

HUBCO

Thar Energy Limited

11th Floor, Ocean Tower
Block-9, Main Clifton Road
Karachi, Pakistan

Tel: +92 21 3587 4677-86
Fax: +92 21 3583 9018
Mobile: +92 21 3587 0397

11th August, 2016

The Registrar,
National Electric Power Regulatory Authority,
NEPRA Tower Ataturk Avenue (East),
Sector G-5/1,
Islamabad.

Dear Sir,

Subject: Application for Grant of a Generation License for 330 MW Coal Based Power Generation Plant at Thar Block II

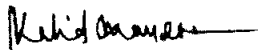
I, Khalid Mansoor, being the duly authorized representative of Thar Energy Limited ("TEL") as Main Sponsor by virtue of Power of Attorney dated 26th May, 2016, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to TEL, pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997, for the subject Project.

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, and undertake to abide by the terms and provisions of the above-said regulations. I further undertake and confirm that the information provided in the attached documents-in-support is true and correct to the best of my knowledge and belief.

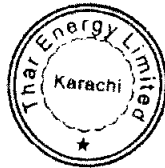
A Pay Order No: 16816844 in the sum of Rs. 729,240 (Rupees Seven Hundred and Twenty-Nine Thousand, Two Hundred and Forty Rupees only), being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

We will appreciate your positive and prompt action in this regard.

Kind regards,



Khalid Mansoor,
Chief Executive Officer





Central Power Purchasing Agency Guarantee Limited

A Company of Government of Pakistan



General Manager (WPPO) CPPA-G

No GM (WPPO)/CPPA-G HUB-144/ 3516-16.

April 13, 2016

Mr. Khalid Mansoor
Chief Executive Officer
The Hub Power Company Limited
11th Floor, Ocean Tower, G-3, Block-9,
Main Clifton Road, Karachi.

SUBJECT:- Consent of Power Purchaser for 330 MW Coal Fired Power Plant of M/s Hub Power Company Ltd at Thar Block-II.

Ref:-

1. M/s Hub Power Company letter date March 25, 2016.
2. GM (Planning) Power NTDC letter No. GMPP/CEMP/1623-24 dated April 06, 2016
3. GM (Planning) Power NTDC letter No. GMPP/CEMP/IRP-274 1713 15 dated April 13, 2016

This is with reference to above mentioned letter at Sr. no. 1 vide which it was requested to provide Power Purchaser's consent for development of above cited project.

Pursuant to GM (Planning) NTDC letter mentioned at Sr. no.3 and upfront tariff mechanism for coal power plant approved by NEPRA and 2015 Power Policy of GOP, it is hereby confirmed that the Power Purchaser shall procure power from 330 MW Coal Fired Power Plant of M/s Hub Power Limited to be located at Thar Block-II in accordance with the upfront tariff to be allowed by NEPRA and the terms and conditions to be finalized in the Power Purchase Agreement. General Manager (Planning) Power has intimated vide above referred letter at Sr. no. 3 that the subject cited power plant may be accommodated after 2021-22. This NOC is being issued for submission of proposal to PPB and for Generation License as well as Tariff approval from NEPRA pursuant to upfront tariff regime.

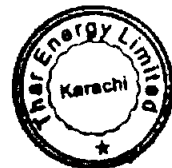
However, the matter pertaining to interconnection with NTDCI system will be governed by "Connection Agreement" to be entered between Power Producer and NTDCI pursuant to NTDC letter under reference and in accordance with terms and condition of standardized PPA.


(Mansoor Hussain)
Chief Engineer I (WPPO)

Copy to:-

1. CLO CPPA-G, 6th Floor, Shaheed-e-Millat Secretariat, Jinnah Avenue, Blue Area, Islamabad
2. Managing Director PPB, 50-Nazimuddin Road, Sector F-7/4, Islamabad
3. Managing Director NTDCI, 414-WAPDA House Lahore
4. Mr. Iftikhar Ali Khan, Deputy Registrar, NEPRA Tower, Atatürk Avenue, G-5/1, Islamabad
5. General Manager (Planning) Power, 4th Floor PIA Tower, Egerton Road, Lahore
6. P A General Manager (WPPO), 325-WAPDA House Lahore

325-WAPDA House, Lahore, Pakistan TEL: +92 42-99202111, Fax: +92 42-99202578 gm_wppe@yahoo.com



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11th August, 2016

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National Electric Power Regulatory Authority,
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Dear Sir,

Subject: Application for Grant of a Generation License for 330 MW Coal Based Power Generation Plant at Thar Block II

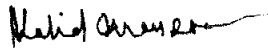
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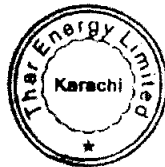
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Kind regards,

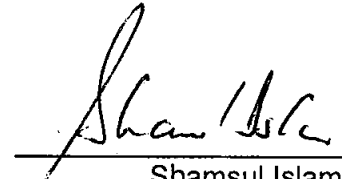
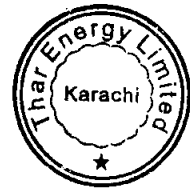


Khalid Mansoor,
Chief Executive Officer



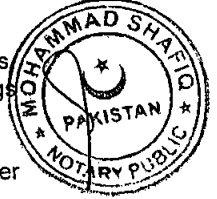
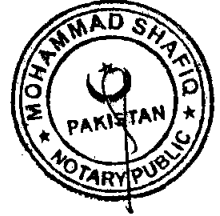
**Certified True Extract from the Resolution by Circulation of the Board of Directors
of the Company dated August 9, 2016 to approve the submission of
Generation License Application to National Power Regulatory Authority (NEPRA) for
1x330MW Coal Based Power Project at Thar
(In accordance with Article 61 of the Company's Articles of Association)**

"UNANIMOUSLY RESOLVED that the Chief Executive Officer and the Company Secretary is singly authorized to file for the Generation License to NEPRA for the 1x330 MW Coal based Power Project at Thar and take all necessary actions as required."

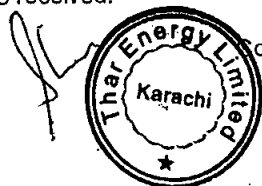

Shamsul Islam
Company Secretary

SECRET

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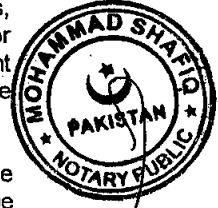


4. To compromise, compound or withdraw cases, to confess judgements and to refer cases to arbitration.
5. To sign and verify complaints, written statements, petitions of claims and objections memoranda of appeal and all kinds of applications and all other forms of pleadings in any such court or office.
6. To accept service of any summons, notice or writ issued by any court or officer against the Company.
7. To apply to any court or officer for copies of records and documents or for certified copies of any decree, order or judgement and to obtain such copies.
8. To apply for inspection of and to inspect judicial records and the documents and records in any public office and to obtain copies of such documents and records.
9. To file and receive bank documents, to deposit and withdraw money and to grant receipts therefor.
10. To obtain refund of stamp duty or repayment of court fees.
11. To appoint and remunerate any barrister, solicitor, advocate, vakil, pleader, mukhtar, revenue agent or any legal practitioner or any accountants, valuers, surveyors and estate agents for such services as may be deemed appropriate, from time to time.
12. To make and sign applications to appropriate government departments, local authorities or other competent authority for all and any licences, permissions and consents required by any order, statutory instrument, regulation, byelaw or otherwise in connection with the management and affairs of the Company.
13. To execute all bonds, deeds and documents and give such security as may be required now or at any future time by the Government of Pakistan or by any person, corporate body, company or firm to enable the Company to carry on its business.
14. To apply or subscribe for, buy, sell, negotiate, transfer, endorse, receive or deliver Government Promissory Notes, Government Securities and such other documents and things of a like nature as may be necessary or proper for carrying on the business of the Company and to do all or any acts and things which may be necessary or expedient in connection therewith.
15. To ask, demand, use, recover and receive all rents, interest, debts, moneys, effects, produce, profits, securities, goods, deeds, documents and other muniments of title, chattels and things which are or may hereafter be due or deliverable to the Company or relate to any of the properties belonging to the Company or which may belong to the Company or on any account whatsoever (expressly including any sum or sums of money which now is or are or may at any time hereafter be payable for or on account of principal, interest or dividend by the Government of Pakistan or by any person, corporate body, company or firm, to the Company as the holder of any securities, debentures and shares or on account of any such securities, debentures and shares being cancelled or paid off or on any other account whatsoever) and to sign and give effectual receipts, acquittances and discharges for the same or any part or portion thereof.
16. To receive certificates of shares, stock, debentures, debenture stock and other securities of any company or other corporation to which the Company may now or hereafter be entitled and to receive money due in respect thereof whether by way of principal, interest, profit, dividend or otherwise and to sign and deliver receipts, acquittances and discharges for the moneys so received.

