : Stack Height

Although stack height works out to 58.M, as per the above equation, it is proposed to provide a new common tri-flue wet chimney with height of 100 m for units-1, 2 and 3 as per CEA recommendation. However, since the plant is located in thickly populated industrial area which

contributes to increased ground level concentration, any upward revision in the chimney height shall be studied by Environmental consultant.

1.8 Impact of Pollution Control Equipment on Plant Design

The impact on the existing plant design due to implementation of recommended Emission reduction plants is described below:

a) The flue gas temperature at chimney inlet after installation of WFGD without GGH will be around 55°C. A separate suitably lined wet Chimney is proposed for the discharge of wet flue gas from units-1, 2 and 3.
b) Auxiliary power requirement for each unit of FGD will be around 1500 kW.
c) 105 m^3/h of Clarified water will be the additional requirement for FGD operation of 3 x150 MW units.
d) Limestone consumption for FGD will be around 1.729 t/h for each unit.
e) Calcium sulphate (Gypsum) generated will be around 2.808 t/h for each unit.
f) Ammonia consumption for SCR will be around 0.078 t/h for each unit.
g) The auxiliary power consumption for SCR will be around 58 kW for each unit.
h) The auxiliary power consumption for waste water treatment system will be around 450 kW for two units.
i) Instrument air and service requirement will be around 1.2 Nm3/minute and 1.0 Nm3/minute respectively. This requirement will be met from existing plant instrument and service air header.
j) Capacity of the existing ash handling system will have to be augmented to cater to disposal of additional ash generated.
k) HT power supply for FGD will have to be extended from Owner's station switchgears located in the switchgear room of TG building, by modifying existing feeders for feeding FGD switchgear.
l) To provide Emergency supply to feed critical load of FGD, one (1) number of feeder will be provided in the existing DG PCC to each unit FGD emergency board. The approximate load of FGD emergency load will be 100 kW each per unit
m) Common PLC based control system is envisaged for the FGD, Nox and Particulate Matter Emission reduction system. PLC based control system for emission reduction plant will be interfaced with the existing plant DCS for monitoring from CCR through soft link. Hardwiring is also envisaged with Plant DCS for the control & interlock signals with main plant.
n) Space has been identified for FGD installation on South West Side of the existing plant. The space identified is adequate for the installation of FGDs and their auxiliaries.

1.9 Project Schedule

The completion period for implementation of abatement methods for the plant on EPC basis would be 26-30 months. The downtime for flue gas duct modification in the existing plant will be 4 weeks/boiler.

1.10 Project Cost Summary

The abstract of the capital cost of Emission reduction plant (to meet Dec 2015 MOEF &CC Norms including amendments) without IDC and FC is as follows:

System / Equipment	Total Estimated Project Cost for Boiler 1 & 2 (INR in Crores)
Limestone based FGD system and its auxiliaries	210
SCR system and its auxiliaries	90
ESP Upgrading	40
UF-RO plant	45
Total Emission reduction plant Cost	**385**
Erection, testing and commissioning	55.06
Taxes & duties including transit insurance	73.84
Overheads (Pre-operative Expenses , Shifting & Relocating of existing facilities, Consultancy, Services, Insurances etc.)	5.13
Contingencies	15.4
Total Project Cost	**534.46**

Note: Civil works and spares cost are included in the respective package

Table 1-9 : Project Cost Summary

1.11 Impact on Generation Cost

The impact on fixed and variable cost by implementation of emission reduction plant with 80% PLF.

Parameter	Unit	Units 1 & 2
Impact on Fixed Cost (First Year)	INR/kWh	0.767
Impact on Variable Cost (Reagents/by product)(First Year)	INR/kWh	0.033
Impact on Total Cost (First Year)	INR/kWh	0.800
Levelised impact on cost (18 Years)	INR/kWh	0.677

Table 1-10 : Impact on fixed and variable cost

2. Basis of Study

This study is conducted to assess the feasibility of implementing suitable Nox, Sox and PM control measure to ensure compliance to Environment (Protection) Amendment Rules, 2015 issued by Ministry of Environment Forest and Climate Change, Government of India as a Gazette Notification dated 7th December, 2015. The basis of the feasibility study is discussed in this Chapter.

2.1 Environment (Protection) Rules Amendment

Ministry of Environment, Forest and Climate Change, Government of India issued Gazette notification on 7th December 2015 amending Environment (Protection) Rules, 1986. Amended rules are called Environment (Protection) Amendment Rule, 2015. Gazette notification on Amendment dated 28th June 2018 provides the norms for the specific water consumption limits and also provides the norms for stack height.

The emission standards for Thermal Power Plants as per Ministry of Environment, Forest and Climate Change are given below:

S.No.	Industry	Parameter	Standards
1	2	3	4
"25.	Thermal Power Plants	**TPPs (units) installed before 31st December, 2003**	
		Particulate Matter	100 mg/Nm^3
		Sulphur Dioxide (SO_2)	600 mg/Nm^3 (Units Smaller than 500 MW capacity units) 200 mg/Nm^3 (for units having capacity of 500 MW and above)
		Oxides of Nitrogen (Nox)	600 mg/Nm^3
		Mercury (Hg)	0.03 mg/Nm^3 (for units having capacity of 500 MW and above)
		TPPs (units) installed after 1st January 2004, up to 31st December, 2016	
		Particulate Matter	50 mg/Nm^3
		Sulphur Dioxide (SO_2)	600 mg/Nm^3 (Units Smaller than 500 MW capacity units) 200 mg/Nm^3 (for units having capacity of 500 MW and above)

S.No.	Industry	Parameter	Standards
1	2	3	4
		Oxides of Nitrogen (Nox)	450* mg/Nm^3
		Mercury (Hg)	0.03 mg/Nm^3
		TPPs (units) to be installed from 1st January, 2017	
		Particulate Matter	30 mg/Nm^3
		Sulphur Dioxide (SO_2)	100 mg/Nm^3
		Oxides of Nitrogen (Nox)	100 mg/Nm^3
		Mercury(Hg)	0.03 mg/Nm^3

* Amended as per MOEF notification dated 19th October 2020.

Table 2-1 : Emission Standards as per MOEF&CC

2.2 Applicable Emission Standard for HEL

Thermal Power Plant Name	Unit Capacity	Date of COD
Hiranmaye Energy Limited	3x150 MW	Unit 1: February 2017 Unit 2:April 2018 Unit 3: Yet to commission

Table 2-2 : List of Units commissioned

Units 1, 2 & 3 come under the category "TPPs (units) installed after 1st January, 2017" and "Units Smaller than 500 MW capacity units", as per the MOEF & CC gazette notification.

Parameters	Unit	Standard
Sulphur Dioxide (SO_2)	mg/Nm^3	100
Oxides of Nitrogen (NO_x)	mg/Nm^3	100
Particulate Matter (PM)	mg/Nm^3	30
Mercury (Hg)	mg/Nm^3	0.03
Specific water consumption	m^3/MWh	3.0

Table 2-3 : Applicable Emission Limits for Units 1, 2 & 3

2.3 Site Study and Data Collection

FI team visited the power plant site to study the existing plant set up and discussed with HEL officials. Plant design data, particulars related to coal analysis and other plant input data received is listed in **Annexure - 1**.

Coal analysis provided in **Annexure-2** is considered to estimate baseline SOx emission values.

Flue gas analysis provided in **Annexure-3** is considered to estimate baseline NOx and PM emission values.

A site walkthrough was conducted to understand the plant equipment layout and to ascertain the space provision and space availability for installation of emission reduction equipment.

2.4 Plant Configuration and Plant Details

Description	Plant Data
Plant Configuration	Unit 1 : 150 MW , Unit 2 : 150 MW and Unit 3 : 150 MW
Steam Generator	Two Pass, Natural circulation, balanced draft, Sub-critical pressure, Pulverized coal fired unit.
Coal Data considered	Indonesian and Indian coal Gross Calorific Value of Design Coal : 3000 kcal/kg Sulphur Content of Design Coal : 0.4 %
Chimney	Common tri flue chimney of 220 m height
Space for Future FGD	Space identified is shown in attached General Layout Refer **Exhibit - 8 for details**

Table 2-4 : Plant data

3. Technology Overview for SO_x, NO_x, PM and Specific Water Consumption Control

This Chapter describes the emission control technologies available to control the Oxides of Sulphur (SOx), Oxides of Nitrogen (NOx), particulate matter (PM) in flue gas and Specific water consumption.

3.1 Pollutant from Coal Combustion

Coal is used as primary fuel in thermal power plants. In India, thermal power plants use both low sulphur Indian coal and high sulphur containing imported coal. Coal contains elements like Carbon, Nitrogen, Sulphur, Ash and other elements. Coal combustion process with air results in formation of pollutants such as NOx, SO2 and SO3 and Particulate matter (PM).

When Sulphur containing fuel undergoes combustion, the sulphur in the fuel combines with oxygen and forms gaseous SO2.

$S + O_2 \rightarrow SO_2$

At higher temperatures, with presence of excess oxygen, some percentage of SO_2 is further oxidized to SO_3.The SOx in flue gas forms acid plumes in the atmosphere when temperature reduces below acid dew point. This causes corrosive environment which is hazardous to life and equipment.

3.2 SO_x Control Methods

The following are the various types of SO_2 removal technology;

a) Wet Limestone based FGD system (WFGD)
b) Semi-Dry FGD system
c) Sea water based FGD system
d) Dry Sorbent injection system
e) Ammonia based FGD
f) Electron Beam Flue gas treatment system
g) ReACT Technology
h) GORETM SO2 and Mercury control system

3.2.1 Wet Limestone Based FGD System

Wet limestone based FGD (Wet FGD) is a proven technology used worldwide for the control of SO_2 from utility power plant.

Limestone is commonly used as a reagent for Wet FGD. The overall process reaction is:
$CaCO_3 + SO_2 + 2\ H_2O + ½\ O_2 \rightarrow CaSO_4.\ 2\ H_2O + CO_2$

The SO_2 removal process occurs as hot flue gas enters the absorber where it is cooled and saturated by the limestone slurry. The flue gas then flows upward through the absorber spray zone, where lime stone slurry is sprayed counter current to the flue gas flow, completing the SO2 removal process. The process includes forced oxidation system to convert Calcium Sulphite ($CaSO_3.½H_2O$) formed by SO2 removal process to Calcium Sulphate dehydrated ($CaSO_4.½H_2O$) or gypsum.

The limestone forced oxidation system could achieve efficiency in the range of 90 - 98% in power plants firing variety of coal.

The major systems/equipment of Wet limestone based FGD system are slurry recirculation pumps, oxidation blowers, Flue gas handling system including Booster fan, Lime slurry preparation, gypsum handling system, waste water recovery system and related duct work, isolation and bypass dampers.

Gas to Gas Heat Exchangers

Wet FGD systems can be with GGH or without GGH.

At GGH heat from unclean hot flue gas entering the Absorber is transmitted to cleaned flue gas leaving the absorber

The use of gas to gas heat exchanger (GGH) in FGD system has got both merits and demerits.

Merits

1) The GGH has advantage of reducing the temperature of inlet raw flue gas to the absorber which reduces potential of damage to scrubber internals in case of flue gas excursion and mal-operation etc.
2) Reheating of treated flue gas helps in reducing stack condensation (due to superheating of saturated moisture).

Demerits

1) Requires additional space
2) Additional pressure drop.
3) Leakage issues.
4) GGH elements getting choked up during operation causing frequent unit shutdown
5) More operating cost,
6) Corrosion of cold end of GGH

Listed demerits offset the merits of GGH, Hence the GGH is not recommended in this project.

Chimney

When using an existing chimney for wet flue gas application, it should be ensured that the velocity inside the flue is restricted to a level to avoid spitting of acidic condensate from the flue exit to atmosphere. In case of wet limestone based FGD, SO_3 component is not removed and hence the wet flue gas from the absorber will have acidic condensate. The velocity of flue will ensure that the condensate adhere to flue lining material to form a thin film to enable condensate collection. As per wet stack model studies conducted in labs, the limiting velocities to enable condensate collection have been determined. For Alloy lining material, the limiting velocity is 16.8 m/s and for borosilicate the limiting velocity is 18.3 m/s. In India, all chimney flues are invariably designed for flue gas velocity of 22 m/s to 25 m/s. The existing flues will not be suitable for wet flue gas and hence use of same is not recommended.

Therefore, it is required to have a new wet chimney.

a) Chimney Lining

The wet chimney will be suitably lined. The chimney flue liner cladding will be made of 2 mm thick Titanium (Grade 2) / C-276 alloy over 8 mm thick (minimum) mild steel base metal of flue liner or Borosilicate Glass Block Lining of minimum 38 mm thickness. Cladding will be done to achieve the required quality as per ASTM B 898-11. External surface of chimney flue liner projecting over the chimney roof will be wrapped with 2 mm thick Titanium / C-276 sheet over insulation. The wet stack will be designed as per the guidelines of EPRI Revised Wet Stack Design Guide.

Description	Units	Data			
Stack inner diameter	m	4.5			
Stack height	m	100			
Stack inner surface area	m2	1413.72			
Lining material		C276	Titanium	Borosilicate	Glassflake
Lining material thickness	mm	2	2	38	3
Lining material density	kg/m3	8890	4500	-	-
Quantity of lining material	kg	9077	4595	-	-
Cost of lining material	Crores in INR	8.17	3.05	3.27	0.99
Ranking based on Initial Cost		4	2	3	1
Life of lining material	Years	25	25	10	10

Description	Units	Data			
Replacement cost of lining material after 10 years	Crores in INR	-	-	4.39	1.33
Replacement cost of lining material after 20 years	Crores in INR	-	-	5.90	1.79
Total cost of lining material	Crores in INR	8.17	3.05	13.55	4.11
Ranking based on evaluated life cycle cost		3	1	4	2

Based on the above life cycle cost analysis and the limited availability of titanium suppliers, glass flake lining is recommended for proposed wet chimney.

b) Wet Chimney Condensate Collection System
To avoid the carryover of the condensate/acidic dews/water droplets/ gypsum coming out of the wet chimney a condensate collection system will be provided. Design of the condensate system should be such that the liquid condensate film near the exit of the stack is collected in the chimney and preventing falling of the acidic dews/water droplet/gypsum from the chimney in the nearby area.

c) Wind tunnel study
Installation of new wet chimney in the vicinity of the existing chimney would require wind tunnel & location study for proposed and existing chimneys.

Flow diagram for Wet limestone based FGD system is presented in Exhibit - 01, Schematic Diagram for Wet Lime stone based FGD system.

This technology is considered for further study in this report.

3.2.2 Semi Dry Circulating Fluidized Bed Scrubber FGD System (CFBS)

Circulating Dry Scrubber FGD technology is semi-dry type SO_2 control technology used for utility power plants where higher SO_2 capture efficiency is required. CFBS system consists of a Circulating Fluidized Bed Scrubber and one no. 100% capacity pulse jet fabric filter (PJFF) as major equipment.

Hydrated Lime (CaO) is used as the reagent in the system. Dry lime is pulverized and stored in lime storage silos. Powdered lime is conveyed to hydrator system where it is hydrated and further stored in hydrated lime storage silos.

Flue gas from the ID Fans enters the CFBS near the bottom of the scrubber vessel. The gas moves in turbulent flow upward through the scrubber. The flue gas, boiler ash, un-reacted lime

and FGD byproducts emerge from the top of the CFBS as a dust / gas mixture that proceeds to the fabric filter. Byproduct material is re-circulated from the PJFF to the CFBS to maximize reagent utilization.

The flue gas is cooled by evaporation of finely sprayed water injected into the CFBS. The water is sprayed through return-flow nozzles and is finely dispersed by hydraulic atomization through the use of high-pressure water pumps. The water flow is automatically adjusted according to the set process temperature and is continuously controlled by a control valve in the return-flow line, leading excess water from the injection nozzles back to the water storage tank.

The cooling of the flue gas reduces its effective volume and also enhances the reactivity of the pollutants to allow for optimized removal.

The mixture of reagent & ash in flue gas are separated in the fabric filter, and a large portion of the solids collected are recirculated through a control valve back into the CFBS. After sufficient retention time in the scrubber the byproduct is discharged out of the fabric filter to a storage silo by an external conveying system. The pulse jet fabric filters are designed for online cleaning of filter bags.

Flow diagram for Semi Dry FGD system is presented in Exhibit - 02 Schematic Diagram for Semi Dry FGD system.

This technology is considered for further study in this report.

3.2.3 Sea Water based FGD

Sea water based FGD is a type of Wet FGD, where the sea water is used as reagent.

The alkalinity in sea water is used for scrubbing the SO_2 from the flue gas. This system is adopted for power plants installed in coastal area based on alkalinity level in sea water and where SO_2 capture efficiency of maximum 90% is required.

This system is not elaborated in this report as the plant is not located in a coastal area.

3.2.4 Dry Sorbent Injection (DSI)

Dry sorbent injection systems involve the injection of a dry sorbent (typically sodium bicarbonate or lime) into the ductwork following the boiler. SO_2 reacts directly with the dry sorbent, and the dry product is collected in a downstream particulate control device. Because a separate absorber vessel is not needed, capital costs are minimized. Dry injection systems are generally applied when lower removal efficiencies are required, or in small plants where the capital cost for other absorber types may not be justified. Dry injection systems can typically

achieve maximum removal efficiencies ranging from 50 to 90% depending on the specific conditions of the application.

DSI systems are not widely used for utility power plants considering lower capture efficiency, high reagent cost and limited suppliers in the market. This technology has problem in refuse disposal (based on ash composition in coal) and lack of revenue generation for the by-product (refuse). This technology is considered for further study in this report, as per CEA's advice dated 07th February 2020.

Flow diagram for Dry Sorbent based FGD system is presented in Exhibit – 07 Schematic Diagram for Dry Sorbent Injection system.

Although the DSI system efficiency is <90%, for system comparison purpose, the same is studied further.

3.2.5 Ammonia based Desulphurisation system

The Ammonia based Desulphurisation system is gaining popularity worldwide due to its environmental friendly and saleable fertilizer generation as a by-product (Ammonium sulphate).

The Ammonia based FGD process is based on reaction between 99.6% purity Ammonia (chemical composition of 18% Hydrogen and 82% Nitrogen) and SO_2 in the Absorber tower to form the intermediate product Ammonium sulphite /bisulphate. Air will be fed into the absorber to oxidise this product into Ammonium sulphate.

The overall process reaction is:

$SO_2 + H_2O + x\ NH_3 \rightarrow (NH_4)x\ H_2\text{-}x\ SO_3$ ---------- (1)
$(NH_4)x\ H_2\text{-}x\ SO_3 + ½\ O_2 + (2\text{-}x)\ NH_3 \rightarrow (NH_4)2\ SO_4$ ---------- (2)

The Ammonia based FGD consists of following three sub-systems:

a) Flue gas system: Flue gas enters the absorber. After cooling, scrubbing, and demisting steps, clean flue gas is discharged from the stack.
b) Absorption and Oxidation system: Ammonia reacts with SO_2 forming Ammonium Sulphite/ bisulphate, which is subsequently oxidised to Ammonium Sulphate by air. Heat from the flue gas is utilised to concentrate the Ammonium sulphate solution.
c) Ammonium sulphate system (AS): The AS slurry is further refined through solid-liquid separation, drying and packaging to produce AS fertilizer.

Very high efficiency (99.9%), lower SO_2 emission (<35 mg/Nm3), no waste water treatment and solid waste disposal cost, zero CO2 emission, 10% lower auxiliary power consumption

compared to limestone based plants and high value fertiliser as by-product are the features of this system.

Flow diagram for Ammonia based FGD system is presented in Exhibit –03 Schematic Diagram for Ammonia based FGD system. This technology is considered for further study in this report.

3.2.6 Electron Beam Flue Gas Treatment system

Flue gas treatment using electron beams is a technology in which desulphurization and denitrating of flue gas is carried out by combining it with ammonia gas and then irradiating it with electron beams. When the flue gas is irradiated with electron beams, highly chemically reactive free radicals are generated within the emissions.

The sulphur oxides (SOx) and nitrogen oxides (NOx) present in the flue gas react with these radicals and are thereby converted first into sulfuric acid and nitric acid and subsequently into aerosols, (fine powdered matter) of ammonium sulphate and ammonium nitrate.

These aerosols are then extracted by means of an electrostatic precipitator and the cleaned flue gas is emitted via the stack.

The advantage of this system being, Desulphurisation and Denitration take place in one process. The Desulphurisation efficiency is over 95% and Denitration efficiency is over 80%.

Flow diagram for system is presented in Exhibit - 04 Schematic Diagram for Electron Beam Flue Gas Treatment system.

Very few references of Industrial coal burning plants are available in the world. Hence this technology is not considered for further study.

3.2.7 ReACT Technology

Regenerative Activated Coke Technology (ReACT) is an Advanced integrated Multi-Pollutant Control Technology. This is a fully dry process based on moving bed adsorption on activated coke.

Contact between flue gas and slow moving bed of activate carbon /coke, provides mechanisms for efficient adsorption of SO_2 and acid gases of Hg, fly ash capture, and surface promoted catalytic and non-catalytic NOx reduction. Ammonia injected into the flue gas upstream of the moving bed of coke, helps in NOx reduction on the surface of activated coke which helps in low temperature SCR reactions. NOx and NH_3 are reduced to N2.Ammonia added will help in SOx reduction also. The design provided for 95% of SOx control generally yields 20-40% NOx reduction. The Ammonia injection is in the range of 0.5 mol: mol of SO2.