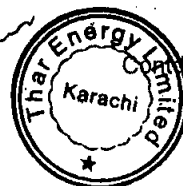


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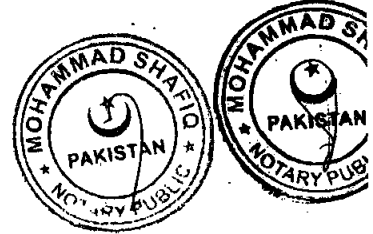


17. To attend, represent, vote or act for the Company at any meeting of members, shareholders, debenture holders, creditors or any class thereof of any company or other corporation in which the Company is interested and to appoint representatives or proxies for attending, representing, voting or acting for the Company at all or any such meetings.
18. To make payments to any person, corporate body, company or firm for any service rendered to the Company and for such other purposes of the Company as may be necessary for carrying on of the Company's business and to sign and deliver all receipts, charges and drafts on the bank and other accounts of the Company or on the customers of the Company and to endorse all bills and bills of exchange received by the Company which may be necessary or may be expedient in the judgement of the Attorney to be signed, endorsed or given for the purpose of carrying on of the Company's business.
19. To obtain securities from any person, corporate body, company or firm for the due performance of any contract in respect of rendering any service or supplying any material to the Company and to accept the same on such terms as may be deemed proper or expedient by the Attorney.
20. To arrange for and accept any surety or sureties guarantor or guarantors for the due performance of any contracts entered into by or on behalf of the Company and to release such surety or sureties and to discharge such guarantor or guarantors in due course.
21. To realise debts due to the Company and to receive any money due to the Company from any person, corporate body, company or firm and to grant receipts and discharges for the same.
22. To purchase, lease, hire or otherwise acquire plant, machinery, equipment or fixtures of trade required for the purposes of the Company and its business and to execute such contracts and deeds as may be necessary in respect thereof.
23. To buy all such material, articles or things as may be required by the Company and to enter into contracts with suppliers and to cancel, modify or vary the same.
24. To acquire office premises for the Company and houses for the executives and officers of the Company on rent from any person, corporate body, company or firm and execute all Agreements, Lease Deeds and all other related documents in respect thereof.
25. To make payments of all dues and submit plans of buildings relating to the Company's properties or lands on the Company's behalf before any competent authority and to obtain receipts therefor.
26. To negotiate and to enter into and complete contracts with any person, corporate body, company or firm for the lease or purchase of any lands and buildings and for the erection or construction of any buildings and structures and for the installation of any machinery, plant or fixtures on any lands and buildings so leased or purchased and to demolish, alter, repair, add to, and improve any building or structure and to let, sub-let, surrender or give up any immovable property held by the Company.
27. To purchase, lease or otherwise acquire vehicles for the Company and to sign and execute leases and all other related documents in respect thereof.
28. To prepare, adjust, settle or cause to be prepared adjusted or settled all matters of accounts whatsoever and examine the same and to settle, adjust, arrange, compromise or submit to arbitration any accounts, debts, disputes, claims, actions, or proceedings in which the Company may be involved.

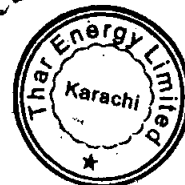


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29. To appear before any authority to represent the Company, to appear in public meetings or elections or official assemblages and vote for and elect any person or persons and take part in deliberations in the name and on behalf of the Company.
30. To use, sign and attest the name and style of the Company in any transaction, deed, document or muniment of title on all such occasions as may be necessary or expedient for conducting the business of the Company or for the due and proper management of the lands and buildings leased or purchased or to be leased or purchased by the Company.
31. To transact, manage and carry on the business of the Company and do all matters and things requisite and necessary or in any manner connected with or having reference to the administration, control and operation of the business and affairs of the Company.
32. To manage the business affairs, investments, securities and property of the Company.
33. To engage, employ, retain, dismiss, terminate or dispense with the services of personnel, agents, contractors, legal and technical advisers and other professionals (including those engaged pursuant to contracts for supply of fuel and operations and maintenance of the plants) and to insure against liability to such personnel or persons arising under any statute or otherwise.
34. To take all such measures as may be necessary for ensuring the safety of the personnel of the Company, its contractors and third parties.
35. To insure the moveable and immovable assets of the Company.
36. To avail Finance Facility(s) and/or borrow money from any Bank or Banks or financial institution, Development Finance Institutions (DFIs), any domestic and/or international organization/bank/DFI or Government or Semi-Government Agency on such terms as the Board may approve from time to time and to secure the repayment thereof by pledge, mortgage or hypothecation of Stocks, shares or other securities or assets of the Company and for that purpose or in connection therewith to sign, execute, register, deliver and renew, agreements, assurances, deeds, promissory notes, mortgage or receipts and negotiate, endorse, assign, transfer any such securities or assets aforesaid.
37. To exercise all day to day management powers of the Company except those prescribed by the Companies Ordinance 1984 or any other law to be mandatorily performed with the prior approval of the board of directors or the shareholders (as the case may be).
38. To appoint substitute or substitutes and delegate to such substitute or substitutes all or any of the powers and authorities hereby conferred on the said Attorney except that the substitute or substitutes shall not have the power of substitution conferred on the said Attorney and to revoke such appointment as the said Attorney may think fit such substitutes being officers of the Company and any such substituted Attorney or Attorneys shall have powers to act on behalf of the Company as if such substitute or substitutes had been originally appointed in this Deed.
39. To execute and sign all such deeds and documents as may be required or proper for or in relation to all or any of the matters or purposes aforesaid.
40. GENERALLY to do all other acts and things incidental to the exercise of the aforesaid powers.



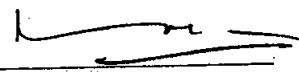
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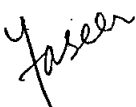
41. And the Company hereby agrees that all acts, deeds and things lawfully done by the Company's Attorney shall be construed as acts, deeds and things done by the Company and the Company undertakes to ratify and confirm all and whatsoever that the Attorney shall lawfully do or cause to be done for the Company by virtue of the power hereby given.

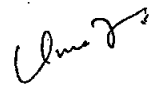
This Power of Attorney supersedes and hereby revokes any prior power of attorney authorization from the undersigned relating to the subject matter hereof, and shall rescind upon the Attorney (Mr. Khalid Mansoor) ceasing to be the Chief Executive of the Company for any reason whatsoever.

IN WITNESS WHEREOF this Power of Attorney has been executed on behalf of Thar Energy Limited and is effective from May 26, 2016


CHAIRMAN

In presence of:


WITNESS
Muhammad Yaseen
42201-6993912-9
C/O Hubco


WITNESS
Amir Shahzad
42201-0683380-3


MUHAMMAD SHAFIQ
NOTARY PUBLIC
PAKISTAN


MUHAMMAD SHAFIQ
NOTARY PUBLIC
PAKISTAN





A020839



SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

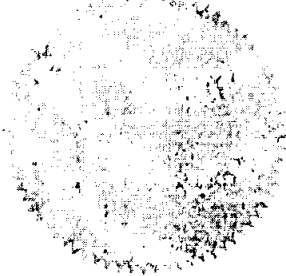
In accordance with the Companies Ordinance 1984 (XIV of 1984)

Corporate Universal Identification No. 0099674

I hereby certify that THAI ENERGY LIMITED is this day incorporated under the Companies Ordinance 1984 (XIV of 1984) and that the company is limited by shares.

Given under my hand at Karachi this seventeenth day of May, Two Thousand and Sixteen

Incorporation Fee Rs. 1,522,000/- only



(Signature)

(Zia-ul-Rasheed Ahlasi)
Joint Registrar of Companies
Karachi

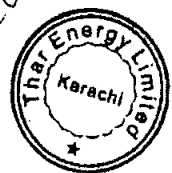


Certified to be True Copy

(Signature)

Joint Registrar of Companies

11/6/16





B007209

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

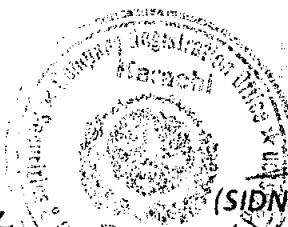
CERTIFICATE FOR COMMENCEMENT OF BUSINESS

[Under section 146(2) of the Companies Ordinance, 1984 (XLVII of 1984)]

Company Registration No. 0099674

I hereby certify that the **THAR ENERGY LIMITED** which was incorporated under the Companies Ordinance, 1984 (XLVII of 1984), on the **17 May, 2016** and which has filed a duly verified declaration in the prescribed form that the conditions of clauses (a) to (e) of sub-section (1) of section 146 of the said Ordinance have been complied with, is entitled to commence business.

Given under my hand at Karachi this 21st day of July Two Thousand and Sixteen.

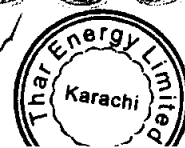


(SIDNEY C. PEREIRA)

ADDITIONAL REGISTRAR / INCHARGE
COMPANY REGISTRATION OFFICE, KARACHI



22/7/16
Certified to be true copy
Joint Registrar
26/7/16



D

THE COMPANIES ORDINANCE, 1984

(COMPANY LIMITED BY SHARES)

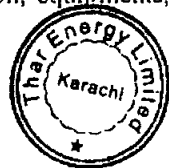
Memorandum of Association of

THAR ENERGY LIMITED

- I. The name of the company is "THAR ENERGY LIMITED" (the "Company").
- II. The Registered Office of the Company will be situated at Karachi, in the province of Sindh, Pakistan.
- III. The objects for which the Company is established are all or any of the following:-
 1. To design, finance, construct, own, operate and maintain coal fired power plants together with all machinery, equipment and works ancillary thereto and to do all such acts and things as shall be necessary for or incidental to that object or purpose
 2. To carry on all or any of the businesses of operating, generating, supplying, converting, transforming, selling, distributing, purchasing, importing, exporting and dealing in electricity and all other forms of energy and products or services associated therewith, including but not limited to steam, fuel, ash, conversion of these into any product and to perform all other acts which are necessary or incidental to the business of electricity generation, supply, transmission and distribution of such forms of energy including but not limited to setting up of power plants, buying and selling of coal, setting up requisite facilities for the same, construction of housing facilities, collection of bills, and in such manner as may be deemed feasible and sell and deliver the electricity thus generated, and other products and enter into any agreements for carrying out such business, as may be permitted under the applicable laws.
 3. To locate, finance, set-up, develop, own, acquire, establish, construct, design, equip, operate, use, manage and maintain power plants (including but not limited to gas, diesel oil, thermal, solar, wind and/or any other means), power grid station, transforming, switching, conversion, and transmission facilities, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centers, shops, depots, factories, workshops, plants, warehouses and other storage facilities, together with all machinery, equipment, cables, wires, lines, accumulators, and works ancillary to the aforesaid (hereinafter referred to as "Power Station") anywhere in Pakistan and to do all such acts, deeds and things, without limitation whatsoever, as may be necessary or desirable in that connection.
 4. To carry on all or any of the businesses of wholesalers, retailers, traders, importers, exporters, suppliers, distributors, designers, developers, manufacturer, installer, fitters, testers, repairers, maintainers, contractors, constructors, operators, users, inspectors, re-conditioners, improvers, alterers, protectors, removers, hirers, replaces, importers and exporters of and dealers in, electrical appliances, systems, products and services used for energy conservation and generation, equipments,



[Handwritten signature]

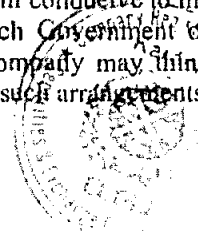
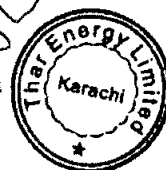


machinery, materials and installations, including but not limited to cables, wires, meters, tracks, rails, pipelines and any other plant, apparatus equipment, systems and things incidental to the efficient generation, procurement, transformation, supply and distribution of electricity.

5. To construct, acquire and maintain roads, bridges, rail sidings, pipelines and storage facilities for water, petroleum products, natural gas, oil and other substances, water desalination and treatment plants, and such other works as may be required for all or any of the above purposes.
6. To carry on the business of electrical engineers, electricians, engineers, consultants, agents, suppliers of services and manufacturers of electrical plant, machinery, and generally to install, acquire, execute, provide, operate and maintain all necessary plant, machinery, equipment, cables, wires, accumulators, lamps, exchanges, telephones, and apparatus and to provide any services related or incidental thereto.
7. To plan, promote, organize, acquire, takeover, establish, buy, develop, construct, react, augment, enlarge, renovate, and modernize, shift, replace, lay, maintain, operate, run, manage, hire, lease, sell, alter, work, give on franchise, use a distribution system and network and all its aspects and any other materials connected with sub-transmission, distribution of electric energy, ancillary services, communication and tele-metering equipment.
8. To import, export, buy, sell, hire or deal in plant, machinery, equipment, cables, wires, accumulators, lamps, exchanges, telephones, fixtures and fittings and apparatus of every kind with special reference to plant, machinery, equipment or apparatus connected with the producing, storing, supplying, using, regulating or measuring the supply or facilitating the use of electricity or electrical currents or force.
9. To buy, sell, import, export, hire, manufacture, deal in and turn to account plant, machinery, implements, conveniences, provisions, articles and products capable of being used in connection with the operations of or required by workmen and other employer by the Company or incidentally or conveniently connected with any such business as aforesaid.
10. To sell, purchase, take in exchange, grant license/permission or lease, rent, occupy or otherwise acquire any lands, hereditaments and estates and any property and effects therein or used or connected therewith and to acquire any grants, concessions, leases, rights, easements, licenses, privileges and any other interests in land.
11. To plan, investigate, research, design and prepare generation projects; to prepare preliminary feasibility and definite project reports for such power generation projects; and to construct, operate and maintain, renovate and modernize power stations, tie-lines, sub stations, dedicated transmission lines and related projects,
12. To acquire, erect, construct, lay down, enlarge, replace, modernize, alter and maintain any buildings, works, and machinery necessary or convenient to the Company's business.

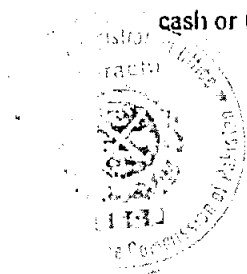


13. To sell, lease, improve, manage, develop, mortgage, exchange, turn to account or otherwise deal with, dispose of absolutely, conditionally, or for any limited interest, and grant any leave or license in respect of all or any of the property, rights or privileges of the Company, and to distribute in specie as dividend or bonus any money, shares, debentures, or debenture stock that may be accepted as consideration for any such sale, lease, exchange or other disposition.
14. To acquire by concession, grant, purchase, barter, licence either absolutely or conditionally and either solely or jointly with others any lands, buildings, machinery, plants, equipments, privileges, rights, licences, trade marks, patents, and other movable and immovable property of any description which the Company may deem necessary or which may seem to the Company capable of being turned to account, subject to any permission as required under the law.
15. To sell, transfer or give any option of purchase or otherwise dispose the whole or any part of the undertaking, property and assets of the Company for such consideration and on such terms as the Company may think fit.
16. To carry on research into and to inquire into and investigate the economic possibilities of promotion and development of and promote and develop commerce, business, trade, industry and all professions, occupations and vocations in Pakistan and elsewhere.
17. To obtain finance, enter into modaraba, musharika or other transactions of Islamic modes of finance, issue (convertible or otherwise) bonds, instruments of redeemable capital, debt instruments, capital market instruments, promissory notes and other securities and instruments and to charge all or any part of the assets of the Company as security for the repayment of any amount so raised or obtained and for the payment of all financial costs, interests, charges, mark-up, fees and costs in relation thereto.
18. To promote, merge, amalgamate with or buy up any other company for the purposes of acquiring all or any of the property and liabilities of that company or for any other purpose and to take or otherwise acquire and hold shares in any other company having objects altogether or in part similar to those of this Company or carrying on any business capable of being conducted so as directly or indirectly to benefit this Company.
19. To enter into partnership or to make any arrangement for sharing profits, union of interests, co-operation, joint-venture, reciprocal concession or otherwise with any person, firm or company carrying on or proposing to carry on any business which this Company is authorized to carry on or which is capable of being conducted so as directly or indirectly to benefit this Company and to have foreign collaborations and to pay royalties/technical fees to collaborators subject to the applicable laws.
20. To enter into any arrangement or agreement with any Government or Authority, Federal, Provincial, Municipal, Local or otherwise that may seem conducive to the Company's object's or any of them, to obtain from any such Government or Authority any rights, privileges and concessions with the Company may think desirable to obtain and carry out, exercise and comply with any such arrangements,



agreements, rights, privileges and concessions, and to apply for and obtain licenses, provisional orders, special acts or other statutory or legislative authority for supplying electricity for any public or private purposes.

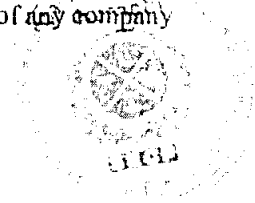
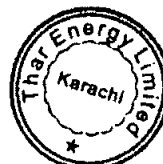
21. To promote any Bills in any legislature or other like body or make any applications to any public authority for any order, provisional order or license and to enter into any contract, to bear and pay the expenses of or in connection with the same or arising there out.
22. To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, lands, building, easements, trade marks, patents, patent rights, copyrights, licenses, machinery, plants, stock-in-trade and any movable and immovable property of any kind necessary or convenient for the purposes of or in connection with the Company's business or any branch or department thereof and to use, exercise, develop, grant licences in respect of or otherwise turn to account any property, rights and information so acquired, subject to any permission required under the law.
23. To purchase or otherwise acquire any patents, brevets, inventions, trademarks, licenses, concessions and the like conferring any exclusive or non-exclusive or limited right to use any invention which may seem capable of being used for any of the purposes of the Company or the acquisition of which may seem calculated directly or indirectly to benefit the Company, and to use, exercise, develop or grant licenses in respect of or otherwise turn to account, the property and rights so acquired.
24. To pay for any property, rights or benefits acquired by the Company either in cash or in shares with such rights, in respect of dividend or otherwise, as may be deemed fit by the Company or by any securities which the Company has power to issue or partly in one mode and partly in another and generally on such terms as the Company may approve.
25. To issue all or any part of the original or enhanced share capital of the Company at par or at a premium or discount subject to any permission required by law.
26. To act as representatives, for any person, firm or company and to undertake and perform sub-contracts, and also act in the business of the Company through or by means of agents, sub-contractors and to do all or any of the things mentioned herein in any part of the world and either alone or in collaboration with others and by or through agents, sub-contractors or otherwise.
27. To acquire and carry on all or any part of the business or property and to undertake any liabilities of any person, firm, association or company's possession of property suitable for any of the purposes of the Company or carrying on any business which this Company is authorised to carry on and in consideration for the same, to pay cash or to issue shares of the Company.