The by-product is Sulphuric acid which is saleable.

Flow diagram for ReACT system is is presented in Exhibit - 05, Schematic Diagram for ReACT system.

This system is not elaborated in this report due to lack of adequate references world-wide for coal fired power plants.

3.2.8 GORE™ SO_2 and mercury control

The mercury and SO_2 control system is a unique fixed catalyst for removing SO_2 and mercury from flue gas. The system is based on discrete stackable modules that are installed downstream of particle collection system. The modules utilize an open channel which results in very low pressure drop.

The flue gas is quenched with water to cool and humidify gas stream (< 800C and 90% relative humidity preferred operating window). The gas is then cooled in modules. Operation is passive; the modules will continuously convert SO_2 to liquid sulphuric acid, and chemically absorb mercury for many years without requiring any adjustment, regeneration or replacement.

SO_2 in the flue gas is catalytically converted to liquid sulphuric acid which is spelled out of the hydrophobic Sorbent Polymer Catalyst (SPC) composite material as large of droplets. The dilute acid is collected in sump below the modules. This part of the process takes place without any reagent and with minimal energy penalty.

Flow diagram for GORE system is presented in Exhibit – 06.

This system is not elaborated in this report due to lack of adequate references world-wide for coal fired power plants.

3.3 Comparison of Technologies

3.3.1 Technical Comparison of Technologies

Based on the available technologies Wet Limestone FGD, DSI, Dry/ Semi Dry FGD, Ammonia based FGD, ReACT& GORE are compared and salient points are provided in the table below

Parameter	Wet Limestone based FGD (WFGD)	Ammonia based FGD	GORETM	Dry/Semi Dry based FGD	REACTTM	Dry Sorbent Injection System (DSI)
Technology	Proven technology for variety of coal based higher capacity Power plants.	Emerging technology for variety of coal based higher capacity Power Plants.	New Multi pollutant control technology (SO_2/Hg control) for variety of coal based small and medium capacity Power Plants.	Proven technology for plants upto 300 MW. For units above 300 MW, multiple modules are required.	New Multi pollutant control technology (SO2/NOx/Hg control) for variety of coal based higher capacity Power Plants.	Emerging technology for coal based Power Plants of capacity less than 250 MW and life of less than 10 years.
SO2 Removal Efficiency	Higher> 90 % and up to 98%	Up to 99.9%	Up to 85%	Maximum 94%.	Upto 99.9%	Upto 90%
Reagent type	Limestone	Anhydrous Ammonia / Aqueous Ammonia / Urea	Sorbent Polymer Catalysts (SPC)	Quick lime	Activated coke and Ammonia	Sodium Bicarbonate for removal efficiency of 50 to 90%. Hydrated lime for removal efficiency of 30 to 70%.
By-product	Gypsum generated is of commercial grade	Ammonium Sulphate generated is widely used as fertilizer	Sulphuric acid which is marketable and usable for water & waste water treatment system within power plant	Unreacted lime along with gypsum, calcium sulphite is recovered in the fabric filter, which are disposed as land fill.	Sulphuric acid which is marketable.	Sodium sulphate in lesser ratio with Flyash. (Vary based on Ash composition on coal)
Requirement of Fabric filter	No	No	No	Yes	No	Yes
Operational Flexibility	Responsive to variation in boiler load.	Responsive to variation in boiler load.	Responsive to variation in boiler load.	Lower part load efficiency.	Responsive to variation in boiler load.	Responsive to variation in boiler load
Power consumption	1% of the Installed Plant capacity.	0.9% of the installed plant capacity.	0.8 – 1% of the installed plant capacity.	1.2 – 1.5 % of the Installed plant capacity.	1.5 – 1.6 % of the Installed Plant capacity.	0.15% of the plant installed capacity
Water requirement	Water requirement is comparatively higher due to slurry preparation.	Water requirement is more as compared to Wet Limestone process	Water requirement is very less	Water requirement is less in comparison to the wet system.	Water requirement is very minimal.	Water requirement is very minimal.
Steam Requirement	Yes (If GGH is provided)	Yes, for Ammonia sulphate production	Yes, for Sulphuric acid concentration plant	No	No	No

Parameter	Wet Limestone based FGD (WFGD)	Ammonia based FGD	GORETM	Dry/Semi Dry based FGD	REACTTM	Dry Sorbent Injection System (DSI)
SO3 capture	SO3 capture is minimal	SO3 capture is about 80 -90%	High removal efficiency for SO3.	High removal efficiency for SO3.	High removal efficiency for SO3.	SO3 capture is about 85%
Pressure drop across the system	Higher	Similar to Wet Limestone FGD	Lower	Lower	Higher	Lower
Raw material cost	Cost of Limestone is less in comparison to Lime powder of dry system	Very Costly. But, the requirement would be 1/3rd of Limestone per MT of SO2 removal.	Nil	Costlier	Very Costly as, it needs to be imported.	Approximately 3 times the limestone cost
Area Requirement	Higher	Equal to Wet Limestone based plant	Less compared to wet Limestone based plant	Lower	Less compared to Wet Limestone plant	Less compared to Wet Limestone plant
Suppliers	Many suppliers available world wide	Limited suppliers	Proprietary design	Many suppliers available world wide	Limited suppliers	Limited suppliers
Operating cost	Higher due to ancillary systems (limestone handling, mills, gypsum handling, etc)	Less due to few ancillary systems	Very less, due to non-requirement of Reagents	More, due to replacement of fabric filters and reagent cost	Higher	Higher due to cost of the reagent
Hazardous	No	Yes	Yes	No	No	No

Table 3-1 : Techno Economic Comparison of Wet FGD/Ammonia based FGD/GORETM/Semi Dry based FGD/REACT™

3.3.2 Techno - Economic Analysis of Technologies

The merits and demerits of the various technologies are compared above. The following technologies have been considered for further economic evaluation mainly since these technologies are proven for coal fired power plant application.

- Wet Limestone based FGD
- Ammonia based FGD
- Semi Dry FGD
- Dry Sorbent Injection (DSI)

The comparison of economics for the above four technologies in terms of evaluated life cycle cost is provided in Table below.

Description	Unit	Data
Boiler configuration	TPH	505
Flue gas flow rate	Nm^3/s	150
Reagent Consumption		
a) Lime stone for WFGD (Purity 85%)	t/h	1.729
b) Anhydrous Ammonia (Purity 99.6%)	t/h	0.527
c) Quick lime (Purity 85%)	t/h	1.264
d) Sodium Bicarbonate	t/h	2.481
By-product generation		
a) Gypsum	t/h	2.808
b) Ammonium Sulphate	t/h	2.005
c) End product (landfill) (Semidry)	t/h	46.346
d) End product (Ash) (DSI)	t/h	47.562

Table 3-2 : Inputs for the Life cycle cost analysis

S.No	Item	Unit	Limestone WFGD	Ammonia	Semi Dry FGD	DSI
1	Capital Cost (including taxes and duties)	INR	1,85,85,00,000	1,67,26,50,000	1,57,97,25,000	41,81,62,500
2	O&M Cost (1st year)	INR	3,71,70,000	3,34,53,000	3,15,94,500	92,92,500
	O&M Cost (NPV)	INR	35,49,16,237	31,94,24,613	30,16,78,802	8,87,29,059
3	Reagent Cost (1st Year)	INR	5,14,96,536	10,98,73,176	7,52,93,952	46,18,38,150
	Reagent(NPV)	INR	44,72,94,505	95,43,49,005.57	65,39,96,824.64	4,01,14,86,654.28

S.No	Item	Unit	Limestone WFGD	Ammonia	Semi Dry FGD	DSI
4	Process Water (1st Year)	INR	53,61,120	48,25,008	21,44,448	-
	Process Water (NPV)	INR	4,38,11,187	3,94,30,069	1,75,24,475	-
5	Aux Power (1st Year)	INR	4,91,43,600	4,42,29,240	4,91,43,600	49,14,360
	Aux Power (NPV)	INR	40,16,02,550	36,14,42,295	40,16,02,550	4,01,60,255
6	Steam (1st Year)	INR	-	4,30,56,495	-	-
	Steam (NPV)	INR	-	37,39,85,031	-	-
7	By-Product Cost (1st Year)	INR	1,46,35,858	4,18,01,844	1,38,03,693	1,33,32,580
	By-Product Handling (NPV)	INR	11,96,04,541	34,16,05,563.24	11,28,04,071	10,89,54,128
	Total evaluated life cycle cost	INR	2,98,65,19,939	3,00,56,90,420	3,06,73,31,723	4,71,39,55,096
	Total evaluated life cycle cost/ MW	Cr/MW	1.99	2.00	2.045	3.143
	Ranking based on evaluated life cycle cost		1	2	3	4

Table 3-3 : Life Cycle Cost analysis of FGD Technologies

The above comparison is based on the following considerations:

a) Considered life of plant = 18 years for both Boilers
b) Plant Load Factor = 80%
c) Landed cost of Limestone = INR 4000/ ton
d) Landed cost of Ammonia = INR 28000/ ton
e) Landed cost per ton of Quick Lime = INR 8000/ ton
f) Landed cost of Sodium Bi Carbonate = INR 25000/ ton
g) Handling & Transportation cost
h) per ton byproduct of dry FGD and DSI = INR 40/ton
i) Selling cost of Gypsum = INR 700/ ton
j) Selling cost of Ammonium Sulphate = INR 2800/ ton
k) Steam cost = INR 1500/ Ton
l) Escalation = 2 % for reagent
m) Electricity selling price per unit = 4.4 INR/kWhr

n) Water Cost = INR 20/m3
o) Operation and maintenance cost = 2% of Capital cost
p) Operation & Maintenance escalation = 3.5%

Wet Limestone based FGD is emerging as the suitable technology based on table 3.3, Hence, Wet lime stone based FGD is considered as suitable technology considering it as well proven technology and majority of the FGD population around the world use this technology. Handling of reagent and byproduct are non-hazardous when compared with Ammonia based FGD system.

Ammonia based FGD installations are very few when compared with limestone based FGD worldwide and Handling / storing of hazardous ammonia could be considered as key factor determining developer's preference for ammonia.

3.4 NOx Control Methods

Following are the various types of NOx reduction technology:

- Reducing peak temperature
- Reducing residence time at peak temperature
- Chemical reduction of NOx
- Oxidation of NOx with subsequent absorption
- Removal of nitrogen
- Using a sorbent

3.4.1 Reducing peak temperature

Flue Gas Recirculation (FGR), Natural Gas Reburning (NGR), Over Fire Air (OFA) Less Excess Air (LEA), Reduced Air Preheat are some of the technique available for NOx reduction.

These techniques are not elaborated in this report due to lack of adequate references world-wide for coal fired power plants with fluidised bed combustion.

3.4.2 Reducing residence time at peak temperature

Injection of steam in combustion chamber is the technique available for NOx reduction.
These techniques are not elaborated in this report due to lack of adequate references world-wide for coal fired power plants with fluidised bed combustion.

3.4.3 Chemical reduction of NOx

Selective Noncatalytic Reduction (SNCR)

SNCR technology is a non-catalyzed chemical reaction utilizing an ammonia based reagent (such as urea or ammonia) for reducing NOx into nitrogen (N_2) and water (H_2O) by injecting

this reagent into the post combustion gas stream at temperatures ranging from 870 to1320°C. The reagent can react with a number of flue gas components. However, the NOx reduction reaction is favored over other chemical reaction processes for a specific temperature range and in the presence of oxygen; therefore, it is considered a selective chemical process.

The conventional SNCR process occurs within the combustion unit, which acts as the reaction chamber. The injection nozzles are located in the post-combustion area in the upper area of the furnace near the convective passes. The injection causes mixing of the reagent and flue gas. The heat of the boiler provides the energy for the reduction reaction. The NOx molecules are reduced and the reacted flue gas then passes out of the boiler.

Flow diagram for SNCR system is presented in Exhibit –09. This technology is considered for further study in this report.

Selective Catalytic Reduction (SCR)

SCR process is based on the chemical reduction of the NOx molecule. The primary difference between SNCR and SCR is that SCR employs a metal-based catalyst with activated sites to increase the rate of the reduction reaction. The primary components of the SCR include the ammonia storage and delivery system, ammonia injection grid, and the catalyst reactor. A nitrogen-based reducing agent (reagent), such as ammonia or urea-derived ammonia, is injected into the post-combustion flue gas. The reagent reacts selectively with the flue gas NOx within a specific temperature range and in the presence of the catalyst and oxygen to reduce the NOx into molecular nitrogen (N_2) and water vapour (H_2O).

Reagent is injected into the flue gas downstream of the combustion unit and economizer through an injection grid mounted in the ductwork. The reagent is generally diluted with compressed air or steam to aid in injection. The reagent mixes with the flue gas, and both components enter a reactor chamber containing the catalyst. As the hot flue gas and reagent diffuse through the catalyst and contact activated catalyst sites, NOx in the flue gas chemically reduces to nitrogen and water. The heat of the flue gas provides energy for the reaction. The nitrogen, water vapor, and any other flue gas constituents then flow out of the SCR reactor.
Flow diagram for SCR system is presented in Exhibit–08. This technology is considered for further study in this report.

3.4.4 Oxidation of NOx with subsequent absorption

Non-Thermal Plasma Reactor (NTPR)

Non-Thermal Plasma Techniques for pollution control is the efficient use of electrical energy through selective dissociation of the toxic molecules. "Non Thermal" plasmas as the name implies, are plasmas in which the electron temperatures are considerably higher than those of the components of the ambient gas. Non-thermal plasma techniques are particularly efficient

when the toxic materials are present in very small concentrations, as is the case for flue gas emissions.

These techniques are not elaborated in this report due to lack of adequate references world-wide for coal fired power plants with fluidised bed combustion.

3.4.5 Removal of Nitrogen

This is accomplished by removing Nitrogen as a reactant either by: (1) using Oxygen instead of air in the combustion process; or (2) using ultra-low Nitrogen content fuel to form less fuel NOx. Eliminating Nitrogen by using oxygen tends to produce a rather intense flame that must be subsequently and suitably diluted.

These techniques are not elaborated in this report due to lack of adequate references world-wide for coal fired power plants with fluidised bed combustion.

3.4.6 Sorption, both adsorption and absorption

Treatment of flue gas by injection of sorbents (such as ammonia, powdered limestone, aluminium oxide, or carbon) can remove NOx and other pollutants (principally sulphur). There have been successful efforts to make sorption products a marketable commodity. This kind of treatment has been applied in the combustion chamber, flue, and baghouse. The use of carbon as an adsorbent has not led to a marketable product, but it is sometimes used to limit NOx emissions in spite of this. The sorption method is often referred to as using a dry sorbent, but slurries also have been used. This method uses either adsorption or absorption followed by filtration and/or electrostatic precipitation to remove the sorbent.

3.5 Comparison of NOx Reduction Technologies

3.5.1 Technical Comparison of Technologies

Based on the available technologies SNCR & SCR are compared and salient points are provided in the table below.

Design Criteria	SNCR	SCR
NOx Reduction Efficiency	25-50%	60-90%
Operating Temperature	750°C to 1100°C	250°C to 425°C
Reactor & Catalyst	Not required	Required
Waste Disposal	None	Spent catalyst
Energy Consumption	Low	High
Space Requirements	Lower (Only for reagent storage & injection system)	Higher (for reactor & reagent injection system)
Maintenance	Low	1 to 3 years

Design Criteria	SNCR	SCR
		(typical catalyst life)
Ammonia Slip	5 to 20 ppmvd	5 to 10 ppmvd
Retrofit	Simple (only injection grid for reagent to be installed at the furnace outlet zone) and requires IBR approval of the modification.	Difficult (Separate Reactor with sorbent injection grid and catalyst array are to be installed)
Suppliers	Many suppliers world wide	Many suppliers world wide

Table 3-4 : Comparison of NOx Reduction Technologies

3.5.2 NOx Technology Selection

HEL needs to check with boiler OEM regarding the possibility of primary NOx reduction measures in the boiler before implementing secondary reduction measures. The primary measure includes Combustion optimization like over fired air, Introduction of low NOx burners or Modified burners.

HEL will implement the primary NOx reduction and then decide on the selection of the SCR system or Hybrid system (SNCR + SCR system). Hybrid system consists of SNCR system and SCR with minimum layer of catalyst to meet the NOx removal efficiency between 50% to 60%. Hybrid system configuration will be confirmed by OEM at later stage.

Generally SNCR system is adopted for NOx removal efficiency of 50% or less. For higher removal efficiency of 60% to 90%, SCR system is adopted. CAPEX is higher for SCR compared to SNCR system.

Based on the technical comparison and to meet the requirement of 77.77% NOx reduction, SCR emerges as the suitable technology. Ammonia will be used as regent.

3.6 Particulate matter control methods

The following are the various types of SPM reduction technology for boilers

i) Pollution control devices
ii) Flue gas conditioning

Various types of Pollution control devices are given below

i) Electrostatic precipitators (ESPs)

ii) Filters and dust collectors (baghouses)
iii) Wet scrubbers

3.6.1 Electrostatic precipitators (ESPs)

Electrostatic precipitators (ESPs) remove particles by using an electrostatic field to attract the particles onto the electrodes. Collection efficiencies for well-designed, well-operated, and well maintained systems are typically in the order of 99.9% or more of the inlet dust loading. ESPs are especially efficient in collecting fine particulates and can also capture trace emissions of some toxic metals with an efficiency of 99%. They are less sensitive to maximum temperatures than are fabric filters, and they operate with a very low pressure drop. Their consumption of electricity is similar to that of fabric filters. ESP performance is affected by fly-ash loading, the resistance of fly ash, and the sulphur content of the fuel. Lower sulphur concentrations in the flue gas can lead to a decrease in collection efficiency.

3.6.2 Filters and dust collectors (baghouses)

Filters and dust collectors (baghouses) collect dust by passing flue gases through a fabric that acts as a filter. The most commonly used is the bag filter, or baghouse. The various types of filter media include woven fabric, needled felt, plastic, ceramic, and metal. The operating temperature of the baghouse gas influences the choice of fabric. Accumulated particles are removed by mechanical shaking, reversal of the gas flow, or a stream of high-pressure air. Fabric filters are efficient (99.9% removal) for both high and low concentrations of particles but are suitable only for dry and free-flowing particles. Their efficiency in removing toxic metals such as arsenic, cadmium, chromium, lead, and nickel is greater than 99%. They also have the potential to enhance the capture of sulphur dioxide (SO_2) in installations downstream of sorbent injection and dry-scrubbing systems.

Fabric filters are sensitive to temperature of flue gas and operate at comparatively higher pressure drops, baghouses are not recommended.

3.6.3 Wet scrubbers

Wet scrubbers rely on a liquid spray to remove dust particles from a gas stream. They are primarily used to remove gaseous emissions, with particulate control a secondary function. The major types are ressur scrubbers, jet (fume) scrubbers, and spray towers or chambers. Spray towers can handle larger gas flows with minimal pressure drop and are therefore often used as pre coolers. Because wet scrubbers may contribute to corrosion, removal of water from the effluent gas of the scrubbers may be necessary. Another consideration is that wet scrubbing results in a liquid effluent. Wet-scrubbing technology is used where the contaminant cannot be removed easily in a dry form, soluble gases and wettable particles are present, and the contaminant will undergo some subsequent wet process (such as recovery, wet separation or settling, or neutralization).

Due to the limitation of temperature of flue gas and liquid effluent discharge, wet scrubbers are not recommended.

3.6.4 Flue gas conditioning

Flue gas conditioning (FGC) involves injection of chemical additives and/or water or steam into the flue gas to alter the physio-electrical properties of the fly ash, such that the collection efficiency of ESP increases substantially. The main objective of FGC is to condition the particles of fly ash / dust in the gas to increase their size, which results in increased collection efficiency.

The following are the various types of flue gas conditioning available for SPM reduction

- Water/steam conditioning
- Sulphur trioxide conditioning
- Ammonia conditioning

3.6.5 Water/steam conditioning

The injection of water by employing an atomizer, or steam to a flue gas stream not only reduces its temperature but also increases its relative humidity. Water or steam is adsorbed on the particles of the fly ash, or dust to form a very thin conductive film. This causes reduction in their surface resistivity and hence in order to have more charge carriers, the critical electrical field strength has to be overcome, for which, high voltage has to be applied. This results in an increased collection efficiency of the ESP without any significant reduction in the volume or temperature of the incoming flue gases.

The demerits of this system are

a) Reduction in temperature, which may lead to acid dew point and cause corrosion problems
b) Formation of ash lumps in hoppers which makes the ash conveying system more difficult.

3.6.6 Sulphur trioxide conditioning

The most commonly used conditioning agent to modify fly ashes of high resistivity is ressur trioxide. Two major factors that control ash electrical resistivity are (i) ressur content of the feed coal; and (ii) overall elemental composition of the ash .

Increasing the ressur content in the system is not recommended; hence this technology is not elaborated further in this report.

3.6.7 Ammonia conditioning

Some fly ashes do not readily absorb Sulphuric acid vapor, which are generated naturally from ressur in the coal or due to the FGC with SO3. This is mainly due to the presence of silica, alumina and iron in the fly ash, making the surface of the ash glassy and less absorbent. For such ashes, the addition of ammonia has been reported to be quite beneficial. During ammonia conditioning, ammonia reacts with the natural ressur trioxide, or moisture present in the fly ash, and produces ammonium bi-sulfate.