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28. To capitalize such portion of the profits of the Company as are not distributed amongst the members of the company in the form of dividends and as the Company may think fit and to issue bonus shares in favour of the members of the Company.
29. To take shares in Companies having similar or other objects and to finance or assist other businesses, to promote other companies for any purpose calculated to benefit the Company.
30. To promote any Company or companies whose objects include the acquisition of all or any of the property, rights and liabilities of this Company, or the promotion of which shall be considered to be calculated to advance directly or indirectly the objects of this Company or the interests of its members.
31. To establish, promote or assist in establishing or promoting and subscribe to or become a member of any other company, society, association or club whose objects are similar or in part similar to the objects of this Company or the establishment or promotion of which may be beneficial to the Company, as permissible under the law.
32. To open accounts with any bank or banks and to draw, make, accept, endorse, execute, issue, negotiate and discount cheques, promissory notes, bills of exchange, bills of lading, warrants, deposit notes, debentures, letter of credit and any other negotiable instruments and securities.
33. To borrow or raise money by means of loans or other legal arrangements from local and foreign banks, or other financial institutions, or in such manner as the Company may think fit and in particular by issue of debentures, debenture stock, perpetual or otherwise convertible into shares and to mortgage, or charge the whole or any part of the property or assets of the Company, present or future, by special assignment or to transfer or convey the same absolutely or in trust as may seem expedient and to, purchase, redeem or payoff any such securities.
34. To make advances upon the security of any property, rights or benefits, acquired by the Company and upon the security of land and buildings or any interest or estate therein in any part of the world and upon any other assets, real or personal, or upon personal security.
35. To purchase or otherwise acquire and to sell, change, surrender, lease, mortgage, charge, convert, turn to account, dispose of and to deal with property and rights of all kinds and in particular, mortgages, charges, hypothecations, debentures, concessions, options, contracts, patents, licenses, shares, bonds, policies, book debts, business concerns, undertakings and actions of all kinds.
36. To manage, improve, farm, cultivate, maintain or otherwise deal with any part of the land and buildings or other real property of the Company not required for the purpose of the Company.
37. To sell or otherwise dispose of the whole or any part of the undertaking of the Company, either together or in portions for such consideration as the Company may think fit and in particular, for shares, debenture-stock or securities of any company purchasing the same.



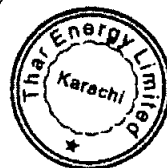
38. To invest and deal with any moneys of the Company in bonds, stocks or any other securities or such other investments and in such manner as may from time to time be determined by the Company and to hold, sell or otherwise deal with such investments, but in any event not to act as an investment company.
39. To accept investments on re-patriable/non-repatriable terms from any person, institution, firm, company or corporation with the approval of competent authorities and to allot shares on such investments on the term and conditions as may be mutually agreed upon with representations of the board of directors of the Company.
40. To subscribe or guarantee money for any purpose which may be considered likely, directly or indirectly, to further the objects of the Company or for any national, charitable, benevolent, public, general or useful object or for any exhibition.
41. To pay all costs, charges, and expenses preliminary or incidental incurred in formation or about the promotion or establishment of the Company or conducting activities of the Company and to remunerate any person, firm or company for services rendered or to be rendered in or about the formation or promotion of the Company or the conduct of its business.
42. To appropriate any part or parts of the property of the Company for the purposes of, and to build offices find other places of business.
43. To employ or engage experts to investigate into or examine the conditions, prospects, value, character and circumstances of any business, concerns and undertakings and generally of any assets, property or rights.
44. To study, investigate, collect information and data, review operations, plan, research, design and prepare project reports, diagnose operational difficulties and weaknesses and advice on the remedial measures to improve and modernize existing electrical lines and sub stations and to prepare forecast of customers demand and sources of purchase of power and to prepare business plan and strategy documentation.
45. To employ or engage persons in or about the business of the Company and to indenture, contract or otherwise engage workmen, skilled and unskilled.
46. To employ contractors, managers, consultants and other skilled persons for the Company.
47. To appoint any persons or companies as agents of the Company and to grant powers of attorney to any person or company with further powers to sub-delegate the authorities.
48. To train personnel and workers both in Pakistan and abroad to obtain technical proficiency in various specialties connected with the business of the Company.
49. To lend money and guarantee the performance of contracts by others.



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50. To give any employee of the Company commission in the profits of the Company's business or any branch thereof and for the purpose to enter into any agreement or scheme of arrangement as the Company may deem fit.
51. To establish and support or aid in the establishment and support of associations, institutions, funds and conveniences calculated to benefit persons who are or have been directors of or who have been employed by or who are serving or have served the Company or any other company which is a subsidiary or associate of the Company or the dependents of such persons and to grant pensions, gratuities, allowances, relief and payments in any other manner calculated to benefit the persons described herein.
52. To remunerate the directors, officials, and employees of the Company or any other person or firm or company rendering services to the Company, out of or in proportion to, the returns or profit of the Company or otherwise as the Company may think proper, either by cash payment or by the allotment to him or them of shares or securities of the Company credited as paid up in full or in part otherwise may be thought expedient, to the extent permitted by applicable law.
53. To distribute any of the Company's property and assets among the Members in specie or in any other manner in case of winding up of the Company.
54. To give any indemnity, guarantee, or security or enter into any bond and, without restricting the generality of the foregoing, to indemnify any person or company, and guarantee or otherwise become liable for the performance by any person or company of any obligation, contract or undertaking as may be required in connection with the business of the Company.
55. To guarantee the performance of contract and obligations of the Company in relation to the payment of any loan, debenture-stock, bonds, obligations or securities issued by or in favour of the Company and to guarantee the payment or return on such investments.
56. To carry out joint venture agreements with other companies or countries within the scope of the objects of the Company.
57. To take out any insurances that the Company deems necessary or appropriate and to pay the premium therefor.
58. To accept gifts of any movable or immovable property of whatsoever kind or wheresoever situate from any person, company or corporation.
59. To subscribe money for any national, charitable, benevolent, public, general or useful object or for any exhibition.
60. To develop and/or transfer technology and to acquire or pass on technical know-how.
61. To apply for and obtain necessary consents, permissions and licences from any government, provincial, local and other authorities for enabling the Company to carry on any of its objects into effect as and when required by law.



62. To constitute and regulate separate branches or departments of the Company's business and to appropriate thereto respectively any of the assets of the Company and any of the capital, issued or to be issued, of the Company and from time to time to vary the constitution or regulations of any such branches or departments or any such appropriations and if thought fit to amalgamate all or any of the said branches or departments.
63. To allow any person or entity to undertake distribution of electricity or any aspect thereof for specified area within the Company's area of supply, to the extent permissible under the law.
64. To procure the Company to be registered or recognized in any country or place outside Pakistan and to keep branch registers.
65. To institute and defend in any forum legal proceedings of every kind or description whatsoever, enter into arbitration agreements and refer disputes to arbitration, pay, satisfy or receive payments in respect thereof, or compound or compromise any claim, demand, action, suit or proceeding of any nature whatsoever made or brought by or against the Company.
66. To carry on any other business or activity of any nature whatsoever which may seem to the Company to be capable of conveniently or advantageously carried on in connection or conjunction with any business of the Company hereinabove or hereinafter authorized or to be expedient.
67. To adopt such means of making known the business, services and products of the Company as may seem expedient and in particular by undertaking seminars, training and demonstration programs and by advertising in the press, media and the internet by circulars and by purchase of exhibition of works of arts or interests, by publication of books and periodicals and by granting prizes, rewards and donations.
68. To establish, implement and revise, consistent with the law, suitable guidelines, suitable circulars, and other instruments to govern various aspects of its operations and to establish, implement and revise, consistent with the law, suitable conditions of supply, contract conditions, guidelines, circulars and other instruments to govern its relationship with consumers.
69. To make rules and regulations not inconsistent with this memorandum, to provide for all matters for which provision is necessary or expedient for the purpose of giving effect to the provisions of this memorandum and the efficient conduct of the affairs of the Company.
70. To allow and pay underwriting and other commissions, broker's fees and remunerations, premiums and charges to any person, firm, or company for services rendered or to be rendered in introducing any property rights, privileges or business to the Company or otherwise providing consultancy services about the conduct of Company's business or placing or assisting to place or guaranteeing or procuring the subscription of any shares, debentures, stocks, or other securities, which brokerage, remunerations, commissions, or charges may be paid either in cash or in stock options and shares of the Company or for negotiating any of the purchase or sales by the Company of any property for the purpose of business of the Company or for rendering any service of any kind whatsoever to the Company.



71. Notwithstanding anything stated in any object clause, the Company shall obtain such other approval or license from the competent authority, as may be required under any law or the time being in force, to undertake a particular business.

72. To do and perform all other acts and things as are incidental or conducive to the attainment of the above objects or any of them.