It must be noted that these particles alter the electrical characteristics of the flue gas between the discharge and collecting electrodes, which produces a space charge enhancement of the electric field . Ammonia is used as a coagulating agent to create larger fly ash particles; therefore it provides a fly ash that is receptive to the available SO3. When the flue gas temperature is above 150 Deg.C, ammonium bisulfate melts and become a semiliquid, acting like glue when mixed with the fly ash. This produces highly cohesive and relatively large particles, resulting in high collection efficiency due to the reduced rapping losses and re-entrainment.

3.6.8 Particulate Matter Technology Selection

The existing power plant layout does not have space reserved for additional ESP Field. Introduction of one more field would result in complicating the duct routing due to major modification. In the view of above, HEL may consider following option, feasibility of Ammonia dosing at ESP along with upgrading of ESP with latest control technology (Replacement of existing ESP transformer sets with low frequency three phase transformer set or with Low ripple high frequency IGBT controlled power supply instead of conventional thyristor) which is expected to give desired reduction in particulate emission in consultation with ESP OEM.

Capacity of the existing ash handling system will have to be augmented to cater to disposal of additional ash generated.

3.7 Specific water Consumption

As per the water balance of 3 x 150MW units, the total water consumption is 1681 m3/h (3.73 m^3/MWh) and the entire CT blow down is used for Ash conveying to ash dyke. As per HEL's latest input clarification, the Specific Water Consumption (SWC) is 3.05 m^3/MWh during normal operation. The SWC increases to 3.27 m^3/MWh and 3.92 m^3/MWh when the chloride content in intake water is 800-1000ppm during normal operation and multiple start-up & shutdown respectively.

Major contributors for increase in specific water consumption of the existing plant as per water balance diagram are as follows.

S.No	Description	Unit	Values	Remarks
1	Evaporation loss of Cooling tower	Cu.m/hr	872	For 3 units
2	Drift loss of Cooling tower	Cu.m/hr	30	For 3 units
3	CT blow down used in ash water sump for ash conveying and coal dust conditioning	Cu.m/hr	660	CT blowdown water (COC - 2.5)
4	Other Miscellaneous (HVAC, Service water , CBD tank)	Cu.m/hr	121	
5	Total	Cu.m/hr	1681	
6	Specific water consumption	Cu.m/MWh	3.73	

Table 3-5 : Present Water Consumption

Reduction of the above listed losses from the plant is not feasible, since all the equipment of 2 Units of 150 MW are designed and commissioned. Further, addition of Emission reduction plant will increase the water consumption around 105 m^3/h for the plant.

The Specific water consumption with implementation of abatement method works out to 3.82 m^3/MWh, considering the scenario of multiple start-ups and shutdown of plant, operating with high chloride content in intake water. This exceeds the specific water consumption MoEF level of 3.0 m^3/MWh.

The meet the specific water consumption of 3.0 m^3/MWh, it is proposed to treat the CT blow down water with an 80-85% efficient UF-RO based waste water treatment plant of capacity 300 m^3/hr for 2 units and extension of the same by additional 150 m^3/hr when the third unit is in operation.

The cooling tower blow down water will be collected in the suitably sized Central Monitoring Basin (CMB). The collected water will be treated in the waste water treatment system through clarification, filtration, ultrafiltration and reverse osmosis system. The required dosing system like lime dosing, soda ash dosing, dolomite dosing, ferric chloride dosing, poly electrolyte dosing, etc. will be provided to meet the required parameters. The treated water will be utilized for CT makeup. The reject water from waste water treatment plant is proposed to be pumped to the neutralizing pit of existing plant Ro treatment plant.

3.8 Technology Selection for Emission Reduction Plant

To meet the latest MOEF & CC Gazette Notification dated 7th December 2015 and its amendments, Three (SOx, NOx and PM) abatement measures are required for this power plant.

Primary reduction measures along with Ammonia/Urea reagent based SCR to be implemented to meet the MoEF stipulated NOx levels.

For PM reduction, with the space limitation, addition of one more fields is not feasible. Upgrading of the existing ESP with latest electrical and control methods (Replacement of existing ESP transformer sets with low frequency three phase transformer set or with Low ripple high frequency IGBT controlled power supply instead of conventional thyristor) and dosing of Ammonia in the ESP will improve the collection efficiency of ESP.

As mentioned above, in both (NOx and PM) abatement measures, Ammonia is used as reagent. Hence storing and handling of Ammonia is inevitable for this project. HEL needs to obtain necessary permissions and clearances for implementation of Ammonia storage and handling

Wet lime stone based FGD is considered as suitable technology considering it is well proven technology and is most established system in Indian power plants. Handling of reagent and byproduct are non-hazardous when compared with Ammonia based FGD system.

UF-RO based waste water treatment plant is considered for reducing the specific water consumption.

4. Technology Description for SO_x and NO_x Control

Flue gas analysis as per site data is attached as Annexure-3 (Flue Gas Analysis).The emission levels are calculated using the Thermoflow software for the coal analysis provided by HEL. These values are assessed and compared with the limiting emission values mandated by December 2015 MOEF&CC norms.

4.1 SO_2 Control

Base line SO_2 Emission and required SO_2 removal efficiency

- The SO_2 emission data estimated by FI based on coal analysis received from HEL is considered as the base emission value.

SO_2 emission based on coal with 0.4 % S = 1850 mg/Nm^3 *

***The emission values indicated are estimated using Thermoflow Software (used for design of Coal Based Thermal Power Plant worldwide) based on coal analysis furnished as input by HEL.**

- As per the MOEF&CC norms units 1, 2 & 3 fall under the category "TPPs (units) installed after 1st January, 2017" and "Units smaller than 500 MW capacity units", the permitted SO_2 emission is 100 mg/Nm^3.

- The base emission values computed above considering coal GCV of 3000 kcal/kg with 0.4 % S at 6% O2 are considered for further study on selection of technology and equipment for SO_2 control to limit the emission level to 100 mg/Nm^3. Based on the above the FGD SO_2 removal efficiency works out to minimum of 94.5 % for Boilers 1 & 2 without limestone injection in the furnace.

4.2 SO_2 Control – Technology Selection

4.2.1 Limestone based FGD

Limestone based Flue Gas Desulphurization (FGD) technology is suitable for SO_2 emission control with a SO_2 removal efficiency 94.5% to meet the December 2015 MOEF&CC norms stipulation. This technology is considered suitable considering proven technology implemented worldwide for utility power plants, gypsum byproduct which is marketable and Reagent being non-hazardous for ease of storage and handling.

This technology is accepted by CEA and published norms for Ammonia based FGD.

4.2.2 Wet Limestone based FGD and Equipment

In the wet limestone based FGD process proposed limestone with 85% purity is used as the desulfurization absorbent to capture the SO2 in the flue gas to form calcium sulfite solution and air is fed into the absorber to oxidize the intermediate to calcium sulfate solution. The flue gas flows upwards through the absorber spray zone where limestone slurry is sprayed counter current to the flue gas flow completing the SOx removal process.

The overall process reaction is;

$CaCO_3 + SO_2 + 2\,H_2O + ½\,O_2 \rightarrow CaSO_4.\,2\,H_2O + CO_2$

The flue gas is tapped from the flue gas duct at downstream of ID fan discharge damper. A booster fan is provided to develop the head required to overcome the pressure drop across the FGD system. The ressurized untreated flue gas from the booster fan enters the absorber. The flue gas will be dispersed to atmosphere through the existing stack during FGD bypass condition.

The treated gas from absorber released to the atmosphere through the chimney over absorber at about 58°C.

FGD system to be installed at this plant will have inlet and bypass dampers to be provided on the ducting. Necessary modifications for the installation of the bypass damper in the flue gas duct and utilization of the existing duct supports will be evaluated during implementation.

The major systems / equipment of the Limestone based FGD systems are listed with their design features and functional aspects are discussed below:

- Booster fan
- Limestone Handling and Slurry preparation system
- Absorber and Slurry recirculation system
- Oxidation air system
- Gypsum Dewatering system
- Waste water treatment system
- Emergency slurry tank
- Process water system

a) Booster Fan for FGD System

Booster fan will be required to feed the flue gas to FGD system to address the following:

- Pressure drop across the FGD system from the unclean flue gas take off point till the clean flue gas connected to proposed wet Chimney
- The flue gas temperature drop in FGD system will reduce the draft available at the proposed wet stack.

In order to develop the head required for the above, booster fans will be provided for the FGD system. Considering the space availability, it is proposed to have one booster fan for each boiler with a common standby unit. The common standby unit (complete set) will be made available at the plant as spare.

b) Limestone handling and Slurry preparation system

The limestone is envisaged to be received through roadways as lumps of (-) 250mm size. Limestone stored in limestone yard will be crushed to (-) 20mm size before feeding to wet limestone ball mill. The limestone storage shed will be sized for 15 days requirement. The limestone from the limestone storage yard will be conveyed by conveyors /bucket elevators to the bulk storage silo and then to day storage silo in the lime slurry preparation area. Ball mills, mill permeate tank, hydro cyclones, lime slurry tanks will have redundancy.

c) Absorber and Slurry re-circulation system

Absorber will be of spray type. In spray type absorber where the flue gas and the limestone slurry flow in the counter current direction. The limestone slurry is sprayed at different levels in the absorber through spray nozzle grids. Each elevation spray nozzle grid is supplied by a dedicated slurry recirculation pump and a common standby for all the recirculation pumps will be provided. The sprayed limestone slurry is collected in the reaction chamber located in the bottom of the absorber. The slurry is re-circulated in the absorber.

The Absorbers to be installed in plant shall be designed for optimum flue gas velocity. The slurry pump capacity and the numbers will be decided based on the optimum Liquid/Gas (L/G) ratio.

In case of absorber with gas bubbling through the slurry, the absorber shall be provided with flue gas distribution system to the slurry and gas cooling water pumps shall be provided to cool and saturate the incoming hot flue gas.
Absorber type and design will be specific to the FGD supplier and hence same shall be finalized during implementation.

d) Oxidation air system

The function of the oxidation air system is to supply oxidation air with designed pressure to the absorber. Limestone sulfite is oxidized into Limestone sulfate solution.

e) Gypsum Dewatering System

The slurry density and Ph in the absorber reaction chamber will be monitored and portion of the slurry shall be bled to maintain the solids concentration in the slurry. The slurry will be pumped to 2x100% hydro cyclones where the over flow is taken back to the absorber and the underflow is taken to the vacuum belt filter.

The gypsum from the vacuum belt filter will have purity >90%, moisture <10% and chlorides <100ppm.

The wall board gypsum generation from the units depends on the quality of the limestone fed to the system. The gypsum storage shed will be sized for 15 days of gypsum generated. Gypsum will be stacked in the shed with the aid of conveyor mounted with travelling tripper for stacking along the length of shed. Gypsum will be reclaiming manually with the aid of dozers and payloaders for loading in the trucks.

f) Emergency Slurry tank

The Emergency slurry tank will be of MS with inside glass flake lining/ ceramic acid resistant tile lining. The capacity of the tank will be suitable for holding the volume of one absorber reaction tank. The Slurry tank will be provided with agitator and pump re-circulation facility to avoid settling of slurry in the tank. The system is common system and is used only during emergency or planned shut down for the transfer of slurry from the absorber to take up maintenance work in the absorber/ reaction tank.

g) Process water tanks

The functions of the process water system are storing process water which is industrial water transported with pipelines and supplying make-up water to the absorber based on the process demand to maintain the water balance of the system. Process water system consists of process water tanks and process water pumps.

The process water is used as make-up water and flushing water for demisters and pipelines. The consumption of the process water includes water evaporated with the flue gas and the moisture taken away with the calcium sulfate product. The process water tank will be sized for holding 4 hours storage requirement. One tank will be used for equipment cooling and the other tank will be used for process and mist cleaning requirement. The gypsum cake wash water is required on continuous basis; this water requirement is met from the clarified water.

h) Power & Utility Consumption for each FGD

The auxiliary power consumption for the FGD equipment is presented in Chapter 6. The major power consumers are the Booster fan and Slurry recirculation pumps. Instrument air requirement for the system will be met from the existing air compressors in the plant.

4.3 Nox Control – Technology Selection

4.3.1 Selective Catalytic Reduction (SCR)

Selective Catalytic reduction (SCR) is a post combustion emissions control technology for reducing Nox by injecting nitrogen based reducing agent (reagent) such as ammonia or urea derived ammonia.

a) Process Description

The basis of SCR technology is catalyzed chemical reaction utilizing ammonia based reagent (such as urea or ammonia) for reducing Nox into nitrogen (N_2) and water (H_2O). Reagent is injected into the flue gas downstream of the combustion unit and economizer through an injection grid mounted in the ductwork. The reagent is generally diluted with compressed air or steam to aid in injection. The reagent mixes with the flue gas, and both components enter a reactor chamber containing the catalyst. As the hot flue gas and reagent diffuse through the catalyst and contact activated catalyst sites, Nox in the flue gas chemically reduces to nitrogen and water. The heat of the flue gas provides energy for the reaction. The nitrogen, water vapor, and any other flue gas constituents then flow out of the SCR reactor.

There are several different locations downstream of the combustion unit where SCR systems can be installed. Flue gas temperature and constituents vary with the location of the SCR reactor chamber. SCR reactors located upstream of the particulate control device and the air heater ("high-dust" configuration) have higher temperatures and higher levels of particulate matter. An SCR reactor located downstream of the air heater, particulate control devices, and flue gas desulfurization (FGD) system ("low-dust" or "tail-end" configuration) is essentially dust- and sulfur-free but its temperature is generally below the acceptable range. In this case, reheating of the flue gas may be required, which significantly increases the SCR operational costs.

The reducing agent employed by the majority of SCR systems is gas-phase ammonia (NH_3) because it readily penetrates the catalyst pores. The ammonia, either in anhydrous or aqueous form, is vaporized before injection by a vaporizer. Within the appropriate temperature range, the gas-phase ammonia then decomposes into free radicals, including NH_3 and an amide (NH_2). After a series of reactions, the ammonia radicals come into contact with the Nox and reduce it to N_2 and H_2O. Since Nox includes both nitrogen monoxide (NO) and nitrogen dioxide (NO_2).

b) Reagents

The SCR system can use either aqueous or anhydrous ammonia for the reduction reaction, or urea-to-ammonia reagent systems where aqueous ammonia is produced onsite (often called onsite urea-derived ammonia production or "ammonia-on- demand"). Anhydrous

ammonia is nearly 100 percent pure ammonia. It is a gas at normal atmospheric temperature; therefore, it must be transported and stored under pressure. Anhydrous ammonia is classified as a hazardous material and often requires special permits as well as additional procedures for transportation, handling and storage.

SCR applications using aqueous ammonia generally transport and store it at a concentration of about 29 percent ammonia in water, although some applications use a 19 percent solution. The use of aqueous ammonia reduces transport and storage problems related to safety. Aqueous ammonia, however, requires more storage capacity than anhydrous ammonia and it also requires shipping costs for the water solvent in the solution. Although the 29 percent aqueous ammonia solution has substantial vapor pressure at normal air temperatures, a vaporizer is generally required to provide sufficient ammonia vapor to the SCR system.

The type of reagent used affects both the capital costs and annual costs. Anhydrous ammonia typically has the lowest capital and operating costs, excluding highly site-dependent permitting and risk management planning and implementation costs. Urea systems have the highest capital costs due to the complexity of the processing equipment. Aqueous ammonia systems tend to have the highest operating costs, primarily because of the cost for transportation.

Generally, anhydrous ammonia, which is typically, used in conventional SCR. HEL to approach the relevant regulating authorities for storage and handling of anhydrous ammonia

c) Catalyst

SCR catalysts are composed of active metals or ceramics with a highly porous structure. Within the pores of the catalyst are activated sites. These sites have an acid group on the end of the compound structure where the reduction reaction occurs. As stated previously, after the reduction reaction occurs, the site reactivates via rehydration or oxidation. Over time, however, the catalyst activity decreases, requiring replacement, washing/cleaning, rejuvenation, or regeneration of the catalyst. Catalyst designs and formulations are generally proprietary. Both the catalyst material and configuration determine the properties of the catalyst.

d) Ammonia Slip

Ammonia slip refers to the excess reagent passing through the reactor. Ammonia in the flue gas causes a number of problems including health effects, visibility of the stack effluent, salability of the fly ash, and formation of ammonium sulfates. Limits on acceptable ammonia slip, imposed by either regulatory limits or design requirements, place constraints on SCR performance.

e) Ammonia injection

For proper dispersion of ammonia in the boiler flue gas path mixing of ammonia with air is required. Two (1W+1S) dilution air blowers for each boiler will supply the required dilution air to the mixing unit where the ammonia is vaporized and mixed in the required proportion.

f) SCR Duct works

In retrofit installations, new ductwork is required to integrate the SCR system with the existing equipment. In high-dust SCR systems for utility and industrial boilers, the reactor is located between the economizer outlet and the air heater inlet.

Low-load boiler operations can decrease the temperature at the SCR reactor inlet below the SCR operating range. In addition, startup and shutdown of the boiler causes drastic temperature fluctuations. For these operating conditions, an SCR bypass may (but not necessarily) be required to route the flue gas around the reactor chamber. The bypass prevents catalyst poisoning and fouling during periods when flue gas stream conditions do not meet design specifications for proper SCR operation. The bypass system also must include zero-leakage dampers to prevent flue gas leakage from poisoning and fouling the catalyst while the SCR is not operating.

g) Soot blower

In coal-fired boilers, soot blowers are usually installed in the SCR reactor to remove particulates that may mask or block active catalyst surfaces and gas passages. Soot blowing helps maintain acceptable flue gas pressure drop in the SCR reactor by keeping the catalyst gas passages free of particulate. Soot blowers also keep the air heater gas passages open and thereby reduce system pressure drop. This is especially true for SCR retrofits where the air heater plate spacing is generally narrow, making it more susceptible to fouling or clogging by ammonia-sulfur salts.

Retractable rake-type soot blowers that use steam or air for blowing are used in SCR designs. The soot blowers are typically located above each catalyst layer. Soot blowing is usually performed on one catalyst layer or part of one catalyst layer at a time.

h) Upgraded or New ID fans

The new ductwork and the SCR reactor's catalyst layers decrease the flue gas pressure. To maintain the same flow rate through the duct work, additional energy is required. The existing ID fan may be unable to provide the required increase in static pressure. In such cases, an upgraded or new ID fan is installed.

Generally, ID fans are designed with head margins, however, the fan capacity and head needs to be check with boiler OEM to ensure the required head.

5. Layout Study

The System and Equipment Layout requirement for the emission control system are studied to ascertain the feasibility of locating the equipment and facilities to meet the functional requirements.

Equipment space for FGD systems is presented in the General Layout – FGD Area Exhibit – 08.

5.1 Layout / Land Requirement

From the site walkthrough survey it was observed that there is very less space available for implementation of emission control system.

In the proposed layout, space has been identified for emission control system installation on West and South Side of the existing stack. The space identified is adequate for the installation of Wet FGDs and their auxiliaries, Nox and PM reduction reagent storage and handling facilities.

5.2 FGD System Layout

The major FGD system equipment namely booster fan and absorber is proposed to be located near west side of existing chimney.

New wet chimney is proposed at the south west corner of plant boundary.

The Slurry re-circulation pumps, Oxidation blowers and standby absorber slurry re-circulation pump are proposed to be located near the proposed absorber system.

The Process water tanks, Emergency slurry tank and pump sheds will be located near the Ammonium storage tank.

Limestone storage shed, handling system, storage and wet ball mill building is proposed to be located near Ammonium storage tank.

The FGD switchgear cum control room will be located near Absorber and Limestone / Gypsum handling system switchgear cum control room will be located near the limestone crusher house.

The Gypsum dewatering building will be located near the limestone storage yard. Gypsum dewatering building will house the Hydro cyclone, Vacuum belt filter, Gypsum bleed pumps

and vacuum pumps. Gypsum storage shed will be annexed to the Gypsum dewatering building.

Waste water treatment plant for specific water consumption reduction is proposed to be located near existing Guard Pond.

5.3 Ammonia storage tank

Ammonia required for SCR and PM reduction requirement will be stored in Ammonia storage tank near the proposed wet stack

Ammonia receipt and storage area will be properly fenced and approval from "Director of Explosives- Nagpur" has to be obtained

5.4 Buildings & Foundations

The installation of emission reduction plant warrants for additional buildings and facilities along with foundation works for the equipment & support structures.

The following list summarizes the major buildings & structures envisaged for installing the emission reduction plant. The facilities are arrived at based on similar installation and considering scope of optimizing and finalization during implementation.