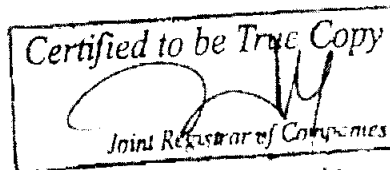
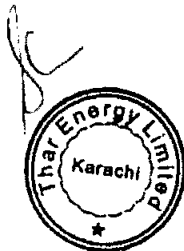
73. It is declared that notwithstanding anything contained in the foregoing object clauses of this Memorandum of Association nothing contained therein shall be construed as empowering the Company to undertake, engage or to indulge in banking business or Forex, illegal brokerage, or any business of investment company or non-banking finance company or insurance or leasing or business of managing agency or in any unlawful business and that nothing contained in the object clauses shall be so construed to entitle it to engage in such business directly or indirectly and the Company shall not launch multi-level marketing (MLM), Pyramid and Ponzi schemes.

74. It is hereby declared that:

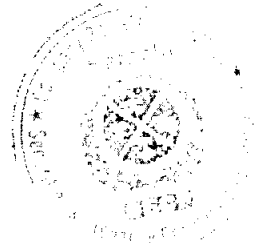
- i. the word "company" in the above clauses, except where used in reference to the Company, shall be deemed to include any partnership or other body of persons, whether corporate or otherwise existing, and whether domiciled in Pakistan or elsewhere;
- ii. the objects specified in each of the paragraph above shall, except if otherwise expressed, be in no way limited or restricted by reference to or inference from the terms of any other paragraph or the name of the Company or the nature of any of the business carried on by the Company, but may be carried out in as full and shall be construed in a manner as if each paragraph defines the objects of a separate and independent company;
- iii. except as otherwise mentioned the words and expressions used in the above paragraphs shall, if not inconsistent with the subject context, bear the same meaning as in the Companies Ordinance 1984

IV. The liability of the Members is limited.

V. The authorized capital of the Company is PKR 500,000,000/- Million (Rupees Five Hundred Million) divided into 50,000,000 Million (Fifty Million) ordinary shares of PKR 10/- (Rupees ten) each. The Company shall have the power to increase, reduce or re-organize the capital of the Company and divide shares in the capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984.



23/07/2014



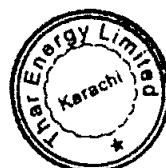
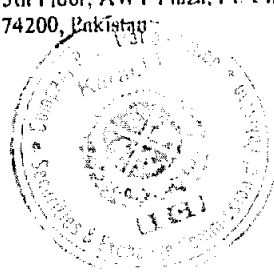
We the several persons, whose names and addresses are subscribed, are desirous of being formed into a company, in pursuance of this Memorandum of Association and we respectively agree to take the number of shares in the capital of the Company set opposite to our names

Name and Surname (Present & Former) in full (in Block Letters)	Father's/ Husband's Name in Full	CNIC/ Passport No.	Nationality with any former Nationality	Occupation	Address	Number of Shares taken by each Subscriber
The Hub Power Company Limited Through: Khalid Mansoor	Mansoor Ul Haq	42301-4000955-5	Pakistani	Subscriber	House No. 124/1, Street No. 12, Khayaban-e-Rahat, Phase 6, Karachi, Pakistan	4,999,996 (Four million, nine hundred and ninety nine thousand, nine hundred and ninety six)
Khalid Mansoor	Mansoor Ul Haq	42301-4000955-5	Pakistani	Director	House No. 124/1, Street No. 12, Khayaban-e-Rahat, Phase 6, Karachi, Pakistan	1 (One)
Tahir Jawaid	Jawaid Ahmed Mirza	61101-7696043-5	Pakistani	Director	Khayaban-e-Muslim, Off 29 th Street, House No. 94/11, Phase VIII, DHA, Karachi.	1 (One)
Abdul Nasir	Mohammad Haroon	42201-7725707-7	Pakistani	Director	House No. 12/3, Jinnah Housing Society, Shahheed-e-Millat Road, Karachi	1 (One)
Iqbal Alimohamed	Ali Mohamed	42201-2214140-7	Pakistani	Director	K.D.A, Scheme I, House No.B-84/1-A, Karachi	1 (One)
						Total: 5,000,000 (Five Million Shares)

Dated the 2nd day of May 2016

Witness to the above signatures

Name: NIFT (Pvt.) Limited
Address: 5th Floor, AWF Plaza, 11 Chundrigar Road
Karachi- 74200, Pakistan



THE COMPANIES ORDINANCE, 1984

(Company Limited by Shares)

ARTICLES OF ASSOCIATION

OF

THAR ENERGY LIMITED

1. TABLE "A" NOT TO APPLY

The Regulations contained in the table marked 'A' of the First Schedule to the Companies Ordinance, 1984, shall not apply to the Company except in so far as the same are repeated or expressly made applicable in these Articles.

2. Interpretation

In these Articles (if not inconsistent with the subject or context or expressly provided to the contrary below) the following words and expressions shall have the following meanings:

"Board" means the Directors collectively or the Directors present at a duly convened meeting of Directors at which a quorum is present, as the context requires;

"Company" means THAR ENERGY LIMITED;

"Directors" mean the directors or the alternate director for the time being of the Company, as the case maybe;

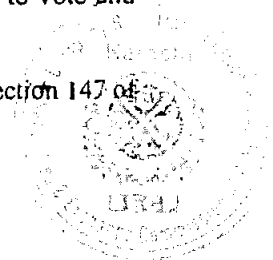
"Month" and "Year" means the calendar month and the calendar year respectively;

"Member" means the member of the Company as defined in Section 2(1) (21) of the Ordinance;

"Ordinance" means the Companies Ordinance, 1984 (XLVII of 1984);

"Ordinary Resolution" means a resolution passed at a general meeting when the votes cast (whether on a show of hands or on a poll, as the case may be) in favour of the resolution (including the casting vote, if any, of the Chairman) by members who, being entitled to vote in person or by proxy, do so vote, exceed the votes, if any, cast against the resolution by members entitled to vote and voting thereon;

"Register" means a Register of Members to be kept pursuant to Section 147 of the Ordinance;



"Registrar" means a Registrar, an Additional Registrar, a Joint Registrar a Deputy Registrar or an Assistant Registrar, responsible under the Ordinance for the registration of companies;

"SECP" means Securities and Exchange Commission of Pakistan.

"Special Resolution" means a special resolution of the Company as defined in Section 2(1)(36) of the Ordinance.

"Seal" means the common seal of the Company;

'Secretary' means Secretary of the Company and the expression Secretary shall include the person appointed to perform the duties of the Secretary.

References to writing shall, unless the contrary intention appears, be construed as including reference to printing, lithography, photography & other modes of representing, transmitting or reproducing words in a legible & non-transitory form.

Words importing singular number only shall include the plural number and vice versa.

Save as aforesaid any words or expressions defined in the Ordinance shall if not inconsistent with the subject or context, bear the same meaning as in these Articles.

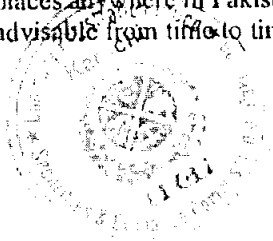
Any reference to statutory provision or enactment shall include any statutory modification or re-enactment thereof.

3. PUBLIC COMPANY

The Company is a public limited company within the meaning of Clause (30) of Section 2(1) of the Ordinance.

4. BUSINESS

The Directors shall have regard to the restrictions on the commencement of business imposed by Section 146 of the Ordinance, if and so far as, those restrictions apply to the Company. The business of the company shall include all or any of the objects and powers enumerated in the Memorandum of Association. The business of the company shall be carried out at such place or places anywhere in Pakistan or elsewhere as the Directors may deem proper or advisable from time to time.



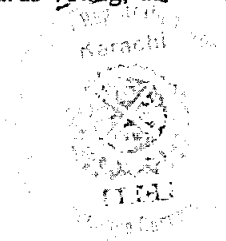
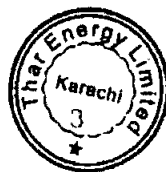
PART II - CAPITAL AND SHARES

5. AUTHORISED SHARE CAPITAL

The authorized capital of the Company is PKR 500,000,000/- Million (Rupees Five Hundred Million) divided into 50,000,000 Million (Fifty Million) ordinary shares of PKR 10/- (Rupees ten) each. The Company shall have the power to increase, reduce or re-organize the capital of the Company and divide shares in the capital for the time being into several classes in accordance with the provisions of the Companies Ordinance, 1984.