Description	Type of Building / Structure	Type of foundation expected	Side cladding	Roofing / Flooring
Booster Fan	Vendor Supply Equipment	Pile foundation	-	-
Flue Gas Duct	Steel ducts supported on Structural steel frame	Pile foundation	-	-
Absorber	Structural Steel tank	Raft Foundation	-	-
Elevator	(if applicable)	Raft Foundation	-	-
Oxidation Blower	Vendor Supply Equipment	Raft Foundation	-	-
Process Water Tank	Steel Tank	Raft Foundation	-	-
Pipe & Cable Racks	Steel Structure	Pile Foundation	-	-
Slurry Recirculation Pump	Vendor Supply Equipment	Raft Foundation	-	-

Description	Type of Building / Structure	Type of foundation expected	Side cladding	Roofing / Flooring
Limestone Storage shed	Steel Structure	Pile Foundation	3mtrs Brick wall from ground and Permanent color coated metal cladding	Permanent color coated metal
Limestone handling, Storage Silo and wet ball mill building	Steel Structure	Pile Foundation	Permanent color coated metal cladding above brick wall	Permanent color coated metal
Calcium sulphate (Gypsum) Dewatering Building	RCC Building	Pile Foundation	Brick Wall	RCC slab
Gypsum storage	Steel Structure	Pile Foundation	3mtrs Brick wall from ground and Permanent color coated metal cladding above brick wall	Permanent color coated metal
Emergency Slurry Tank	Steel Tank	Raft Foundation	-	-

Description	Type of Building / Structure	Type of foundation expected	Side cladding	Roofing / Flooring
Process Water pump shed	Steel Structure	Pile Foundation	Permanent color coated metal cladding	Permanent color coated galvanized MS troughed metal deck sheet
SCR System				
Aqueous Ammonia Storage tank	Steel Tank	Raft Foundation		
Ammonia metering & mixing system	Vendor Supply Equipment	Raft Foundation		

Table 5-1 : List of Buildings and foundation

6. Auxiliary Power Consumption & Utility Requirements

The auxiliary power required for operation of the selected technologies for the boilers 1 & 2 are discussed in this Chapter.

6.1 Auxiliary Power Requirement

The power consumption for Emission reduction plant is provided below.

Equipment	Unit	FGD
FGD Auxiliary Power Consumption for each unit	kW	1500
SCR auxiliary Power Consumption for each unit	kW	58
UF-RO based Waste water treatment system for two units	kW	450

Table 6-1 : Auxiliary Power Consumption for FGD system

6.2 Process Utility Requirement

The following are the process utility requirement for the proposed Emission reduction system.

a) Make Up water

The FGD make up water requirement is around 35 m^3/hr on continuous basis for each unit; this requirement will be met from the clarified water system.

b) Reagent requirement

Limestone consumption for FGD will be around 1.729 t/h for each unit. Ammonia consumption for SCR will be around 0.078 t/h for each unit.

c) Instrument air and Service air requirement

Instrument air and service requirement will be around 1.2 Nm3/minute and 1.0 Nm3/minute respectively. This requirement will be met from existing plant instrument and service air header.

6.3 Utilization of By-product

Calcium sulphate (Gypsum) generated from FGD will be around 2.808 t/h for each unit, the by-product is of commercial grade and marketable.

7. Interface Requirements With Existing Plant

The FGD installation is to be done as retrofit to the existing power plant. This would require many interfaces for process utility electrical and control system. This Chapter covers the interface details with the operating plant.

7.1 Mechanical Interface

System	Interface Detail
Flue Gas System	Ducting from the existing flue gas duct (with isolation damper) to FGD and return duct from FGD up to wet chimney. Bypass duct to existing chimney with bypass damper for FGD will be provided. All ducting and different retrofitting will be overhead structures and lines. Duct from the Economizer outlet and after SCR treatment connect to air preheater inlet.
Fire Fighting system	From the existing network. Fire detection and alarm system will be provided for control rooms.
Make up water for FGD System	The water required for the FGD plant is sourced from the clarified water system
Potable & Service water	Potable & service water required for the FGD plant will be sourced from the existing headers near boiler area.
Auxiliary Cooling Water	Auxiliary Cooling Water (if required) for makeup of CCW system of FGD will be sourced from existing CW header
Instrument air and service air	Instrument air and service air requirements for the Emission reduction facilities proposed will be sourced from existing instrument and service air header.

7.2 Electrical Interface

HT power supply for FGD will be extended from Owner's station switchgears located in the switchgear room of TG building, by modifying existing feeders for feeding FGD switchgear. For FGD, separate 6.6 kV switchgear will be provided comprising two incomers and a Bus coupler. The Switchgear will feed LV Service Transformers and motors rated >200 kW.

To supply LT motors (rated up to 200 kW) and other loads, required numbers of LV Service transformers will be provided. 2X100% Transformers will be provided for each Power Cum Motor Control centers (PMCC). Each transformer will be rated to feed both the bus sections of PMCC.

One (1) number of Power Cum Motor Control centers (PMCC) will be provided for each unit. Each PMCC will receive power from transformers through bus duct. PMCC will comprise two incomers and a Bus coupler. Each incomer will be rated to feed both the bus sections.

To provide uninterrupted power supply to PLC and other Control Panels, 240V AC UPS system, one (1) number of feeder will be provided from the respective existing UPS DB. To provide Emergency supply to feed critical load of FGD, one (1) number of feeder will be provided in the existing DG PCC to each unit FGD emergency board. The approximate load of FGD emergency load will be 100 kW each per unit.

415V power required for FGD, SCR System, Absorber System, Process Water System, Reagent By-product Handling and waste water treatment plant will be derived from 415V FGD PMCC.

Earthing and lightning protection system will be provided for FGD area as per requirement and will be interconnected with Main plant Earthing system at minimum two points.

7.3 Instrumentation & Controls System Interface

Common PLC based control system will be provided for the FGD, NOx and Particulate Matter (PM) emission reduction control systems. This PLC based control system will be interfaced with the existing plant DCS (for monitoring from CCR through soft link and will be hardwired with existing plant DCS for necessary Interlock and protection signals).

7.4 Reliability and Availability

The minimum target reliability of the control system hardware like each electronic module/card power supply peripheral devices etc. considering its failure rate/mean time between failures (MTBF) meantime to repair (MTTR) should be designed in such a way that the availability of the complete C&I system is assured for 99.7%. Redundancy of components and system will be dictated by availability criteria as mentioned above to ensure that the system availability target as well as safety considerations in critical applications are fully met.

To ensure the availability of control system, suitable redundancy will be provided at sensor level hardware and software.

7.5 Operability and Maintainability

The design of the control systems and related equipment will adhere to the principle of 'Fail Safe' operation wherever safety of personnel / plant equipment is involved. 'Fail Safe'

operation signifies that the loss of signal or failure of any component will not cause a hazardous condition.

7.6 Control System

The programmable logic controller (PLC) based control system will fully achieve the various functions of modulating controls, open loop controls including sequence interlock and equipment protection monitoring alarming etc. for FGD, NOx and PM control systems. This PLC will be interfaced with existing Plant DCS through redundant soft link interface and will be hardwired with existing plant DCS for necessary Interlock and protection signals. Control operation & monitoring of the FGD, NOx and PM reduction system will be done from the common local control room.

All the C&I devices and equipment will be provided to achieve these functions and to make the system complete and operable. The control system will be latest with State of the Art technology. All equipment system and accessories of this project will be from the latest proven product range of a reputed experienced manufacturer whose successful performance has been established by a considerable period of satisfactory operation in similar operations of coal fired and utility power stations and will be based on the best modern engineering practice. All equipment / systems located in air conditioned areas will also be designed and constructed to operate for short periods of plant operation when air-conditioning equipment malfunctions (without loss of function departure from specifications requirements or damage) at the maximum ambient temperature of 50°C and relative humidity of 95% RH).

7.7 Control Room

A common local control room will accommodate the Operator and Engineering stations of FGD, NOx, PM and Specific Water consumption reduction control system PLC for control and monitoring equipments of the Flue gas desulphurization, NOx, Particulate Matter and Specific water consumption reduction systems and this local control room is envisaged in the proposed FGD area.

Control room will house the operator stations; engineering station, printers and PLC control panels of the FGD, NOx and Particulate Emission reduction systems.

8. Project Cost Estimate

8.1 Project Cost

The project cost estimates for proposed emission reduction system have been worked out on the following basis:

i) Available in-house data base
ii) Market prices prevailing as on date
iii) Project cost estimate given in this report are indicative and for report purpose only based on prevailing market prices as on date

The project cost estimates is presented in below:

System / Equipment	Total Estimated Project Cost for Boiler 1 & 2 (INR in Crores)
Limestone based FGD system and its auxiliaries	210
SCR system and its auxiliaries	90
ESP Upgrading	40
UF-RO plant	45
Total Emission reduction plant Cost	**385**
Erection, testing and commissioning	55.06
Taxes & duties including transit insurance	73.84
Overheads (Pre-operative Expenses , Shifting & Relocating of existing facilities, Consultancy, Services, Insurances etc.)	5.13
Contingencies	15.4
Total Project Cost	**534.46**

Table 8-1 : Project Cost Estimate

9. Project Implementation and Schedule

9.1 Method of Implementing the Project

The Project is envisaged to be implemented as three package EPC contracts,
Package 1: FGD system and its auxiliaries,
Package 2: SCR system and its auxiliaries
Package 3: ESP Upgrading

The supply& execution of civil works including equipment foundations buildings; engineering supply & installation of electrical equipment's and instruments are also included under the scope of respective EPC contractor.

Contractor's EPC scope will include the submission of required design inputs/ drawings for execution of civil and electrical works.

The EPC Contractor will be assisted in formulating the concepts, systems basic and detailed engineering procurement interface engineering construction management services Erection and testing management services Inspection quality control expediting and Project management by Engineering Consultants / competent professionals.

9.2 Project Schedule

Based on FI's interaction with various OEMs and experience on similar capacity plants, the following project implementation schedule is envisaged.

The downtime for flue gas duct modification in the existing plant will be 4 weeks/boiler. The EPC project schedule for implementation of emission control system will be 26-30 months.

9.3 Owner's Responsibility

The proposed project being brown field, project construction facilities will have to be developed around the available infrastructure and there is a need to implement the project within scheduled time frame.

Owner will have to carry out project preparatory works such as identification of storage and fabrication yard, approach roads for the material gate, arranging construction power and construction water etc.

It is recommended that owner arranges for the space for the emission control system and its auxiliary's installation in phases with minimum effects to the plant operation.

10. Financial

10.1 General

The project cost estimates have been worked out on the following basis:

- Project cost estimate given in this report are indicative and for report purpose only.
- Cost estimates have been prepared and presented based on market prices prevailing as on date and based on internal data base.
- CAPEX have been considered for 2x150 MW.

10.2 Cost of Reagents and by products

- Landed cost per ton of Ammonia has been considered as Rs. 28000
- Landed cost per ton of Limestone has been considered as Rs. 4000
- Saleable per ton of Gypsum has been considered as Rs. 700

10.3 Cost of Land

The required land is identified inside the existing Plant boundary.

10.4 Cost of other items

- Cost of various other items has been estimated based on prevailing market price.
- GST has been considered as 18% wherever applicable (i.e. supplies, civil works and erection testing and commissioning.)

10.5 Fixed and Variable Cost

The following fixed and variable costs are considered along with appropriate escalations.

The fixed costs include;

- Interest on Loan
- Return on Equity
- Depreciation
- O&M Expenses
- Water Cost
- Interest on working capital

The variable cost covers the Limestone and Ammonia.

Appropriate escalations have been considered for the Operation & Maintenance expenses.

10.6 Assumptions

The salient parameters used in the analysis are;

Debt – Equity Ratio	:	70:30
Interest on Loan	:	13.19 % p.a.
Repayment period	:	7 years
Loan grace period	:	1 year
Design useful life of the plant	:	18 years
Balance useful life of the plant	:	18 years
Plant Load Factor	:	80 %
Increase in Auxiliary Power consumption	:	1.5%
Discount Rate	:	11%
Return on equity*	:	14%
Depreciation for Plant & Machinery*	:	Straight line method
Operation & Maintenance cost*	:	2% of Capital cost
Escalation on O&M cost*	:	3.5% per annum

*Indicated values are considered as per CERC regulation 2019. The values shall be revisited based on WBERC.

10.7 Impact on Generation Cost

The impact on fixed and variable cost is listed below based on proposed emission reduction system

Parameter	Unit	Units 1 & 2
Impact on Fixed Cost (First Year)	INR/kWh	0.767
Impact on Variable Cost (Reagents/by product)(First Year)	INR/kWh	0.033
Impact on Total Cost (First Year)	INR/kWh	0.800
Levelised impact on cost (18 Years)	INR/kWh	0.677

Table 10-1 : Impact on fixed and variable cost

11. Conclusions

i) To restrict the SO_2 emission levels below the stipulated value of 100 mg/Nm^3 for Unit 1and 2, Wet Limestone based FGD technology can be considered with dedicated absorber for boilers.

ii) It is proposed to provide a tri-flue wet chimney of height 100 m for Units 1, 2 and 3 to meet the above stipulation without using Gas-to-Gas Heat Exchanger.

iii) Auxiliary power requirement for each unit of FGD will be around 1500 kW.

iv) Water requirement of the proposed WFGD will be around 35m3/hr for each unit.

v) Limestone consumption for FGD will be around 1.729t/h for each unit.

vi) Calcium sulphate (Gypsum) generated will be around 2.808 t/h for each unit.

vii) Ammonia consumption for SCR will be around 0.078 t/h for each unit.

viii) The auxiliary power consumption for SCR will be around 58 kW for each unit.

ix) The auxiliary power consumption for waste water treatment system will be around 450 kW for two units.

x) Instrument air and service requirement will be around 1.2 Nm3/minute and 1.0 Nm3/minute respectively. This requirement will be met from existing plant instrument and service air header.

xi) HT power supply for FGD will be extended from Owner's station switchgears located in the switchgear room of TG building, by modifying existing feeders for feeding FGD switchgear. For FGD, separate 6.6 kV switchgear will be provided comprising two incomers and a Buscoupler. The Switchgear will feed LV Service Transformers and motors rated >200 kW.

xii) To provide uninterrupted power supply to PLC and other Control Panels, 240V AC UPS system, one (1) number of feeder will be provided from the respective existing UPS DB.

xiii) To provide Emergency supply to feed critical load of FGD, one (1) number of feeder will be provided in the existing DG PCC to each unit FGD emergency board. The approximate load of FGD emergency load will be 100 kW each per unit.

xiv) Common PLC based control system is envisaged for the FGD, NOx, Particulate Matter Emission and Specific water consumption reduction system. This PLC will be interfaced with the existing plant DCS for monitoring from CCR through soft link. Hardwiring is also envisaged with Plant DCS for the control & interlock signals with main plant.

xv) Space has been identified for FGD installation on West and South Side of the existing plant. The space identified is adequate for the installation of FGDs and their auxiliaries.

xvi) HEL may carry out separate survey/ study for arranging the reagents for the emission reduction plant for the source suppliers and transportation logistics. The reagents will be received in the plant by road.

12. List Of Original Equipment Suppliers (OEMS)

The various technology providers of FGD system are listed below:

A) Original technology suppliers:

i) Andritz Technologies
ii) K C Cottrell
iii) GE-Alstom
iv) Babcock Power Engineering
v) Hitachi Japan
vi) GORETM
vii) Mitsubishi Hitachi Power Systems
viii) Shanghai Electric Group Co. Ltd
ix) MELCO India

Service providers in India

B) Ammonia based FGD supplier

i) Jiangnan Environmental Technology – China
ii) Marsulex Environmental Technologies Inc. USA

C) Licensee

i) BHEL (licensee of MHPS Japan)
ii) China Datang Technologies & Engineering Co Ltd
iii) Thermax Limited (licensee of Marsulex Environmental Technologies Inc. USA)
iv) Hamon Air quality systems
v) ISGEC (License of Babcock)
vi) ERC Chemtrols Pvt Ltd.

The various technology providers of SCR system are listed below:

A) Original technology suppliers:

i) Andritz Air Pollution Control, Austria
ii) Fuel Tech, USA
iii) GE steam power
iv) Mitsubishi Hitachi Power Systems

B) Licensee

i) ISGEC (MOU with Fuel tech)

List of Annexures

Annexure - 1	List of Inputs
Annexure - 2	Coal Analysis
Annexure - 3	Site Data - Flue Gas Analysis
Annexure -4	Typical Limestone Analysis
Annexure-5	Financial Calculation

Annexure-1

List of Inputs

Annexure – 1

List of Inputs

- **The following key inputs received from HEL are used for preparing the report:**

Sl.No.	Description
1	Coal Analysis
2	Site Plan
3	Flue gas analysis for November, December 2020 and January
4	Boiler GA drawing
5	ESP GA drawing
6	Chimney – GA drawing
7	ID/FD/PA Fan capacity
8	Soil investigation report

Annexure-2
Coal Analysis

Inspectorate Griffith India Pvt. Ltd.
Bhubaneswar Laboratory
Plot # 211, Ground Floor, Sector - A, Zone - B
Mancheswar Industrial Estate, Bhubaneswar 751 010, Odisha, India
Tel : +91 0674 258 1320/258 1430
bsslab@in.bureauveritas.com
www.bureauveritas.com

TEST REPORT

Test Report No. : IGI/BBSR/TR/2021/BH039523 ULR-TC676621000001724F

DATE: 27.02.2021

Chemical Testing

Solid Fuels

Job No. :	BH039523
*NAME & ADDRESS OF CUSTOMER :	HIRANMAYE ENERGY LTD. HIRANMAYE ENERGY LTD. PLOT NO. X 1,2 & & 3, BLOCK EP, SECTOR V SALT LAKE CITY, KOLKATA.
*CUSTOMERS REFERENCE : (POST/COURIER/FAX/E-MAIL)	E-MAIL DATE: 13.02.2021
SAMPLE PARTICULARS : (MATERIAL TO BE TESTED)	Coal
SAMPLE RECEIPT DATE :	23.02.2021
NO. OF SAMPLE(S) :	1
SAMPLE DESCRIPTION :	SAMPLE RECEIVED FROM CUST: M/S. HIRANMAYE ENERGY LIMITED.
CONDITION OF SAMPLE :	POWDER (01 X 600 GMS.)
*PARAMETERS TESTED :	Carbon, Hydrogen, Nitrogen, Oxygen (by difference), Total Sulfur, Moisture in Analysis Sample (IM), Ash
TEST METHOD : (ASTM / IS / ISO / OTHERS)	C, H, N - ASTM D5373 - 16 Ash - ASTM D 3174: 12, (2018) e1 Ultimate Analysis (Oxygen) - ASTM D 3176 -15 Sulphur - ASTM D 4239 - 18e1 Moisture in Analysis Sample (IM) - ASTM D3173/D3173M-17

TEST RESULTS

Analysis Commencement Date: 23.02.2021 Analysis Completion Date: 26.02.2021

SAMPLE REF/ID (Customer)	SAMPLE CODE (Laboratory)	TEST PARAMETERS Carbon % (adb)	Hydrogen % (adb)	Nitrogen % (adb)	Oxygen (by difference) % (adb)	Total Sulfur % (adb)	Moisture in Analysis Sample (IM) % (adb)	Ash % (adb)	
CUST: HIRANMAYE ENERGY LIMITED, SAMPLE ID- COAL SAMPLE - 01	2566286	32.2	2.95	0.66	11.424	0.451	2.937	52.315	

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

REMARKS:

Sample tested on air dry basis (ADB).Submitted by the party

*Indicates information supplied by the customer for which the laboratory has no control.
Enclosures ()

PREPARED BY

RASHMI RANJAN SAHOO

SHYAMAL KUMAR MALLIK
(DEPUTY TECHNICAL MANAGER)
AUTHORISED SIGNATORY

Certificate No.:TC-5760

597661

TEST REPORT CONTINUATION SHEET

Test Report No. : IGI/BBSR/TR/2021/BH039523/1

DATE: 27.02.2021

Chemical Testing

Solid Fuels

*PARAMETERS TESTED : Hg

TEST METHOD : (ASTM / IS / ISO / OTHERS) Hg- IS 12041-1987

TEST RESULTS									
Analysis Commencement Date: 23.02.2021						Analysis Completion Date: 26.02.2021			
		TEST PARAMETERS							
SAMPLE REF/ID (Customer)	SAMPLE CODE (Laboratory)	Hg ppm (adb)							
CUST: HIRANMAYE ENERGY LIMITED, SAMPLE ID- COAL SAMPLE - 01	2566286	0.109							

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

REMARKS:

Sample tested on air dry basis (ADB). Submitted by the party

*Indicates information supplied by the customer for which the laboratory has no control.
Enclosures ()

PREPARED BY

RASHMI RANJAN SAHOO

SHYAMAL KUMAR MALLIK
(DEPUTY TECHNICAL MANAGER)
AUTHORISED SIGNATORY

Annexure-3

Site Data - Flue Gas Analysis

R. V. BRIGGS & CO. PRIVATE LTD.

ANALYTICAL CONSULTING & TECHNICAL CHEMISTS
(AN ISO 9001:2015 CERTIFIED COMPANY)
TAHER MANSION, 1ST FLOOR
9, BENTINCK STREET, KOLKATA - 700 001
Ph. : (BSNL) 2248-3661/2698/7803, 2262-4153/4154, Fax : 33 2248-0447
Ph. : (Airtel) 4044-3380/3381/3382/3383
E-mail : rvbriggs.kolkata@gmail.com, Website : www.rvbriggs.com
CIN : U51109WB1931PTC007007

NABL ACCREDITED LABORATORY
Certificate No. TC-7815

TEST REPORT

No. AP-FG/20-21/508	Date: November 30, 2020	Page 1 of 2

Issued to	: M/S Hiranmaye Energy LTD.
Address	: Vill: Kashbere, PS: Bhabanipur, P.O.: Shibramnagar, Haldia, Dist.: Purba Medinipur, Pin: 721635
Your Ref. No.	: P.O NO. 6900001576, dt. 12.11.2020
Sample Description	: Stack Gas
Date & time of sampling	: 28.11.2020 at 12:10 P.M. to 12:55 P.M.
Test Completed on	: 30.11.2020

Parameters Tested
Physical : Temp., Velocity, Gas flow
Chemical : SO_2, NO_2, CO, CO_2, Hg & PM

A. General information about stack :

1. Stack connected to : Boiler #1
2. Emission due to : Combustion of Coal
3. Material of construction of stack : M.S.
4. Shape of stack : Circular.
5. Whether stack is provided with permanent platform & ladder : Yes
6. Generator capacity : 150 MW

B. Physical characteristics of stack :

1. Height of the stack (a) from ground level : 220 M (b) from roof level : ---
2. Diameter of the stack (a) at bottom : --- (b) at top : ---
3. Diameter of the stack at sampling point* : 3.8 M
4. No. of Traverse point : 30 Nos.
5. Height of the sampling point from GL* : 65.0 M

C. Analysis / Characteristic of stack :

1. Fuel used : Coal
2. Fuel consumption : Load- 108 MW. & C.F- 79 MT/hr.

D. Results of Physical Parameters of Flue Gas : Barometric pressure : 754 mmHg

Sl No	Test Parameters	Test Method	Unit	Results
1.	Temperature of emission	IS 11255 : Part 3 : 2008	°C	129
2.	Velocity of gas in duct	IS 11255:Part 3:2008 RA 2010 (1st Rev.)	m/sec	22.20
3.	Quantity of gas flow	IS 11255:Part 3:2008 RA 2010 (1st Rev.)	NM^3/hr	605298

E. Results of gaseous emission :

Sl No	Test Parameters	Test Method	Unit	Results	Norms as per Environment (Protection) Amendment Rules 2015, for TPP
1.	Sulphur dioxide	IS 11255 : Part 2 : 1985 RA 2012	mg/Nm^3	832.0	600 max.
2.	Sulphur dioxide at 6% O_2 correction		mg/Nm^3	946.3	
3.	Nitrogen dioxide	IS 11255 : Part 7 : 2005 RA 2012	mg/Nm^3	274.0	300 max.
4.	Nitrogen dioxide at 6% O_2 correction		mg/Nm^3	311.6	
5.	Carbon monoxide	IS 11255 : Part 1 : 1985 By Orsat	% v/v	<0.2	N.A
6.	Oxygen	IS 11255 : Part 1 : 1985 By Orsat	%	7.8	N.A
7.	Carbon dioxide	IS 11255 : Part 1 : 1985 By Orsat	% v/v	11.6	N.A
8.	Particulate Matters	IS 11255 : Part 1 : 1985 RA 2009	mg/Nm^3	45	50 max.
9.	Particulate Matters at 12% CO_2 correction		mg/Nm^3	46.5	

F. Pollution control device
Details of pollution control devices attached with the stack : E.S.P consists 14 Nos. of fields.

G. Remarks : All fields were running at the time of sampling.

HIRANMAYE ENERGY LIMITED (Formerly known as India Power Corporation (Haldia) Limited) Kolkata 700 091

(J. MUKHERJEE)
Quality Manager
Authorised Signatory
For R.V.BRIGGS & CO. (P) LTD.

R. V. BRIGGS & CO. PRIVATE LTD.

ANALYTICAL CONSULTING & TECHNICAL CHEMISTS
TAHER MANSION, 1ST FLOOR
9, BENTINCK STREET, KOLKATA - 700 001
Ph. : (BSNL) 2248-3661/2698/7803, 2262-4153/4154, Fax : 33 2248-0447
Ph. : (Airtel) 4044-3380/3381/3382/3383
E-mail : rvbriggs.kolkata@gmail.com, Website : www.rvbriggs.com
CIN : U51109WB1931PTC007007

TEST REPORT

Issued to	**: M/S Hiranmaye Energy LTD.**
Address	: Vill: Kashbere, PS: Bhabanipur, P.O.: Shibramnagar, Haldia, Dist.: Purba Medinipur, Pin: 721635
Your Ref. No.	: P.O NO. 6900001576, dt. 12.11.2020
Sample Description	: Stack Gas
Date & time of sampling	: 28.11.2020 at 12:10 P.M. to 12:55 P.M.
Test Completed on	: 30.11.2020

Parameters Tested
Physical : Temp., Velocity, Gas flow
Chemical : SO_2, NO_2, CO, CO_2, Hg & PM

A. General information about stack :

1. Stack connected to : Boiler #1
2. Emission due to : Combustion of Coal
3. Material of construction of stack : M.S.
4. Shape of stack : Circular.
5. Whether stack is provided with permanent platform & ladder : Yes
6. Generator capacity : 150 MW

B. Physical characteristics of stack :

1. Height of the stack (a) from ground level : 220 M (b) from roof level : ---
2. Diameter of the stack (a) at bottom : --- (b) at top : ---
3. Diameter of the stack at sampling point : 3.8 M
4. No. of Traverse point : 30 Nos.
5. Height of the sampling point from GL : 65.0 M

C. Analysis / Characteristic of stack :

1. Fuel used : Coal
2. Fuel consumption : Load- 108 MW. & C.F- 79 MT/hr.

D. Results of Physical Parameters of Flue Gas : Barometric pressure : 754 mmHg

Sl No	Test Parameters	Test Method	Unit	Results	Norms as per CPCB
1.	Mercury as Hg	EPA Method 29	mg/Nm^3	0.0006	0.03

E. Pollution control device

Details of pollution control devices attached with the stack : E.S.P consists 14 Nos. of fields.

F. Remarks : 13 Nos. of fields were running at the time of sampling.

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CIN : U51109WB1931PTC007007

NABL ACCREDITED LABORATORY
Certificate No. TC-7815

TEST REPORT

No. AP-FG/20-21/572 | **Date: December 29, 2020** |

Issued to	**: M/S Hiranmaye Energy LTD.**
Address	: Vill: Kashbere, PS: Bhabanipur, P.O.: Shibramnagar, Haldia, Dist.: Purba Medinipur, Pin: 721635
Your Ref. No.	: P.O NO. 6900001576, dt. 12.11.2020
Sample Description	: Stack Gas
Date & time of sampling	: 22.12.2020 at 02:20 P.M. to 02:50 P.M.
Test Completed on	: 28.12.2020

Parameters Tested

Physical : Temp., Velocity, Gas flow

Chemical : SO_2, NO_2, CO, CO_2, Hg & PM

A. General information about stack :

1. Stack connected to : Boiler #1
2. Emission due to : Combustion of Coal
3. Material of construction of stack : M.S.
4. Shape of stack : Circular.
5. Whether stack is provided with permanent platform & ladder : Yes
6. Generator capacity : 150 MW

B. Physical characteristics of stack :

1. Height of the stack (a) from ground level : 220 M (b) from roof level : ---
2. Diameter of the stack (a) at bottom : --- (b) at top : ---
3. Diameter of the stack at sampling point : 3.8 M
4. No. of Traverse point : 30 Nos.
5. Height of the sampling point from GL : 65.0 M

C. Analysis / Characteristic of stack :

1. Fuel used : Coal
2. Fuel consumption : Load- 145 MW. & C.F- 107 MT/hr.

D. Results of Physical Parameters of Flue Gas : Barometric pressure : 754 mmHg

Sl No	Test Parameters	Test Method	Unit	Results
1.	Temperature of emission	IS 11255 : Part 3 : 2008	°C	130
2.	Velocity of gas in duct	IS 11255:Part 3:2008 RA 2010 (1st Rev.)	m/sec	22.63
3.	Quantity of gas flow	IS 11255:Part 3:2008 RA 2010 (1st Rev.)	NM^3/hr	621546

E. Results of gaseous emission :

Sl No	Test Parameters	Test Method	Unit	Results	Norms as per Environment (Protection) Amendment Rules 2015, for TPP
1.	Sulphur dioxide	IS 11255 : Part 2 : 1985 RA 2012	mg/Nm^3	985	600 max.
2.	Nitrogen dioxide	IS 11255 : Part 7 : 2005 RA 2012	mg/Nm^3	434	300 max.
3.	Carbon monoxide	IS 11255 : Part 1 : 1985 By Orsat	% v/v	<0.2	N.A
4.	Oxygen	IS 11255 : Part 1 : 1985 By Orsat	%	6.6	N.A
5.	Carbon dioxide	IS 11255 : Part 1 : 1985 By Orsat	% v/v	12.6	N.A
6.	Particulate Matters	IS 11255 : Part 1 : 1985 RA 2009	mg/Nm^3	49	50 max.
7.	Particulate Matters at 12% CO_2 correction		mg/Nm^3	46.6	

F. Pollution control device

Details of pollution control devices attached with the stack : E.S.P consists 14 Nos. of fields.

G. Remarks : 11 Nos. of fields were running at the time of sampling.

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CIN : U51109WB1931PTC007007

TEST REPORT

No. AP-FG/20-21/572 **Date: December 29, 2020**

Issued to : **M/S Hiranmaye Energy LTD.**
Address : Vill: Kashbere, PS: Bhabanipur, P.O.: Shibramnagar, Haldia, Dist.: Purba Medinipur, Pin: 721635

Your Ref. No.	: P.O NO. 6900001576, dt. 12.11.2020	***Parameters Tested***
Sample Description	: Stack Gas	***Physical*** : Temp., Velocity, Gas flow
Date & time of sampling	: 22.12.2020 at 02:20 P.M. to 02:50 P.M.	***Chemical*** : SO_2, NO_2, CO, CO_2, Hg & PM
Test Completed on	: 28.12.2020	

A. General information about stack :

1. Stack connected to : Boiler #1
2. Emission due to : Combustion of Coal
3. Material of construction of stack : M.S.
4. Shape of stack : Circular.
5. Whether stack is provided with permanent platform & ladder : Yes
6. Generator capacity : 150 MW

B. Physical characteristics of stack :

1. Height of the stack (a) from ground level : 220 M (b) from roof level : ---
2. Diameter of the stack (a) at bottom : --- (b) at top : ---
3. Diameter of the stack at sampling point : 3.8 M
4. No. of Traverse point : 30 Nos.
5. Height of the sampling point from GL : 65.0 M

C. Analysis / Characteristic of stack :

1. Fuel used : Coal
2. Fuel consumption : Load- 145 MW. & C.F- 107 MT/hr.

D. Results of Physical Parameters of Flue Gas : Barometric pressure : 754 mmHg

Sl No	Test Parameters	Test Method	Unit	Results	Norms as per CPCB
1.	Mercury as Hg	EPA Method 29	mg/Nm^3	0.0007	0.03

E. Pollution control device

Details of pollution control devices attached with the stack : E.S.P consists 14 Nos. of fields.

F. Remarks : 11 Nos. of fields were running at the time of sampling.

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CIN : U51109WB1931PTC007007

NABL ACCREDITED LABORATORY
Certificate No. TC-7815

TEST REPORT

No. AP-FG/20-21/663	Date: January 28, 2021	Page 1 of 2

Issued to	: M/S Hiranmaye Energy LTD.
Address	: Vill: Kashbere, PS: Bhabanipur, P.O.: Shibramnagar, Haldia, Dist.: Purba Medinipur, Pin: 721635
Your Ref. No.	: P.O NO. 6900001576, dt. 12.11.2020
Sample Description	: Stack Gas
Date & time of sampling	: 22.01.2021 at 06:30 P.M. to 07:04 P.M.
Test Completed on	: 25.01.2021

Parameters Tested

Physical : Temp., Velocity, Gas flow

Chemical : SO_2, NO_2, CO, CO_2, Hg & PM

A. General information about stack :

1. Stack connected to : Boiler (Unit-2)
2. Emission due to : Combustion of Coal
3. Material of construction of stack : M.S.
4. Shape of stack : Circular.
5. Whether stack is provided with permanent platform & ladder : Yes
6. Generator capacity : 150 MW

B. Physical characteristics of stack :

1. Height of the stack (a) from ground level : 220 M (b) from roof level : ---
2. Diameter of the stack (a) at bottom : --- (b) at top : ---
3. Diameter of the stack at sampling point : 3.8 M
4. No. of Traverse point : 30 Nos.
5. Height of the sampling point from GL : 65.0 M

C. Analysis / Characteristic of stack :

1. Fuel used : Coal

2. Fuel consumption : Load- 113 MW. & C.F- 76 MT/hr.

D. Results of Physical Parameters of Flue Gas : Barometric pressure : 759 mmHg

Sl No	Test Parameters	Test Method	Unit	Results
1.	Temperature of emission	IS 11255 : Part 3 : 2008	°C	142
2.	Velocity of gas in duct	IS 11255:Part 3:2008 RA 2010 (1st Rev.)	m/sec	22.08
3.	Quantity of gas flow	IS 11255:Part 3:2008 RA 2010 (1st Rev.)	NM^3/hr	597468

E. Results of gaseous emission :

Sl No	Test Parameters	Test Method	Unit	Results	Norms as per Environment (Protection) Amendment Rules 2015, for TPP
1.	Sulphur dioxide	IS 11255 : Part 2 : 1985 RA 2012	mg/Nm^3	934	600 max.
2.	Nitrogen dioxide	IS 11255 : Part 7 : 2005 RA 2012	mg/Nm^3	455	300 max.
3.	Carbon monoxide	IS 11255 : Part 1 : 1985 By Orsat	% v/v	<0.2	N.A
4.	Oxygen	IS 11255 : Part 1 : 1985 By Orsat	%	6.2	N.A
5.	Carbon dioxide	IS 11255 : Part 1 : 1985 By Orsat	% v/v	12.4	N.A
6.	Particulate Matters	IS 11255 : Part 1 : 1985 RA 2009	mg/Nm^3	45	50 max.
7.	Particulate Matters at 12% CO_2 correction		mg/Nm^3	43.5	

F. Pollution control device

Details of pollution control devices attached with the stack : E.S.P consists 14 Nos. of fields.

G. Remarks : All fields were running at the time of sampling.

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TEST REPORT

Issued to	: M/S Hiranmaye Energy LTD.
Address	: Vill: Kashbere, PS: Bhabanipur, P.O.: Shibramnagar, Haldia, Dist.: Purba Medinipur, Pin: 721635

Your Ref. No.	: P.O NO. 6900001576, dt. 12.11.2020	***Parameters Tested***
Sample Description	: Stack Gas	*Physical* : Temp., Velocity, Gas flow
Date & time of sampling	: 22.01.2021 at 06:30 P.M. to 07:04 P.M.	*Chemical* : SO_2, NO_2, CO, CO_2, Hg & PM
Test Completed on	: 25.01.2021	

A. General information about stack :

1.	Stack connected to	: Boiler (Unit-2)
2.	Emission due to	: Combustion of Coal
3.	Material of construction of stack	: M.S.
4.	Shape of stack	: Circular.
5.	Whether stack is provided with permanent platform & ladder	: Yes
6.	Generator capacity	: 150 MW

B. Physical characteristics of stack :

1.	Height of the stack	(a) from ground level : 220 M	(b) from roof level : ---
2.	Diameter of the stack	(a) at bottom : ---	(b) at top : ---
3.	Diameter of the stack at sampling point	: 3.8 M	
4.	No. of Traverse point	: 30 Nos.	
5.	Height of the sampling point from GL	: 65.0 M	

C. Analysis / Characteristic of stack :

1. Fuel used : Coal
2. Fuel consumption : Load- 113 MW. & C.F- 76 MT/hr.

D. Results of Physical Parameters of Flue Gas : Barometric pressure : 759 mmHg

Sl No	Test Parameters	Test Method	Unit	Results	Norms as per CPCB
1.	Mercury as Hg	EPA Method 29	mg/Nm^3	0.0005	0.03

E. Pollution control device

Details of pollution control devices attached with the stack : E.S.P consists 14 Nos. of fields.

F. **Remarks** : All fields were running at the time of sampling.

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Annexure-4

Limestone Analysis

The typical chemical analysis of limestone is as below

Chemical Analysis(% by mass)			
1.	CaO	%	47-51.0*
2.	MgO	%	0.9-2.0
3.	Fe_2O_3	%	0.45-1.0
4.	Al_2O_3	%	1.19-2.1
5.	Si_2O_3	%	2.1-4.5
6.	Mn_2O_3	%	<0.12
7.	P_2O_5,	%	Traces
8.	Cl_2	%	<0.015
9.	Na_2O	%	<0.16
10.	K_2O	%	<0.01
11.	TiO_2	%	<0.02
12.	Total Sulphur	%	<0.1
13.	LOI	%	39.0-41.3
Physical properties			
1	Bond Index	kWh/sht	13
2	Granule size		Medium

Annexure-5

Financial Calculation

PART-I
FORM-5B

Hiranmaye Energy Limited

Detailed Project Report for Emission reduction plant - 2x150 MW TPP

Sl.No.	Break Down	Cost in Rs. Millions
(1)	(2)	(3)
1.0	**Cost of Land & Site Development**	**0.00**
2.0	**Plant & Equipment**	
2.1	Flue Gas Desulphurisation Plant	2100.00
2.2	NOx Control Equipment (SCR)	900
2.3	ESP retrofit	400.00
2.2	UF- RO Plant	450.00
	Total Plant & Equipment excluding taxes & Duties (Sl.No. 2.1+2.2+2.3)	**3850.00**
2.2	Taxes & Duties (GST 18%)	693.00
2.3	Transit Insurance@1%	45.43
	Total Plant & Equipment (incl. taxes and duties)	**4588.43**
4.0	**Erection, Testing and Commissioning** (Included in Sl. No.2.1)	**550.61**
	Total EPC Cost	**5139.04**
5.0	**Overheads**	
5.1	Total Overheads	51.39
5.2	Contingency	154.17
6.0	**Capital cost excluding IDC & FC (Hard cost)**	**5344.60**
6.1	Interest During Construction (IDC)	748.04
6.2	Financing Charges (FC)	21.40
7.0	**Capital cost including IDC & FC**	**6114.04**

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

FINANCIAL AND PLANT DATA

Plant Life (Balance useful life)	years	18
Installed Capacity	MW	300
Equity	%	30%
Basic Return on Equity (RoE)	%	14.00%
up-Front Equity	%	0%
Loan Repayment Period	yrs	7
Loan Grace Period	yrs	1
Interst on loan	% p.a.	13.19%
Electricity price to compute the opportunity cost	Rs./kWHr	1.44
Target Availability	%	80.0%
Aux. Power Consumption	%	12.00%
O & M	Rs. Mio/MW	0.356
O & M Escalation	% pa	3.50%
Water consumption	m3/h	70
Water Cess Charges	Rs./kl	20.00
Annual Water Cess Cost	Rs..Millions	9.81
Escalation	% p.a.	1.00%
Depreciation		
Residual value	%	10.00%
Plant & Machinery	%	5.00%
Discount Rate	%	11.00%
Limestone consumption	T/h	1.728
Lime stone Consumption	TPA	12109.82
Limestone Cost	Rs/Tonne	5000.00
Annual Limestone Cost	Rs. Millions	60.55
Escalation	% p.a.	2.00%
Ammonia Consumption for SCR and ESP	T/h	0.08
Ammonia Consumption	TPA	546.62
Ammonia Cost	Rs/Tonne	28000.00
Annual Ammonia Cost	Rs. Millions	15.31
Escalation	% p.a.	2.00%
Gypsum generation	T/h	2.808
Gypsum Selling cost	Rs/Tonne	700
Annual gypsum handling cost	Rs. Millions	14
Gypsum cost escalation per annum	%	2%

SUMMARY OF PROJECT FINANCING
(FIGS.in Rs.MILLIONS)

TOTAL PROJECT COST	Mio Rs.	6114.04		
Plant & Equipment (incl. Taxes and Duties)	Mio Rs.	4588.43		
Erection, Testing and Commissioning (Included in Sl. No.2.1)	Mio Rs.	550.61		
Overheads& Pre Operative Expenses	Mio Rs.	205.56		
Interest During Construction	Mio Rs.	748.04		
Financing Charges	Mio Rs.	21.40		
Margin Money for W.C.	Mio Rs.	0.00		
		6114.04		
EQUITY	Mio Rs.		1834.21	30.00%
LOAN	Mio Rs.		4279.83	70.00%

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

TARIFF CALCULATIONS (FIXED CHARGES)
(FIGS. IN Rs. MILLIONS)