6. ALLOTMENT OF SHARES

- i) Subject to the provisions of the Ordinance and these Articles, the shares in the capital of the Company for the time being shall be under the control of the Directors who may allot or otherwise dispose of the same or any of them to such persons and on such terms and conditions and at such times as the Directors may think fit and with powers to the Directors to give to any person the right to call for the allotment of any shares of the Company at par or at a premium, for such times and for such consideration as the Directors may think fit.
- ii) Shares may be registered in the name of any limited company or other corporate body but not in the name of minor or a firm. Not more than four persons shall be registered as joint holders of any shares.
- iii) The joint holder of a share shall be severally as well as jointly liable for the payment of all dues in respect of such share and for all other costs and obligations incidental thereto according to the Company's regulations.
- iv) Every shareholder shall name to the Company an address and such address shall for all purposes be deemed to be his registered address.
- v) Subject to the provisions of the Ordinance, the Companies (Issue of Capital) Rules 1996 and these Articles, the Directors may allot and issue shares in the capital of the Company as payment or part payment of any property sold or transferred, land, machinery, goods supplied or any services rendered to the Company in the conduct of its business and any shares which may be so allotted may be issued as fully paid up shares and if so issued, shall be deemed to be fully paid up shares.
- vi) The share capital of the Company shall comprise of ordinary shares, and subject as aforesaid the Company may issue shares of a single class or of different classes, but where ordinary shares of more than one class are issued the rights as between the various classes of such shares shall be strictly proportionate to the paid up value of the shares as regards ~~voting~~ dividends and other benefits



7. RESTRICTION ON ALLOTMENT / PURCHASE OF OWN SHARES

- 7.1 The Board shall as regard any allotments of shares duly comply with such of the provisions of Sections 68 to Section 73 of the Ordinance as may be applicable thereto. The minimum subscription amount of the Company with which the Directors may proceed to allotment shall be PKR 10,000.
- 7.2 Except to the extent allowed by Section 95 and 95A of the Ordinance, no part of the funds of the Company shall be employed in the purchase of its own shares or in giving, whether directly or indirectly and whether by means of a loan, guarantee, security or otherwise, any financial assistance for the purpose of or in connection with a purchase made or to be made by any person of any shares in the Company.

8. COMMISSION AND BROKERAGE

Subject to Section 82 and 83 of the Ordinance, the Company may at any time pay a commission to any person for subscribing or agreeing to subscribe whether absolutely or conditionally for any shares in, or debentures or other securities of the Company or procuring or agreeing to procure subscriptions whether absolute or conditional for any shares or debentures or other securities of the Company, provided that the conditions and requirements set out in the Ordinance shall be observed and complied with. Such commission may be satisfied by the payment of cash or the allotment of fully paid shares, or the issuance of securities or by any combination thereof. The rate of commission and brokerage shall not exceed the rate, if any, from time to time fixed by the SECP.

9. SHARES AT DISCOUNT

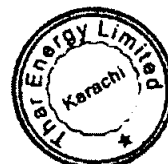
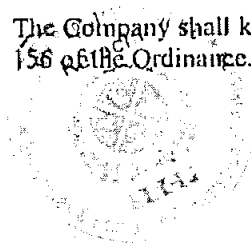
The Company may under a Special Resolution and with the consent of SECP and upon otherwise, complying with Section 84 of the Ordinance, the Board may issue shares at a discount.

10. TRUST NOT RECOGNIZED

No notice of any Trust expressed, implied or constructive shall be entered on the Register. The Company shall not, save as ordered by a court of competent jurisdiction, or as by statute required, be bound to recognize any benami, equitable, contingent, future, or partial interest in any share, or any other right in respect of a share, except an absolute right thereto in the person or persons from time to time registered as the holder or holders thereof.

11. REGISTER

- 11.1 The Company shall keep a Register in accordance with Sections 147, 149 and 156 of the Ordinance.



- 11.2 The Register shall be kept at the Office and, except when closed under the provisions of the Ordinance, shall during business hours (subject to such reasonable restrictions as the Company in general meeting may impose so that not less than two hours in each working day be allowed for inspection), be open to the inspection of any Member, as the Company may prescribe, for each inspection. Any such Member or other person may take extracts therefrom.
- 11.3 Any Member or other person may require a certified copy of the Register, or any part thereof, on payment of One Rupee (Rs. 1) for every 100 words or fractional part thereof, and the Company shall cause any copy so required by any person to be sent to that person within a period of ten days, exclusive of nonworking days and days on which the transfer books of the company are closed commencing on the day next after the day on which the requirement is received by the Company.
- 11.4 The Register shall be prima facie evidence of any matters the Ordinance directors authorizes to be inserted therein.
- 11.5 No member who shall change his name shall be entitled to recover any dividend or to vote, until notice of the change is given to the company in order that the same may be registered, after the Company is satisfied that the name has been legally changed.

PART III – CERTIFICATES

12. CERTIFICATES

The certificates of title of shares shall be issued under the Seal and signed by at least two Directors. Every share certificate shall specify the number and class and the distinguishing number (if any) of the shares to which it relates. A Director's signature on such certificates may be affixed or printed by any mechanical or electronic method. No share certificate shall represent shares of more than one class.

13. MEMBERS RIGHTS TO CERTIFICATES

Every person whose name is entered as a Member in the Register of Members shall, unless the conditions of issue of the shares otherwise provide, be entered without payment to receive within sixty (60) days after the allotment or within forty five (45) days of the application for the registration of the transfer of any shares of the Company, a certificate under the Seal specifying the shares held by him/her and the amount paid up thereon. If any Member shall require additional certificates he/she shall pay for each such certificate, a sum not exceeding Rs.10/- or otherwise as the Board may determine, provided that in respect of any share held jointly by several persons the Company shall not be bound to issue more than one certificate, and delivery of the certificate for a shares to one of the several joint holders shall be sufficient delivery to all.



14. ISSUE OF NEW CERTIFICATES

- 14.1 Subject to the provisions of Section 75 of the Ordinance, if a share certificate is defaced, lost or destroyed, it may be renewed on payment of such fee (if any) not exceeding Rs.10/- and on such terms (if any) as to evidence and indemnity and the payment of expenses incurred by the Company in investigating evidence, as the Board thinks fit.
- 14.2 Where some of the share comprised in a share certificate are transferred the old certificate shall be cancelled and a new certificate for the balance of such shares be issued without charge.
- 14.3 The shares are indivisible but more than one person may have a share in one share but shall be represented by one person towards the Company. The shares may not be represented by negotiable instruments.

PART IV - TRANSFER AND TRANSMISSION OF SHARES

15. TRANSFER OF SHARES

- 15.1 Every transfer of shares must be in writing in the form specified in Article 16.2 herein or in any other form that the Board may approve and must be left at the office accompanied by the certificate or, if no such certificate is in existence the letter of allotment of the shares to be transferred and such other evidence, if any, as the Board may require to prove the title of the intending transferor of his/her right to transfer the shares.
- 15.2 The shareholders and Directors of the Company have a right of priority in the event of one of the shareholders alienating some or all of his/her shares. But any transfer whether to the shareholders or to the Directors of the Company or to third parties must follow the provisions of the applicable law.

16. EXECUTION OF TRANSFER

- 16.1 The instrument of transfer of any share should be duly stamped and executed both by the transferor and the transferee and the transferor shall be deemed to remain the holder of such shares until the name of the transferee is entered in the Register of Members in respect thereof. Each signature of such transfer shall be duly attested by the signature of one witness who shall add his/her address and occupation.
- 16.2 Shares in the Company shall be transferred in the following form, or in any usual or common form which the Directors shall approve:

I..... of..... In consideration of the sum of Rupees..... Paid to me by..... of..... (hereinafter called "the transferee") do hereby transfer to the said transferee.....share(s) numbered to inclusive, in the THAR ENERGY LIMITED to hold unto the said transferee,



his/her executors, administrators and assigns, subject to the several conditions on which I held the same at the time of the execution hereof, and I, the said transferee, do hereby agree to take the said share(s) subject to the conditions aforesaid.

As witness our hand this Day of

Signature Transferor

Witness

Signature

Full Address

Signature Transferee

Full Name

Full Address

Fathers/Husband's name

Nationality

Occupation

Signature.....

Full Address

17. CASES IN WHICH THE DIRECTORS SHALL REFUSE TO REGISTER TRANSFER

17.1 The Directors may refuse to register any transfer of any fully paid shares if:

(a) the transfer deed is for any reason defective or invalid, provided that the Company shall within thirty (30) days, from the date on which the instrument of transfer was lodged with it, notify the defect or invalidity to the transferee who shall after removal of such defect or invalidity be entitled to re-lodge the transfer deed with the Company; or

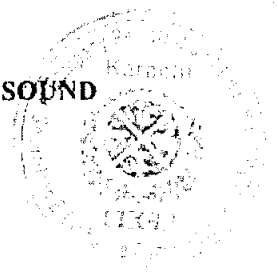
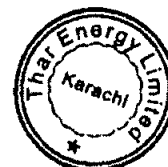
(b) the transfer is in breach of the provisions of Article 16;

17.2 The Directors may also suspend the registration of transfers during ten days immediately preceding a general meeting or prior to the determination of entitlement or rights of the shareholders by giving seven days previous notice in the manner provided in the Ordinance.

17.3 If the Company refuses to register the transfer of any share for the reason specified in Article 16, the Company shall within thirty (30) days after the date on which the instrument of transfer was lodged with it, send to the transferee notice of the refusal indicating the reason for such refusal.

18 NO TRANSFER TO AN INSOLVENT OR PERSON OF UNSOUND MIND

7



No transfer shall be made to an insolvent or person of unsound mind.

19. TRANSMISSION OF REGISTERED SHARES

19.1 The executors, administrators, heirs or nominees, appointed under Section 80 of the Ordinance as the case may be, of a deceased Member not being one of several joint holders shall be the only persons recognized by the Company having any title to the shares registered in the name of such Member. In case of death of any one or more of the joint holders of any shares the survivor or survivors shall be the only persons recognized by the Company as having any title to or interest in such share. Before recognizing any executor, or administrator the Board may request him/her to obtain a grant of Probate or Letters of Administration, Successions Certificates or other legal representation(s) as the case may be from a competent court provided nevertheless that where the Board in its absolute discretion thinks fit it shall be lawful for the Board to dispense with the production of Probate or Letters of Administrator or Succession Certificates or such other legal representation(s) upon such terms as to indemnity or otherwise as the Board in its absolute discretion may consider necessary.

19.2 Any person becoming entitled to any Shares in consequence of the death, lunacy, bankruptcy or insolvency of any Member or by any lawful means other than by a transfer in accordance with these presents, may, with the consent of the Directors (which they shall not be under any obligation to give) upon producing such evidence as the Directors shall require, either be registered as a Member in respect of such Shares or elect to have some person nominated by him and approved by the Directors registered as Member in respect of such Shares provided nevertheless that if such person shall elect to have his nominee registered, he shall testify his election by executing in favour of his nominee an instrument of transfer in accordance with the provision herein contained and until he does so he shall not be freed from any liability in respect of such Shares.

20. RIGHT OF PERSONS ENTITLED TO SHARES UNDER ARTICLE 19

A person so becoming entitled under Article 19 shall subject to the right of the Board to retain such dividends or monies as hereinafter provided have the right to receive and give a discharge for any dividend or other monies payable or other advantages arising in respect of the shares but he/she shall have no right to attend or vote at meetings of the Company or save as aforesaid to any of the rights or privileges of a Member in respect of the shares unless and until he/she shall be registered as the holder thereof.

21. DIRECTOR MAY DECLINE TO REGISTER PERSONS ENTITLED BY TRANSMISSION

The Directors shall have the same right to refuse to register a person entitled by transmission to any shares or to his nominee as if he/she were the transferee named in any ordinary transfer presented for registration



22. CLOSURE OF REGISTER

The Company may on giving seven (7) days previous notice in the manner prescribed in the Ordinance, close the Register for any period not exceeding in the aggregate forty-five (45) days in each year but not exceeding thirty (30) days at any one time, in accordance with the manner specified in Section 151 of the Ordinance.

23. TRANSFER OF DEBENTURES

The provision relating to transfer of shares herein contained shall apply mutatis mutandis to transfer of debentures and other securities of the Company.

PART V - ALTERATION OF CAPITAL

24. POWER TO INCREASE CAPITAL

The Company may, from time to time, increase its share capital in accordance with the provisions of the Ordinance.

25. SHARES TO BE OFFERED TO EXISTING MEMBERS

25.1 All new shares shall be offered in the first instance to the Members in proportion as nearly as the circumstances admit to the existing shares held by each Member and such offer shall be made by notice specifying the number to which the Member is entitled and limiting a time within which the offer if not accepted will be deemed to be declined.

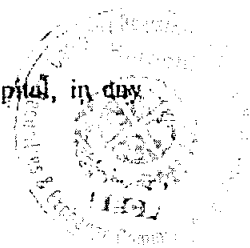
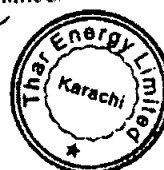
25.2 After expiration of the time for acceptance of an offer of new shares specified in Article 25.1 above or on receipt of an intimation from the Member to whom such notice is given that he/she declines to accept the shares offered, the Board may, subject to the provisions of Section 86 of the Ordinance, dispose of the same in such manner as they think most beneficial to the Company.

26. RANKING OF NEW SHARES WITH THE ORIGINAL CAPITAL

The new shares shall be subject to the same provisions with reference to transfer, transmission, and otherwise as the shares in the original share capital.

27. REDUCTION OF SHARE CAPITAL

The Company may, by Special Resolution, reduce its share capital, in any manner subject to the provisions of the Ordinance.



28. CONSOLIDATION AND SUB-DIVISION

Subject to the provisions of Section 92 of the Ordinance, the Company may, by Ordinary Resolution:

- (a) Consolidate and divide the whole or any part of its share capital into shares of larger nominal value than its existing shares.
- (b) Sub-divide its existing shares or any of them into shares of smaller amount than is fixed by the Company's Memorandum of Association, subject nevertheless, to the provisions of clause (d) of sub-Section (1) of Section 92.
- (c) Cancel any shares which at the date of the passing of the Ordinary Resolution in that behalf have not been taken or agreed to be taken by any person.

PART VI - GENERAL MEETINGS

29. STATUTORY MEETING

The statutory meeting of the Company shall be held in the manner for the purpose and within the period required under Section 157 of the Ordinance.

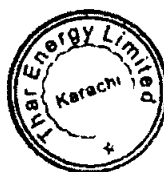
30. ANNUAL GENERAL MEETINGS

The Company shall hold in addition to any other general meeting, a general meeting as its annual general meeting, within eighteen months from the date of its incorporation and thereafter at least once in every calendar year within a period of four months following the close of its financial year and not more than fifteen months after the holding of its last preceding annual general meeting. The general meeting shall be held on a date, time and place as may be determined by the Board.

31. EXTRAORDINARY GENERAL MEETING

All general meetings of the Company other than the annual general meeting and the statutory meeting shall be called extraordinary general meetings ("EGM"). The Board may whenever it thinks fit convene an EGM and an EGM shall also be convened on such requisition, or, in default may be convened by such requisitions, as provided by Section 159 of the Ordinance. An EGM may be held in such places as the Board may determine.

32. NOTICE OF MEETINGS



All general meetings of the Company shall be called by not less than twenty-one clear days notice in writing. The notice shall specify the place, the day and the hour of the meeting along with a statement of the business to be transacted at the general meeting and in case of special business, a the general nature of that business , shall be given in the manner provided by the Ordinance for the general meeting, to such persons as are, under the Ordinance or the regulations of the Company entitled to receive such notices from the Company; but the accidental omission to give notice to, or the non-receipt of notice by, any Member shall not invalidate the proceedings at any general meeting. In case of an EGM, a shorter notice may be given with the consent of Registrar as provided in Section 159 of the Ordinance

33. PROXIES

In every notice calling a meeting of the Company there shall appear with reasonable prominence a statement that a Member entitled to attend and vote is entitled to appoint a proxy to attend the vote in his/her stead and that a proxy need not be a Member.

34. ENTITLEMENT TO RECEIVE NOTICE AND ARRANGEMENT FOR MEETINGS

Subject to any restrictions contained in the Ordinance or in any of the Articles every Member shall be entitled to attend a general meeting in person or by proxy.

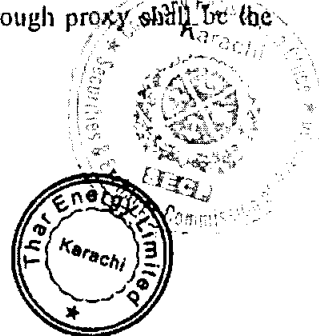
35. BUSINESS AT GENERAL MEETINGS

All business that is transacted at an EGM shall be deemed special, and also all that is transacted at an annual general meeting with the exception of declaring a dividend, the consideration of the accounts, balance sheet and the reports of the Directors and auditors, the election of Directors, the appointment of, and the fixing of the remuneration of the auditors and appointment of other officers other officers in place of those retiring.

36. QUORUM

No business shall be transacted at any general meeting unless quorum of Members is present at the time when the meeting proceeds to business, save as herein otherwise provided. At least 2 Members having not less than twenty-five percent of the voting power present in person or through proxy shall be the quorum at any general meeting of the Company.

37. EFFECT OF QUORUM NOT BEING PRESENT



If within half an hour from the time appointed for the meeting a quorum is not present, the meeting, if convened upon the requisition of Members, shall be dissolved, in any other case, it shall stand adjourned to the same day in the following week at the same time and place. The quorum for any such meeting shall remain as provided for in Article 36 above.

38. CHAIRMAN OF GENERAL MEETING

The Chairman, if any, elected under Article 58 shall preside as Chairman at every general meeting of the Company, but if there is no such Chairman or if at any general meeting the Chairman is not present within fifteen minutes after the time appointed for holding the meeting, or is unwilling to act as Chairman, the Members present whether in person or by the proxy shall choose one of their number to be Chairman of the meeting.

39. POWER TO ADJOURN GENERAL MEETING

39.1 The Chairman of a general meeting may at any time with the consent of the general meeting at which a quorum is present (and shall if so directed by the meeting) adjourn the meeting to another time or place. In addition the Chairman may at any time without the consent of the meeting adjourn the meeting to another time or indefinitely if it appears to the Chairman that:

- (i) The number of persons wishing to attend cannot be conveniently accommodated in the place(s) appointed for the meeting; or
- (ii) The unruly behavior of any person attending the meeting prevents or is likely to prevent the orderly conduct of the business of the meeting; or
- (iii) An adjournment is otherwise necessary so that business of the meeting may be properly conducted.

No business shall be transacted at any adjourned meeting other than business left unfinished at the meeting from which the adjournment took place.