PARTICULARs. / YEARs.		1	2	3	4	5	6	7	8	9	10
STATION CAPACITY	MW	300	300	300	300	300	300	300	300	300	300
AUXILIARY CONSUMPTION	%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
GENERATION AT NORMATIVE AVAILABILITY	Mio kWHr	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11
FIXED CHARGES											
INTEREST ON NORMATIVE LOAN	Mio Rs.	564.51	524.19	483.87	443.54	403.22	362.90	322.58	282.25	241.93	201.61
RETURN ON EQUITY	Mio Rs.	326.46	326.46	326.46	326.46	326.46	326.46	326.46	326.46	326.46	326.46
DEPRECIATION	Mio Rs.	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70
O & M CHARGES	Mio Rs.	106.89	110.63	114.51	118.51	122.66	126.95	131.40	136.00	140.76	145.68
Opportunity cost towards shutdown of the unit towards FGD installation for 28 days at Rs 1.44 /kWh With NPV computation considering discount rate of 11%	Mio Rs.	37.71	38.84	40.01	41.21	42.44	43.72	45.03	46.38	47.77	49.20
COMPENSATION ALLOWANCE	Mio Rs.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O & M CHARGES	Mio Rs.	144.60	149.47	154.51	159.72	165.10	170.67	176.43	182.38	188.53	194.89
WATER COST	Mio Rs.	9.81	9.91	10.01	10.11	10.21	10.31	10.41	10.52	10.62	10.73
INTEREST ON WORKING CAPITAL LOAN	Mio Rs.	30.69	30.35	30.03	29.72	29.42	29.13	28.85	28.59	28.34	28.10
OTHER FIXED CHARGES	Mio Rs.	**1093.02**	**1058.47**	**1024.13**	**990.00**	**956.10**	**922.43**	**889.00**	**855.82**	**822.89**	**790.23**
TOTAL FIXED COST	Mio Rs.	**1419.49**	**1384.93**	**1350.59**	**1316.46**	**1282.56**	**1248.89**	**1215.46**	**1182.28**	**1149.36**	**1116.69**
IMPACT ON FIXED COST	Rs./kWHr	**0.7672**	**0.7486**	**0.7300**	**0.7116**	**0.6932**	**0.6750**	**0.6570**	**0.6390**	**0.6212**	**0.6036**

TARIFF CALCULATIONS (FIXED CHARGES)
(FIGS. IN Rs. MILLIONS)

PARTICULARs. / YEARs.		11	12	13	14	15	16	17	18
STATION CAPACITY	MW	300	300	300	300	300	300	300	300
AUXILIARY CONSUMPTION	%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%	12.0%
GENERATION AT NORMATIVE AVAILABILITY	Mio kWHr	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11	1850.11
FIXED CHARGES									
INTEREST ON NORMATIVE LOAN	Mio Rs.	161.29	120.97	80.64	40.32	0.00	0.00	0.00	0.00
RETURN ON EQUITY	Mio Rs.	392.69	392.69	392.69	392.69	392.69	392.69	392.69	392.69
DEPRECIATION	Mio Rs.	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70
O & M CHARGES	Mio Rs.	150.78	156.06	161.52	167.17	173.03	179.08	185.35	191.84
Opportunity cost towards shutdown of the unit towards FGD installation for 28 days at Rs 1.44 /kWh With NPV computation considering discount rate of 11%	Mio Rs.	50.68	52.20	53.77	55.38	57.04	58.75	60.51	62.33
COMPENSATION ALLOWANCE	Mio Rs.	0.60	0.60	0.60	0.60	0.60	1.50	1.50	1.50
O & M CHARGES	Mio Rs.	202.06	208.86	215.89	223.15	230.67	239.33	247.36	255.67
WATER COST	Mio Rs.	10.84	10.95	11.06	11.17	11.28	11.39	11.50	11.62
INTEREST ON WORKING CAPITAL LOAN	Mio Rs.	29.00	28.79	28.59	28.41	28.24	28.80	29.33	29.88
OTHER FIXED CHARGES	Mio Rs.	**759.57**	**727.46**	**695.64**	**664.13**	**632.92**	**643.98**	**654.42**	**665.20**
TOTAL FIXED COST	Mio Rs.	**1152.26**	**1120.15**	**1088.34**	**1056.82**	**1025.62**	**1036.67**	**1047.11**	**1057.89**
IMPACT ON FIXED COST	Rs./kWHr	**0.62**	**0.61**	**0.59**	**0.57**	**0.55**	**0.56**	**0.57**	**0.57**

TARIFF CALCULATIONS (VARIABLE CHARGES)
(FIGS. IN Rs..MILLIONS)

PARTICULARs. / YEARs.		1	2	3	4	5	6	7	8	9	10	11
VARIABLE CHARGES												
Annual limestone cost	Mio Rs.	60.55	61.76	63.00	64.26	65.54	66.85	68.19	69.55	70.94	72.36	73.81
Lime stone cost	Rs./kWHr	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Annual ammonia cost	Mio Rs.	15.31	15.61	15.92	16.24	16.57	16.90	17.24	17.58	17.93	18.29	18.66
Ammonia Cost	Rs./kWHr	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Annual Gypsum Selling Cost	Mio Rs.	13.77	14.05	14.33	14.62	14.91	15.21	15.51	15.82	16.14	16.46	16.79
GYPSUM HANDLING COST	Rs./kWHr	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
DOWNTIME / OPPORTUNITY COST	Rs./kWHr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IMPACT ON VARIABLE COST	**Rs./kWHr**	**0.0336**	**0.0342**	**0.0349**	**0.0356**	**0.0363**	**0.0370**	**0.0378**	**0.0385**	**0.0393**	**0.0401**	**0.0409**
IMPACT ON TOTAL COST	**Rs./kWHr**	**0.8008**	**0.7828**	**0.7649**	**0.7472**	**0.7296**	**0.7121**	**0.6948**	**0.6776**	**0.6606**	**0.6437**	**0.66**
NPV OF TARIFF												
DISCOUNT RATE	%	11.00%										
NPV OF TARIFF	Rs./kWHr	**5.473605005**										
LEVELISED IMPACT ON COST (18 YEARS)	Rs./kWHr	**0.677839913**										

TARIFF CALCULATIONS (VARIABLE CHARGES)
(FIGS. IN Rs..MILLIONS)

PARTICULARs. / YEARs.		12	13	14	15	16	17	18
VARIABLE CHARGES								
Annual limestone cost	Mio Rs.	75.29	76.79	78.33	79.89	81.49	83.12	84.78
Lime stone cost	Rs./kWHr	0.04	0.04	0.04	0.04	0.04	0.04	0.05
Annual ammonia cost	Mio Rs.	19.03	19.41	19.80	20.20	20.60	21.01	21.43
Ammonia Cost	Rs./kWHr	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Annual Gypsum Selling Cost	Mio Rs.	17.13	17.47	17.82	18.18	18.54	18.91	19.29
GYPSUM HANDLING COST	Rs./kWHr	0.01	0.01	0.01	0.01	0.01	0.01	0.01
DOWNTIME / OPPORTUNITY COST	Rs./kWHr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
IMPACT ON VARIABLE COST	**Rs./kWHr**	**0.0417**	**0.0426**	**0.0434**	**0.0443**	**0.0452**	**0.0461**	**0.0470**
IMPACT ON TOTAL COST	**Rs./kWHr**	**0.65**	**0.63**	**0.61**	**0.60**	**0.61**	**0.61**	**0.62**
NPV OF TARIFF								
DISCOUNT RATE	%							
NPV OF TARIFF	Rs./kWHr							
LEVELISED IMPACT ON COST (18 YEARS)	Rs./kWHr							

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

PROJECTED DEPRECIATION FOR TARIFF
(FIGS. IN Rs..MILLIONS)

Project Cost		6114.04
Land Cost		0.00
Plant Cost		6114.04
Residual value	10%	611.40
Depreciable Asset Value		**5502.64**
Useful life		18
Accelerated depreciation period		18
Plant & Machinery		5.00%

Particulars	Basic	Others	Total
	(Rs. In millions)		
Plant & Machinery	4,588.43	1,525.61	6,114.04
Total	**4,588.43**	**1,525.61**	**6,114.04**

PARTICULARs. / YEARs.		1	2	3	4	5	6	7	8	9	10	11
Depreciation Rate - Plant & Machinery	% pa	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Depreciation - Plant & Machinery		305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70
Total depreciation		305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70	305.70
Net Block		5808.34	5502.64	5196.94	4891.23	4585.53	4279.83	3974.13	3668.42	3362.72	3057.02	2751.32
Depreciation cumulative		305.70	611.40	917.11	1222.81	1528.51	1834.21	2139.91	2445.62	2751.32	3057.02	3362.72

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

PROJECTED DEPRECIATION FOR TARIFF
(FIGS. IN Rs..MILLIONS)

Project Cost		6114.04
Land Cost		0.00
Plant Cost		6114.04
Residual value	10%	611.40
Depreciable Asset Value		**5502.64**
Useful life		18
Accelerated depreciation period		18
Plant & Machinery		5.00%

PARTICULARs. / YEARs.		12	13	14	15	16	17	18
Depreciation Rate - Plant & Machinery	% pa	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Depreciation - Plant & Machinery		305.70	305.70	305.70	305.70	305.70	305.70	305.70
Total depreciation		305.70	305.70	305.70	305.70	305.70	305.70	305.70
Net Block		2445.62	2139.91	1834.21	1528.51	1222.81	917.11	611.40
Depreciation cumulative		3668.42	3974.13	4279.83	4585.53	4891.23	5196.94	5502.64

WORKING CAPITAL REQUIREMENT
(FIGS. IN Rs..MILLIONS)

PARTICULARs./YEARs.	INVENTORY		1	2	3	4	5	6	7	8	9	10	11
RECEIVABLES	45	DAYS	182.16	178.06	174.00	169.96	165.95	161.98	158.04	154.13	150.26	146.42	150.98
LIME STONE COST	50	DAYS	8.27	8.44	8.61	8.78	8.95	9.13	9.32	9.50	9.69	9.89	10.08
SPARES INVENTORY (% OF O&M EXP)	20%		28.92	29.89	30.90	31.94	33.02	34.13	35.29	36.48	37.71	38.98	40.41
O&M EXPENSES	1	MONTH	12.05	12.46	12.88	13.31	13.76	14.22	14.70	15.20	15.71	16.24	16.84
TOTAL			232.66	230.13	227.69	225.32	223.05	220.85	218.75	216.75	214.83	213.02	219.84

WORKING CAPITAL REQUIREMENT
(FIGS. IN Rs..MILLIONS)

PARTICULARs./YEARs.	INVENTORY		12	13	14	15	16	17	18
RECEIVABLES	45	DAYS	147.21	143.49	139.81	136.17	137.73	139.22	140.76
LIME STONE COST	50	DAYS	10.28	10.49	10.70	10.91	11.13	11.36	11.58
SPARES INVENTORY (% OF O&M EXP)	20%		41.77	43.18	44.63	46.13	47.87	49.47	51.13
O&M EXPENSES	1	MONTH	17.40	17.99	18.60	19.22	19.94	20.61	21.31
TOTAL			218.24	216.74	215.36	214.10	218.36	222.38	226.53

SCHEDULE OF REPAYMENT OF TERM LOAN

PARTICULARs.		Operating Period 1	2	3	4	5	6	7	8
OPENING BALANCE		4279.83	4279.83	3668.42	3057.02	2445.62	1834.21	1222.81	611.40
REPAYMENT	1st Qua	0.00	152.85	152.85	152.85	152.85	152.85	152.85	152.85
	2nd Qua	0.00	152.85	152.85	152.85	152.85	152.85	152.85	152.85
	3nd Qua	0.00	152.85	152.85	152.85	152.85	152.85	152.85	152.85
	986.65	0.00	152.85	152.85	152.85	152.85	152.85	152.85	152.85
ANNUAL ADDITION		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CLOSING BALANCE		4279.83	3668.42	3057.02	2445.62	1834.21	1222.81	611.40	0.00
INTEREST PAYABLE		564.51	534.27	453.62	372.98	292.34	211.69	131.05	50.40
TOTAL Rs. LOAN SERVICING		564.51	1145.67	1065.03	984.38	903.74	823.10	742.45	661.81
TOTAL REPAYMENT		0.00	611.40	611.40	611.40	611.40	611.40	611.40	611.40
TOTAL INTEREST		564.51	534.27	453.62	372.98	292.34	211.69	131.05	50.40

PHASING OF EXPENDITURE AND CASHFLOW DURING IMPLEMENTATION

Quarter			1	2	3	4	5	6	7	8	9	10	Total
Plant Cost Disbursement (%)			10	5	15	15	15	15	5	5	5	10	100
Plant Cost		Mio Rs.	534.46	267.23	801.69	801.69	801.69	801.69	267.23	267.23	267.23	534.46	5344.6
Financing Charges		Mio Rs.	21.40										
Total Funds Requirement		Mio Rs.	555.86	267.23	801.69	801.69	801.69	801.69	267.23	267.23	267.23	534.46	5366
Interest (previous period)		Mio Rs.	0.00	12.24	18.40	36.45	54.91	73.78	93.05	100.99	109.10	117.38	748.04
Cash Flow													
Expenditures			555.86	279.47	820.09	838.15	856.60	875.47	360.28	368.22	376.33	651.84	6114
Margin Money for W.C.			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
Equity INR portion			166.76	83.84	246.03	251.44	256.98	262.64	108.09	110.47	112.90	195.55	1834
Loan INR portion			389.10	195.63	574.06	586.70	599.62	612.83	252.20	257.75	263.43	456.29	4279.8
Loan accmltd. (boq) INR			389.10	584.73	1158.79	1745.49	2345.11	2957.94	3210.14	3467.89	3731.32	4187.61	4279.8
Interest (eoq) INR portion		Mio Rs.	12.24	18.40	36.45	54.91	73.78	93.05	100.99	109.10	117.38	131.74	748.04
Total Cash Out flow (INR)		Mio Rs.	555.86	279.47	820.09	838.15	856.60	875.47	360.28	368.22	376.33	651.84	6114
EQUITY													
TOTAL EQUITY		Mio Rs.	166.76	83.84	246.03	251.44	256.98	262.64	108.09	110.47	112.90	195.55	1834.21
LOAN													
LOAN		Mio Rs.	389.10	195.63	574.06	586.70	599.62	612.83	252.20	257.75	263.43	456.29	4279.83
CASH FLOW													
TOTAL CASH OUT FLOW		Mio Rs.	555.859	279.471	820.086	838.145	856.602	875.466	360.284	368.218	376.327	651.844	6114.041
	Equity					748.1				738.2		348.0	1834
Cash flow w/o IDC	Total					2405.1				2137.8		801.7	5344.60

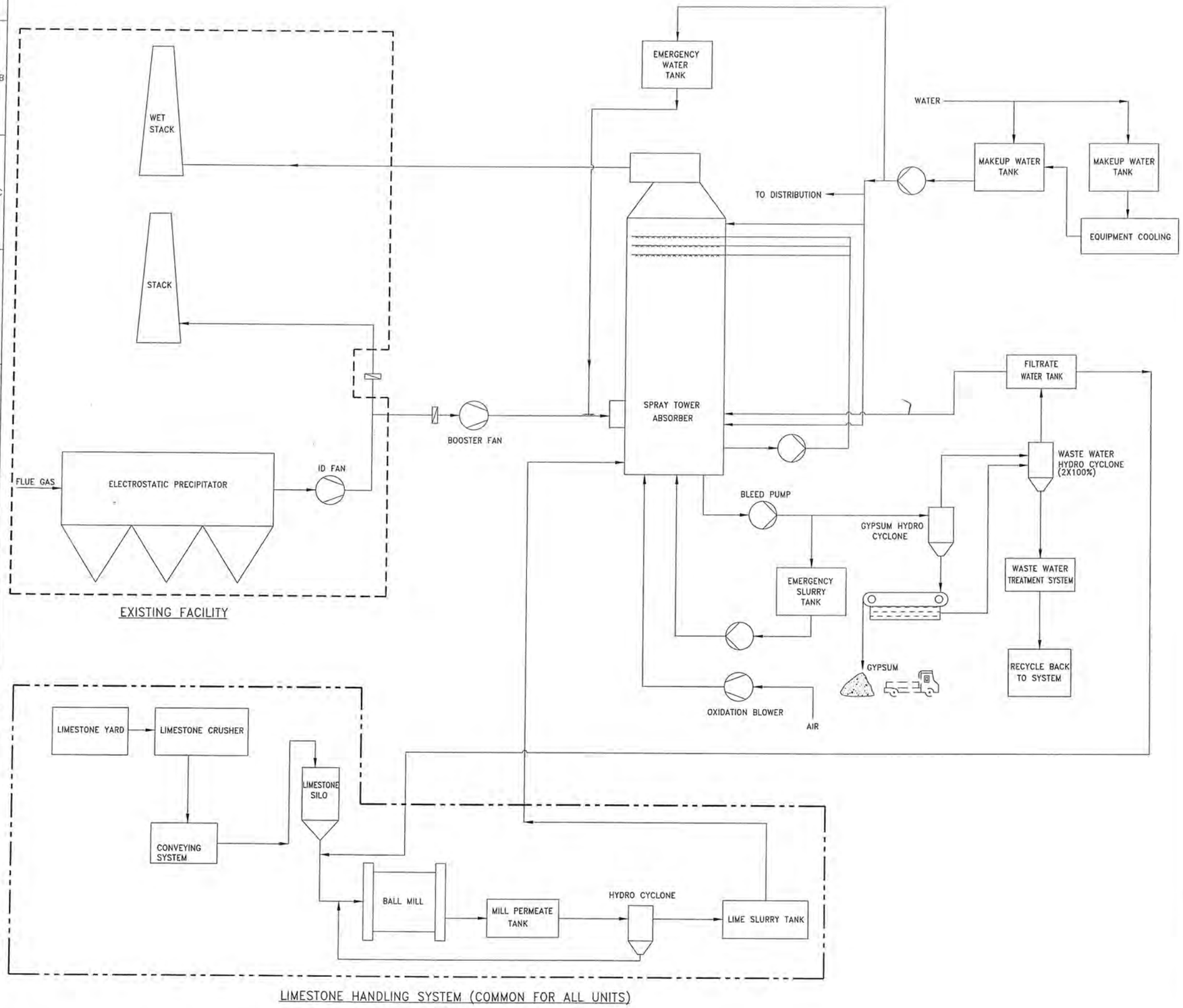
List of Exhibits

Exhibit - 01	Schematic Diagram for Wet Limestone based FGD System
Exhibit - 02	Schematic Diagram for Semi Dry FGD System
Exhibit - 03	Schematic Diagram for Ammonia based FGD
Exhibit - 04	Schematic Diagram for Electron Beam Flue gas Treatment
Exhibit - 05	Schematic Diagram for ReACT
Exhibit - 06	Schematic Diagram for GORE
Exhibit - 07	Schematic Diagram for Dry Sorbent Injection System
Exhibit - 08	Schematic Diagram for SCR
Exhibit - 09	Schematic Diagram for SNCR
Exhibit - 10	General Layouts – Emission Reduction Plant Area
Exhibit - 11	Single Line Diagram for Emission reduction plant

HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

NOTES

1. THIS SCHEME IS TYPICAL FOR ONE UNIT.
2. THIS SCHEME IS INDICATIVE FOR FSR PURPOSE.



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PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0	16.03.2021	PRELIMINARY ISSUE	MAH	–	VM	–	–

FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

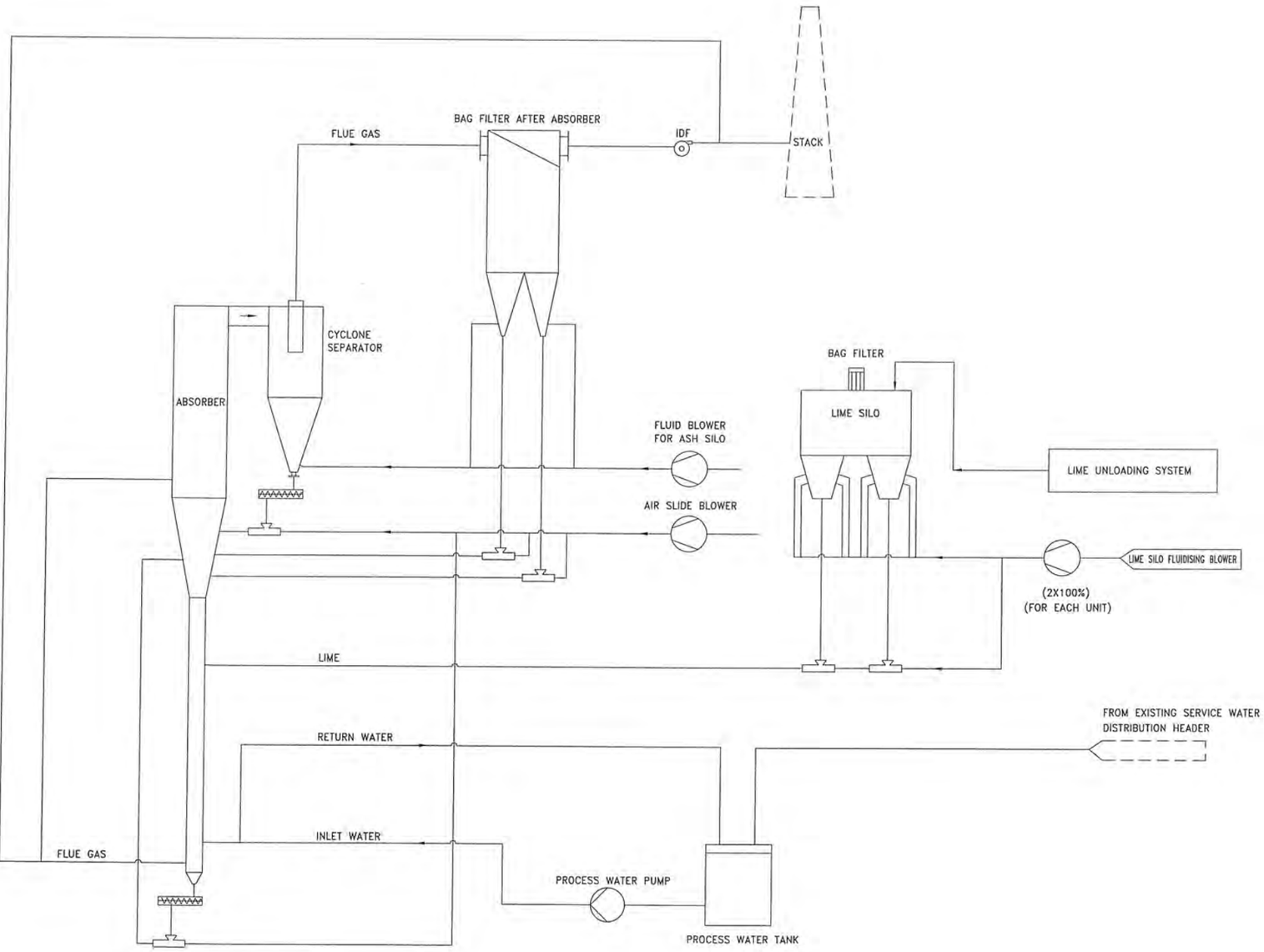
	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR WET LIMESTONE BASED FGD SYSTEM

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - 01 | 0



NOTES

1. THIS SCHEME IS INDICATIVE FOR FSR PURPOSE

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PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
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FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

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DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

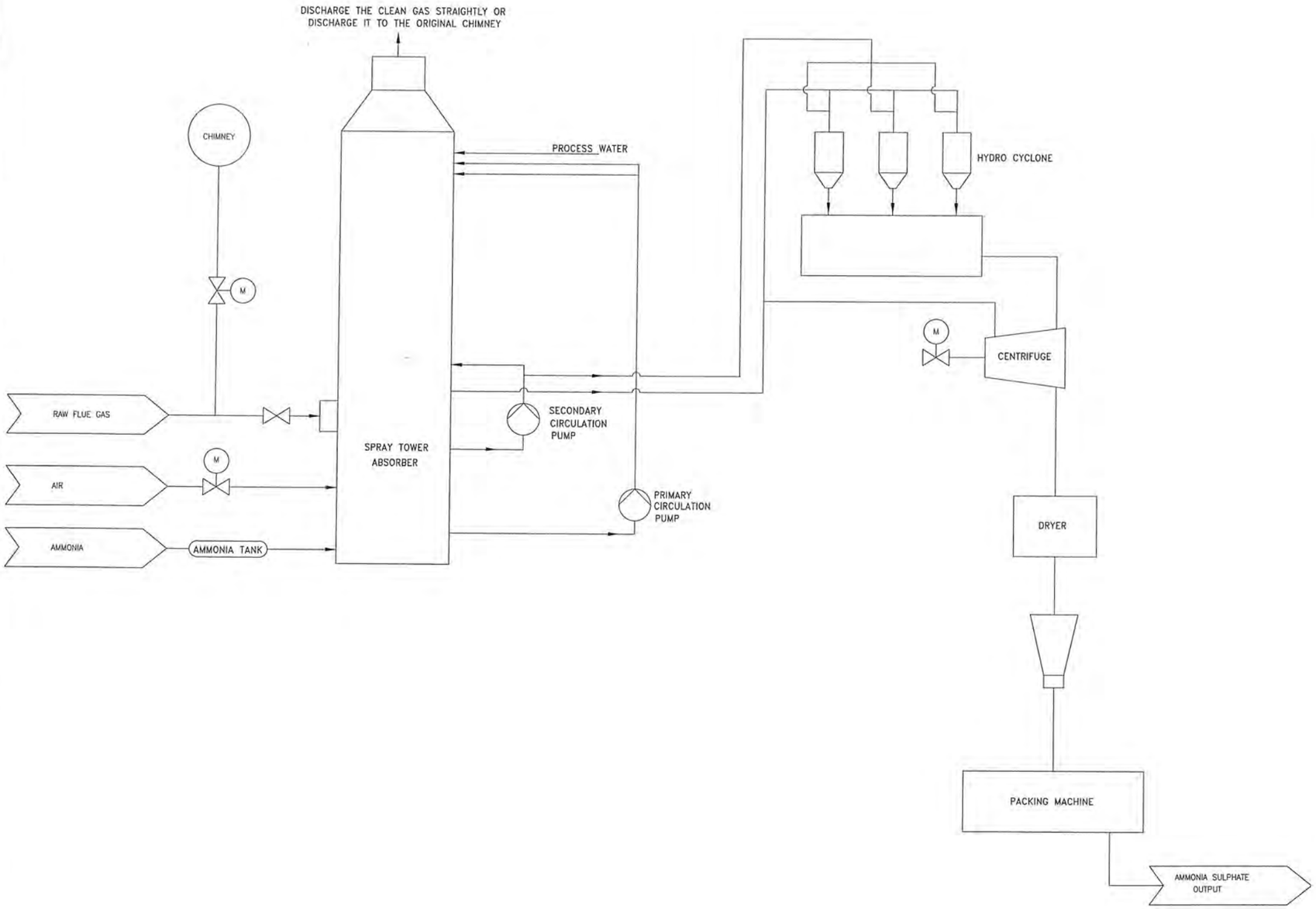
SCHEMATIC DIAGRAM FOR SEMI DRY FGD SYSTEM

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - 02 | 0

FICHTNER-A1



NOTES

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PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
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0	16.03.2021	PRELIMINARY ISSUE.	MAH	–	VM	–	–

FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

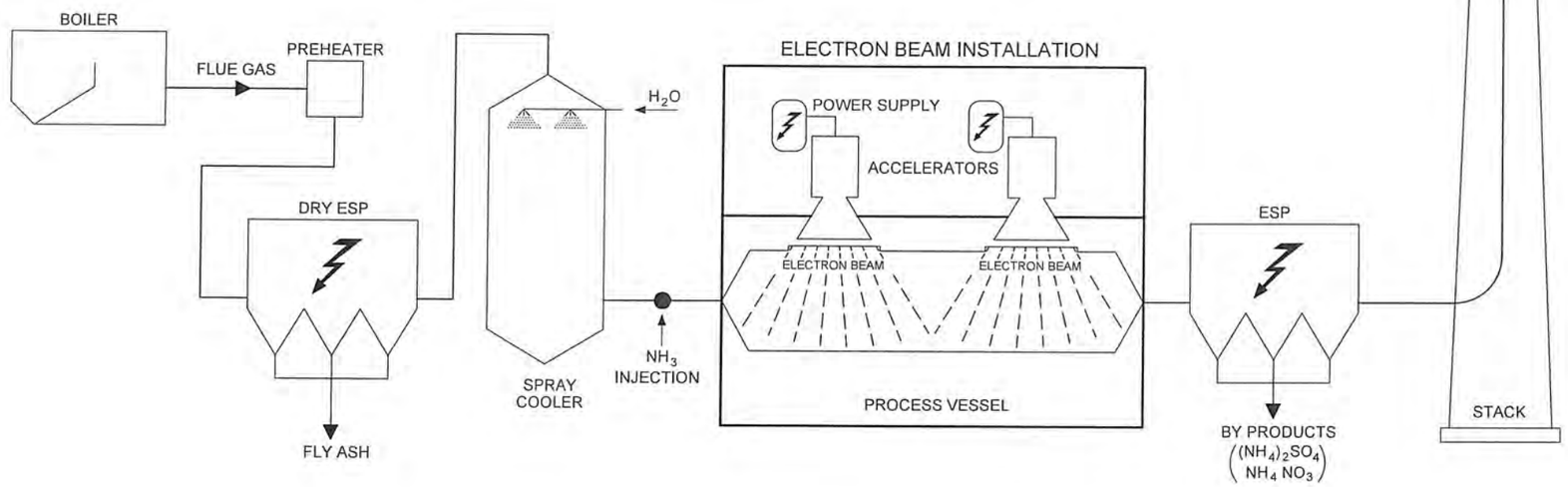
	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR AMMONIA BASED FGD

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - 03 | 0



NOTES

1. THIS SCHEME IS INDICATIVE FOR FSR PURPOSE

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PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	APPROVED BY STR.	MECH	ELEC.	INST
0	16.03.2021	PRELIMINARY ISSUE	MAH	–	VM	–	–

FICHTNER
Consulting Engineers
(India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

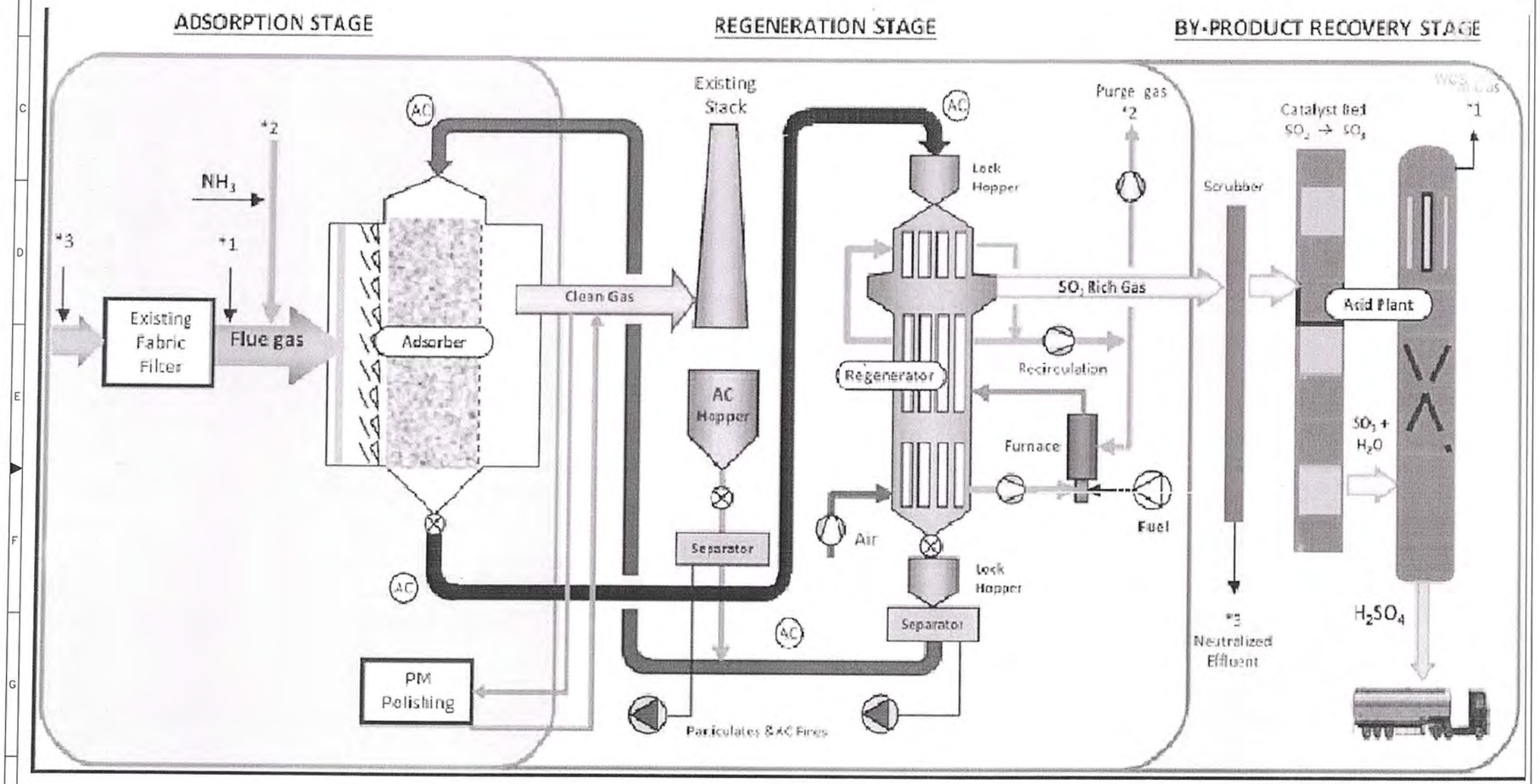
	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR
ELECTRON BEAM FLUE GAS TREATMENT

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - 04 | 0



NOTES

1. THIS SCHEME IS INDICATIVE FOR FSR PURPOSE.

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PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0	16.03.2021	PRELIMINARY ISSUE	MAH	–	VM	–	–

FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

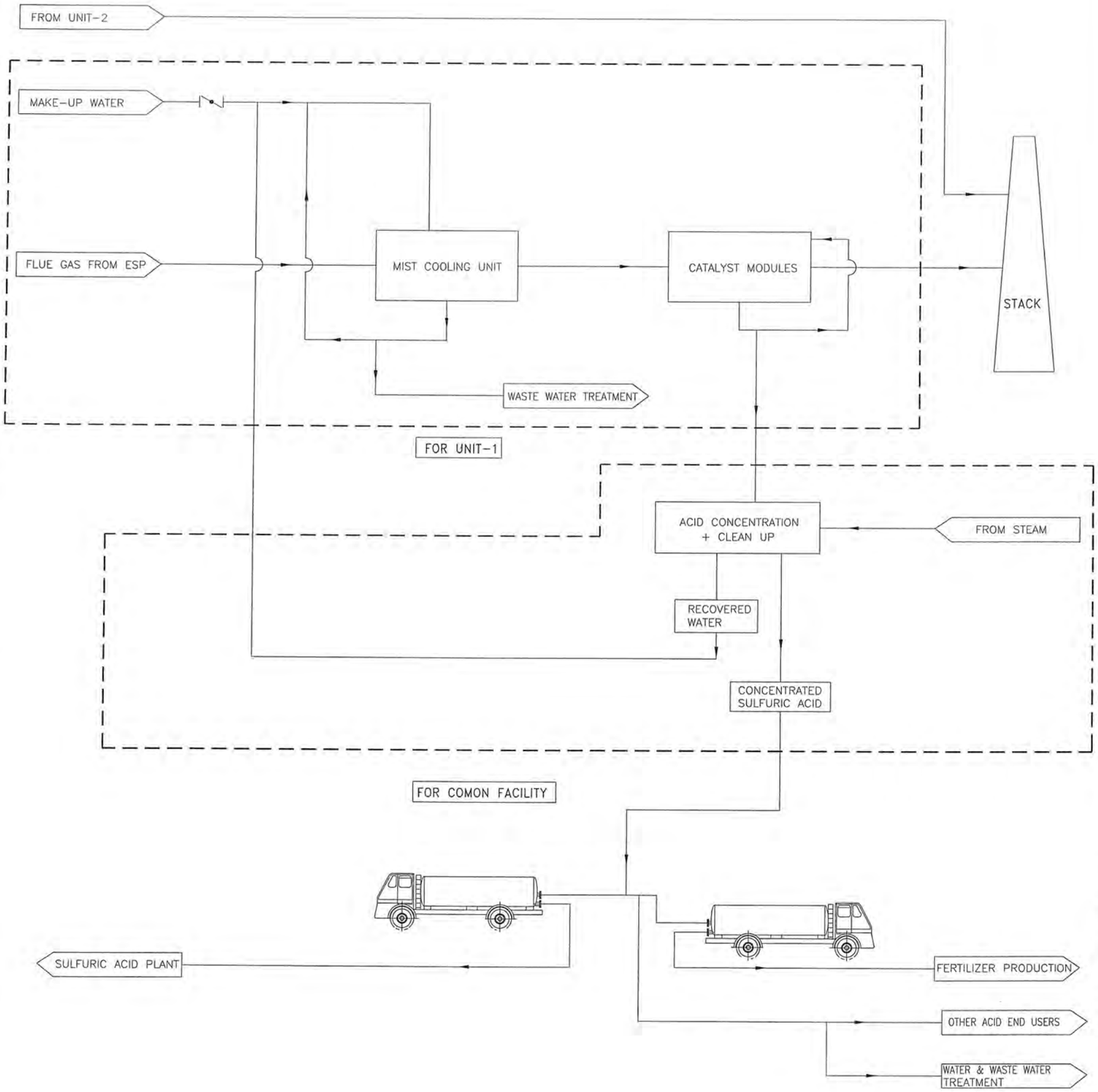
	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR ReACT

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - 05 | 0



NOTES

1. THIS SCHEME IS APPLICABLE FOR UNIT 1 & 2 WITH COMMON FACILITIES.
2. THIS SCHEME IS INDICATIVE FOR FSR PURPOSE.

PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
0	16.03.2021	PRELIMINARY ISSUE	MAH	–	VM	–	–

APPROVED BY

FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

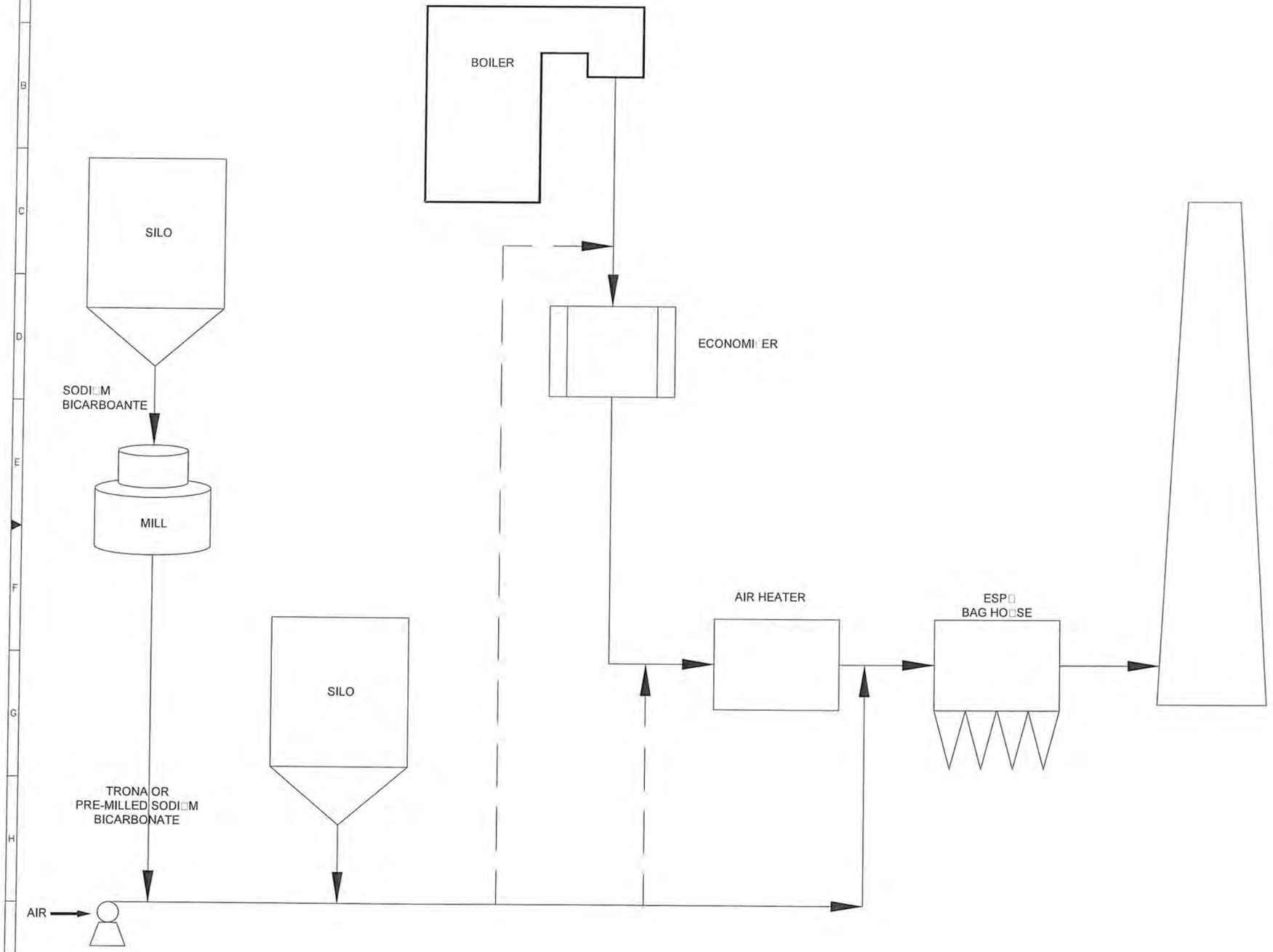
	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR GORE

RELEASED FOR	
PRELIMINARY	✓
BID	
ENGINEERING	
CONSTRUCTION	

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV. 0

DWG.NO. EXHIBIT - 06



NOTE

1. THIS SCHEME IS INDICATIVE FOR FSR PURPOSE.

HIRANMAYE ENERGY LIMITED (Formerly known as India Power Corporation (Haldia) Limited) Kolkata 700 091

PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH.	ELEC.	INST.
				APPROVED BY			
0	16.03.2021	PRELIMINARY ISSUE	MAH	–	VM	–	–

FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 2 x 150 MW THERMAL POWER PLANT

	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR DRY SORBENT INJECTION

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - | 0

(COMMON FOR ALL UNITS)

ANHYDROUS AMMONIA VESSEL

UNLOADING COMPRESSORS

PUMPS
(FOR EACH UNIT)

VAPORISER

MIXER

BOILER

ECONOMISER

AIR PRE HEATER

INJECTION GRID

REACTOR

QT NOx

QT NOx

QT O2

QT NH3

PRELIMINARY ISSUE

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FICHTNER
Consulting Engineers
(India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 1 x 150 MW THERMAL POWER PLANT

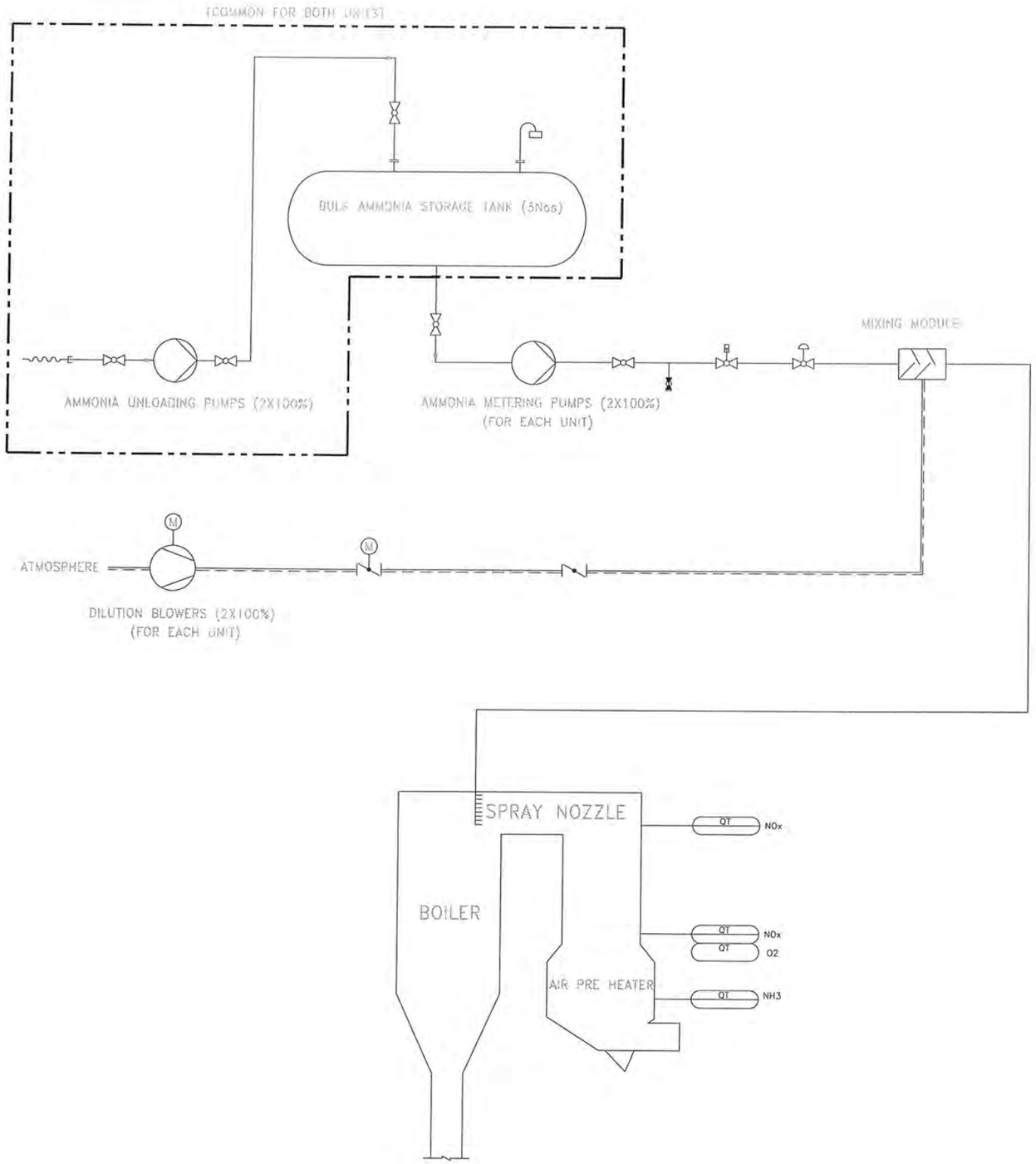
	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SHK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR SCR SYSTEM

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. ELEC. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV. 0

DWG.NO. EXHIBIT - 1



HIRANMAYE ENERGY LIMITED (Formerly Known as India Power Corporation (Haldia) Limited) Kolkata 700 091

PRELIMINARY ISSUE

REV.	DATE	DESCRIPTION	DRN.	STR.	MECH	ELEC.	INST.
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FICHTNER
Consulting Engineers
(India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 2 x 150 MT THERMAL POWER PLANT

	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	VM	16.03.2021
CHECKED	VM	16.03.2021
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SCHEMATIC DIAGRAM FOR SNCR SYSTEM

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. MECH. | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 1 | REV.

DWG.NO. EXHIBIT - □ | 0

Nº	NAME	BUILDING SIZE IN METERS
1.	400 KV SWITCHYARD	[illegible]
2.	SWITCHYARD CONTROL ROOM	[illegible]
3.	TRANSFORMER YARD	320x30.5
4.	POWER HOUSE BUILDING	[illegible]
5.	AC PLANT	[illegible]
6.	AIR WASHER PLANT	[illegible]
7.	COMPRESSOR HOUSE & MCC ROOM	[illegible]
8.	DG SHED	14x18
9.	OIL TANK & PUMP HOUSE	[illegible]
10.	BOILER HOUSE	[illegible]
11.	MILL BAY	[illegible]
12.	ESP	[illegible]
13.	ESP CONTROL ROOM	[illegible]
14.	RAIN WATER COLLECTION SUMP	75x15
15.	CHIMNEY	[illegible]
16.	SPACE FOR FGD	[illegible]
17.	ASH WATER CLARIFIER	[illegible]
18.	ASH HANDLING EQUIPMENT BUILDING	[illegible]
19.	FO TANK, PUMP HOUSE AND UNLOADING AREA	64x58
20.	DM PLANT & CHEMICAL LAB	60x20 / 21x8
21.	GUARD POND	100x75
22.	ETP	[illegible]
23.	NOT USED	[illegible]
24.	GRAVITY FILTER HOUSE	55x24
25.	FILTER WATER RESERVOIR	[illegible]
26.	MILL REJECT HOPPER	[illegible]
27.	CHLORINATION BUILDING & CHEMICAL BUILDING	26x29
28.	CWPH & MCC ROOM	[illegible]
29.	COOLING TOWER	[illegible]
30.	CANTEEN	25x20
31.	PERMANENT STORE	[illegible]
32.	WORK SHOP	30x15
33.	COAL STACK WITH STACKER-RE-CLAIMER	[illegible]
34.	TRANSFER POINT-1	[illegible]
35a.	CHP MCC ROOM #1	[illegible]
35b.	CHP MCC ROOM #2	[illegible]
36.	CRUSHER HOUSE	[illegible]
37.	ASH SILO	[illegible]
38.	SILO AREA UTILITY BUILDING	[illegible]
39.	PENT HOUSE	[illegible]
40.	DUMPER UNLOADING HOPPERS AND TUNNEL	[illegible]
41.	ASH DUMP AREA	[illegible]
42.	FIRE STATION	[illegible]
43.	WEIGH BRIDGE & CONTROL ROOM	[illegible]
44a.	PLANT SECURITY OFFICE	[illegible]
44b.	PLANT SECURITY OFFICE (FOR MATERIAL GATE)	[illegible]
45.	MAIN GATE	[illegible]
46.	CHECK POST	[illegible]
47.	ADMIN. BUILD.	[illegible]
48.	RAW WATER RESERVOIR	[illegible]
49.	RAW WATER, FIRE WATER PUMP HOUSE, MCC ROOM & CHLORINATION BUILDING	[illegible]
50.	MATERIAL GATE	[illegible]
51.	WATCH TOWERS	[illegible]
52.	COAL PILE RUN OFF SETTLING BASIN	24x45
53.	DEWATERING BIN	[illegible]
54.	CHEMICAL HOUSE & RECYCLE SUMP (ASH SYSTEM)	[illegible]
55.	ID FAN	[illegible]
56.	OVERFLOW COLLECTION (COLLECTION TANK & PUMP HOUSE)	[illegible]
57.	FUEL OIL AREA RETENTION PIT	[illegible]
58.	BOILER BLOWDOWN QUENCHING PIT	[illegible]
59.	TRANSFORMER YARD OIL PIT	[illegible]
60.	POWER HOUSE AREA RETENTION PIT	[illegible]
61.	RECOVERED WATER PUMP HOUSE	[illegible]
62.	TRANSFER POINT TP-2	
63.	TRANSFER POINT TP-3	
64.	TRANSFER POINT TP-4	
65.	TRANSFER POINT TP-5	
66.	TRANSFER POINT TP-6	
67.	TRANSFER POINT TP-7	
68.	TRANSFER POINT TP-8	
69.	TRANSFER POINT TP-9	
70.	LDO/HFO STORAGE TANK ON GROUND	[illegible]
71.	CONTROL ROOM FOR EXTERNAL COAL YARD	
72.	LOCAL INSTRUMENT AIR RECEIVER	[illegible]
73.	CHEMICAL HOUSE & MCC ROOM FOR CAN PIG	
74.	CHEMICAL HOUSE & MCC ROOM FOR ETP	
75.	DM PLANT CHEMICAL LAB	
76.	ETP CLEAR WATER RESERVOIR	
77.	RETAINING WALL	

LEGEND:

COAL CONVEYOR — PLANT BOUNDARY — ROAD — GREEN BELT — GATE — PERGOLA — WATCH TOWER

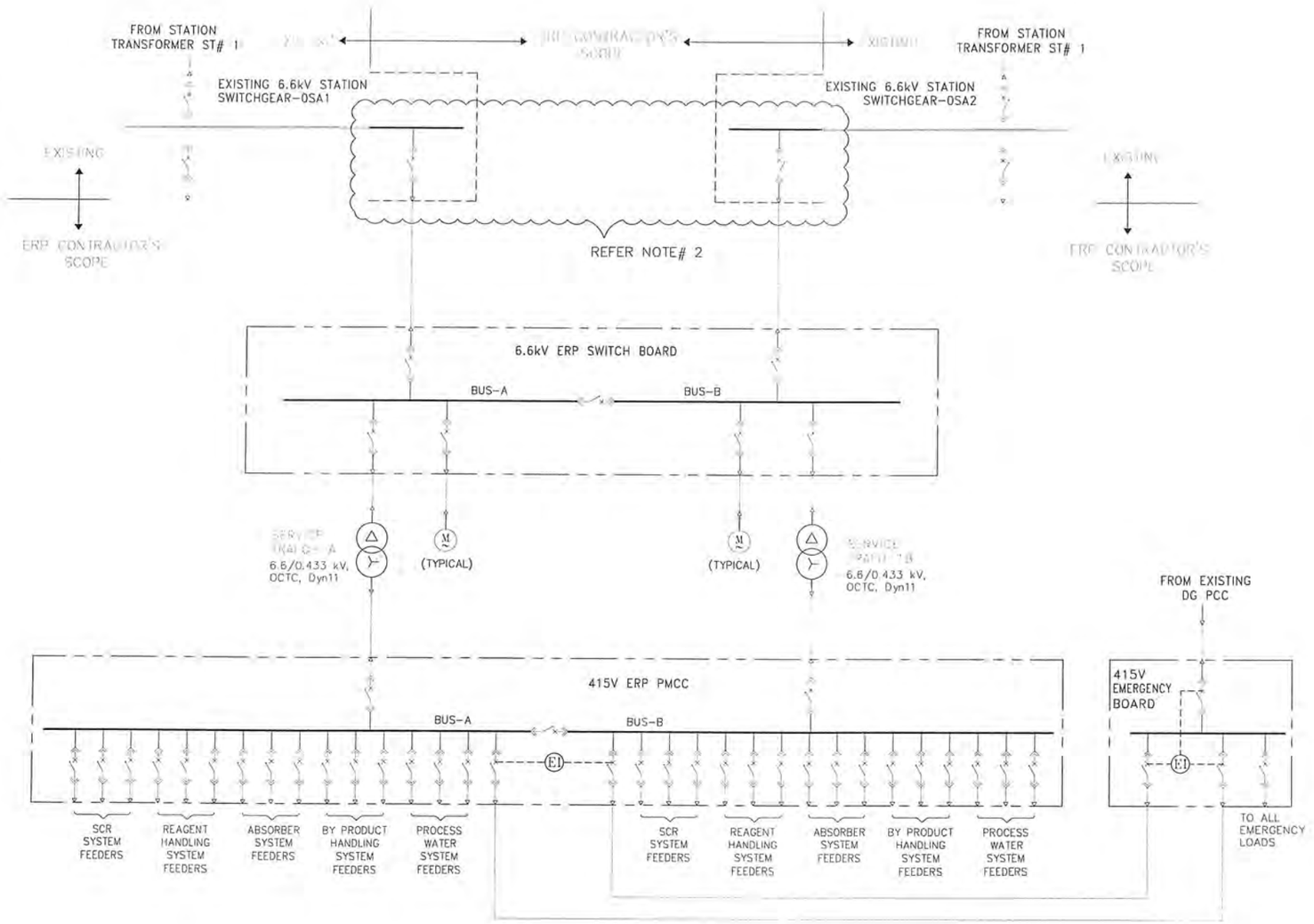
NOTES:

PLOT PLAN

HALDIA THERMAL POWER PLANT
3 X 150 MW UNITS

INDIA POWER CORPORATION (HALDIA) LIMITED
HALDIA WEST BENGAL INDIA

DWG. NO. BF-C001-100-OC-M101



LEGEND:

	TWO WINDING DRY TYPE TRANSFORMER
M	MOTOR
	CIRCUIT BREAKER
	DRAW OUT
	POWER CABLE TERMINATION
	EARTH
EI	ELECTRICAL INTERLOCK
PMCC	POWER MOTOR CONTROL CENTER
MCC	MOTOR CONTROL CENTER
ERP	EMISSION REDUCTION PLANT
TRAFO	TRANSFORMER
DG	DIESEL GENERATOR
OCTC	OFF CIRCUIT TAP CHANGER

NOTES:

1. THE POWER FLOW ARRANGEMENTS SHOWN IS TENTATIVE ONLY. TRANSFORMER, PCC, MCC, ACDB FEEDERS, MLDB & CABLES SHALL BE PROVIDED AS REQUIRED FOR THE COMPLETE SYSTEM.
2. MODIFICATION AS REQUIRED AND EXTENSION OF ONE FEEDER AT EXISITING 6.6 KV STATION SWITCHGEARS OSA1 & OSA2 LOCATED IN THE TG BUILDING BC BAY ELEVATION 3.1M INCLUDING CABLES ARE IN THE FGD CONTRACTOR'S SCOPE
3. 6.6 kV ERP SYSTEM SWITCH BOARD & 415V ERP PMCC SHALL COVER ALL THE ERP LOADS & SYSTEMS
4. INTERLOCK SHALL BE PROVIDED BETWEEN THE THREE CIRCUIT BREAKERS OF 415V EMERGENCY MCC TO CLOSE THE ONE CIRCUIT BREAKER AT A TIME.

REFERENCE DRAWING:

1. BF-C001-426-DG-E101, REV-5: SINGLE LINE DIAGRAM - ELECTRICAL SYSTEM.

(Formerly known as India Power Corporation (Haldia) Limited) ENERGY LIMITED Kolkata 700 091

PRELIMINARY ISSUE

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FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

PROJECT: DETAILED PROJECT REPORT FOR EMISSION REDUCTION PLANT FOR 3 x 150 MW THERMAL POWER PLANT

	SIGNATURE	DATE
DRAWN	MAH	16.03.2021
DESIGNED	KR	16.03.2021
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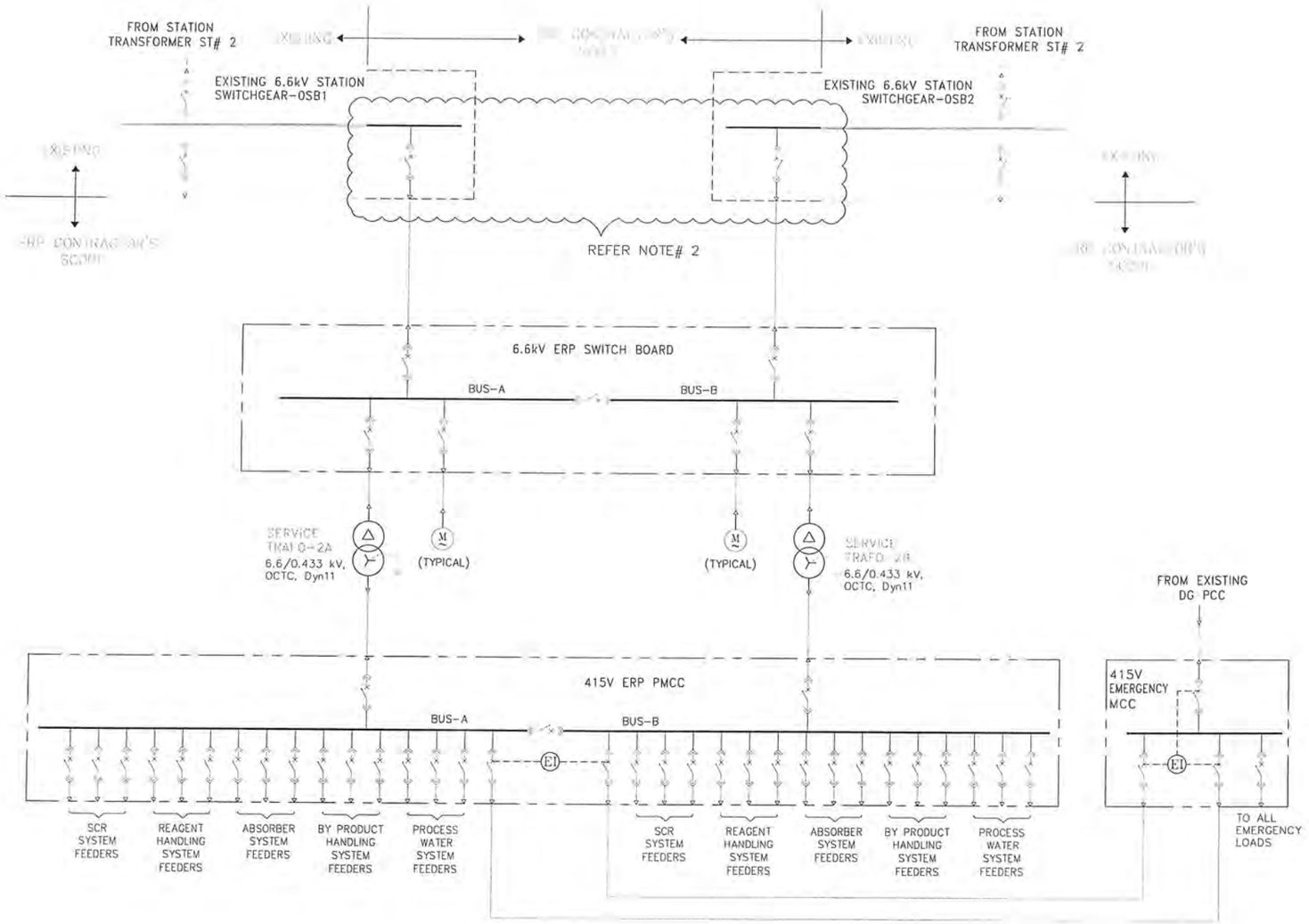
DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SINGLE LINE DIAGRAM FOR THE PROPOSED EMISSION REDUCTION PLANT (UNIT-1)

RELEASED FOR: PRELIMINARY ✓ | BID | ENGINEERING | CONSTRUCTION

DEPT. ELECTRICAL | JOB NO. 3120152 | SCALE: NTS | SHEET 1 OF 2 | REV. 0

DWG.NO. EXHIBIT - 11



LEGEND:

	TWO WINDING DRY TYPE TRANSFORMER
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	CIRCUIT BREAKER
	DRAW OUT
	POWER CABLE TERMINATION
	EARTH
EI	ELECTRICAL INTERLOCK
PMCC	POWER MOTOR CONTROL CENTER
MCC	MOTOR CONTROL CENTER
ERP	EMISSION REDUCTION PLANT
TRAFO	TRANSFORMER
DG	DIESEL GENERATOR
OCTC	OFF CIRCUIT TAP CHANGER

NOTES:

1. THE POWER FLOW ARRANGEMENTS SHOWN IS TENTATIVE ONLY. TRANSFORMER, PCC, MCC, ACDB FEEDERS, MLDB & CABLES SHALL BE PROVIDED AS REQUIRED FOR THE COMPLETE SYSTEM.
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3. 6.6 kV ERP SYSTEM SWITCH BOARD & 415V ERP PMCC SHALL COVER ALL THE ERP LOADS & SYSTEMS
4. INTERLOCK SHALL BE PROVIDED BETWEEN THE THREE CIRCUIT BREAKERS OF 415V EMERGENCY MCC TO CLOSE THE ONE CIRCUIT BREAKER AT A TIME.

REFERENCE DRAWING:

1. BF-C001-426-DG-E101, REV-5: SINGLE LINE DIAGRAM – ELECTRICAL SYSTEM.

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FICHTNER
Consulting Engineers (India) Private Limited
Chennai, Bangalore.

CLIENT: HIRANMAYE ENERGY LIMITED
HALDIA, WEST BENGAL, INDIA.

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DEPT.HEAD	SNK	16.03.2021
PROJ.MGR.	VM	16.03.2021

SINGLE LINE DIAGRAM FOR THE PROPOSED EMISSION RED□CTION PLANT (□NIT-□)

RELEASED FOR		
	PRELIMINARY	✓
	BID	
	ENGINEERING	
	CONSTRUCTION	

DEPT. ELECTRICAL | JOB NO. 3120152 | SCALE: NTS | SHEET 2 OF 2 | REV. 0

DWG.NO. EXHIBIT - 11