39.2 When a meeting is adjourned for an indefinite period, the date, time and place of the adjourned meeting shall be fixed by the Board. When a meeting is adjourned for 60 days or more, notice of the adjourned meeting shall be given as in the case of the original meeting. When a meeting is adjourned for more than 14 days but less than 60 days (or for 14 days or less if the date of the adjourned meeting is fixed by the Board), notice of the day, time and place of the adjourned meeting shall be given in the same manner as in the case of an original meeting and notice of the business to be transacted at such an adjourned meeting shall not be required. Where a meeting is adjourned for 14 days or less, and the date of the adjourned meeting is fixed by the Chairman of the meeting, it shall not be necessary to give any notice of the adjourned meeting or of the business to be transacted at an adjourned meeting whatever the reason for the adjournment.

40. MODE OF DECIDING QUESTIONS AT MEETINGS



At any general meeting, a resolution put to the vote of the meeting shall, be decided on a show of hands unless a poll is (before or on the declaration of the result of the show of hands) demanded. Unless a poll is so demanded, a declaration by the Chairman that a resolution has, on a show of hands, been carried, or carried unanimously, or by a particular majority, or lost, and an entry to that effect in the book of the proceedings of the Company shall be conclusive evidence of the fact, without proof of the number or proportion of the votes recorded in favour of, or against, that resolution.

41. POLL

- 41.1** A poll may be demanded only in accordance with the provisions of Section 167 of the Ordinance. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in Section 168 of the Ordinance and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.
- 41.2** A poll demanded on the election of the Chairman or on a question of adjournment shall be taken at once.

42. RIGHT OF DIRECTORS TO ATTEND GENERAL MEETINGS

Subject to Section 162 of the Ordinance every Director of the Company shall have the right to attend any general meeting of the Company and also to take part in the discussions thereat, but he/she shall not be entitled to cast a vote at a general meeting of the Company unless he/she is Member of the Company.

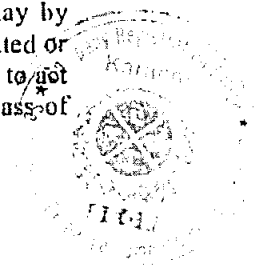
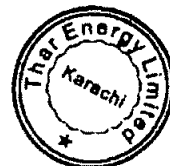
PART VII - VOTES OF MEMBERS

43. VOTES OF MEMBERS

Subject to any rights or restrictions attached to any shares and to the provisions of these Articles, on a show of hands every Member who is present in person shall have one vote and on a poll every Member present in person or by a representative or proxy shall have one vote for each share held by him/her. Provided that in case of election of Directors, the provisions of Article 53 shall apply.

44. REPRESENTATION OF COMPANIES OR CORPORATIONS AT GENERAL MEETING

Any company or corporation which is a Member of the Company may by resolution of its Board of directors or in such manner as may be permitted or required by its constitution, authorize, in writing, any person or persons to act as its representative at any general meeting of the Company or any class of



Members in respect of its entire holding or any part thereof. A person so authorized shall be entitled to exercise the same powers on behalf of the company or corporation he/she represents as that company or corporation could exercise if it were an individual Member of the Company. A representative so appointed shall not be deemed to be a proxy.

45. JOINT HOLDERS

In the case of joint holders of a share the vote of the senior who tenders a vote, whether in person or by proxy, shall be accepted to the exclusion of the votes of the other joint holders and for this purpose seniority shall be determined by the order in which the names stand in the Register in respect of the shares.

46. THE INSTRUMENT OF PROXY

The instrument appointing a proxy shall be in writing and be signed by the appointer or his/her attorney duly authorized in writing or if the appointer or his/her attorney duly authorized in writing or if the appointer is a body corporate be under its seal or be signed by an officer or any attorney duly authorized. A proxy need not be a Member. A proxy who is appointed for a specified meeting only shall be called a Special Proxy. A special proxy shall be valid only for the meeting to which it relates and it shall not be used for more than one meeting. An instrument appointing a proxy may be in the following form or a form near thereto as may be approved by the Directors:

THAR ENERGY LIMITED

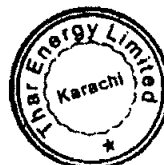
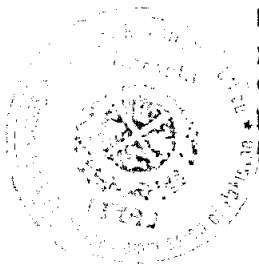
I-----of-----being a member of THAR ENERGY LIMITED hereby appoint-----of-----as my proxy to vote for me and on my behalf at the annual/extraordinary general meeting of the Company to be held on the _____ day of _____, _____ and at any adjournment thereof.

Dated: _____

Signed: _____

47. INSTRUMENT APPOINTING A PROXY TO BE DEPOSITED AT THE OFFICE OF THE COMPANY

The instrument appointing a proxy and the power of attorney or other authority, if any under which it is signed or a notarized certified copy of that power or authority shall be deposited at the office of the Company not less than 48 hours before the time for holding the meeting or adjourned meeting at which the person named in the instrument proposed to vote and in default the instrument of proxy shall not be treated as valid. Delivery of an instrument appointing a proxy shall not preclude a Member from attending and voting in person at the meeting or poll concerned.



48. REVOCATION OF AUTHORITY

A vote given in accordance with the terms of an instrument appointing a proxy shall be valid notwithstanding the previous death or insanity of the Member or revocation of the proxy or of the authority under which the proxy was executed or the transfer of the shares in respect of which the proxy is given unless intimation in writing of the death, insanity, revocation or transfer shall have been received by the Company at least forty eight (48) hours before the commencement of the meeting or adjourned meeting at which the proxy is used. Provided nevertheless that the Chairman of any meeting shall be entitled to require such evidence as he/she may in his/her discretion think fit of the due execution of an instrument of proxy and that the same has not been revoked.

49. EQUALITY OF VOTES

In case of an equality of votes, whether on a show of hands or on a poll, the Chairman of the meeting at which the show of hands takes place, or at which the poll is demanded, shall have and exercise a second or casting vote.

PART XIII - DIRECTORS

50. NUMBER OF DIRECTORS

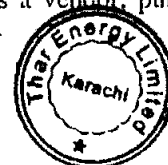
- a) The number of Directors to be elected shall be fixed by the Directors, subject to the condition that until otherwise determined by the Company in a general meeting, the number of Directors including Directors nominated by the Company's creditors or other special interests by virtue of contractual arrangements shall not be less than three.
- b) The following shall be the first Directors of the Company:-
 - 1. Mr. Khalid Mansoor
 - 2. Mr. Tahir Jawaid
 - 3. Mr. Iqbal Ahimohamed
 - 4. Mr. Abdul Nasir
- b) Save as provided in Section 187 of the Ordinance, no person shall be appointed as a Director unless he/she is a Member of the Company.

51. REMUNERATION OF DIRECTORS

The remuneration of the Directors shall from time to time be determined by the Company in a general meeting subject to the provisions of the Ordinance.

52. DIRECTORS MAY CONTRACT WITH COMPANY

No Director or intending Director shall be disqualified by his/her office from entering into any contract, arrangement, transaction or proposal with the Company either acting in a professional capacity as a vendor, purchaser or



otherwise, nor shall any contract, arrangement, transaction or proposal entered into by or on behalf of the Company in which any Director shall be so concerned or interested, be liable to account to the Company for any profit realized by any such contract, arrangement, transaction or proposal by reason of such Director holding that office or of the fiduciary relation thereby established provided that the nature of his/her interest has been disclosed by him/her at the time and in the manner specified in Section 214 of the Ordinance. Provided further that any such contract, arrangement, transaction or proposal as afore-mentioned shall not be entered into with the Company by a Director or intending Director without the approval of the Board. In a Board meeting held for the purposes of granting such afore-said approval, the Director who is directly or indirectly interested or concerned in any way shall not take part in the discussion, nor vote in such meeting.

PART IX - APPOINTMENT, ELECTION AND REMOVAL OF DIRECTORS

53. ELECTION OF DIRECTORS

- 53.1** At the first annual general meeting of the Company, all the Directors shall stand retired from office, and directors shall be elected in their place in accordance with Section 178 for a term of three years.
- 53.2** A retiring Director shall be eligible for re-election.
- 53.3** The Directors shall comply with the provisions of Sections 174 to 178 and Sections 180 and 184 relating to the election of Directors and matters ancillary thereto.
- 53.4** Subject to the provisions of the Ordinance, the Company may from time to time increase or decrease the number of Directors.
- 53.5** Any casual vacancy occurring on the Board of Directors may be filled up by the Directors, but the person so appointed shall be subject to retirement at the same time as if he/she had become a Director on the day on which the Director in whose place he/she is chosen was last elected as Director.
- 53.6** The Company may remove a Director in accordance with the provisions of the Ordinance.

54. VACATION OF OFFICE OF DIRECTOR

The office of a Director shall be vacated if

- (a) He/she becomes ineligible to be appointed as a Director on any or more of the grounds enumerated in clause (a) to (h) of Section 187 of the Ordinance subject always to the proviso to such Section;



- (b) He/she absents himself/herself from three consecutive meetings of the Board or from all meetings of the Board for a continuous period of three months whichever is the longer without leave of absence from the Board and the Board resolve that his/her office be vacated;
- (c) He/she or any firm of which he/she is a partner or any private company of which he/she is a Director;
 - (i) without the sanction of the Company in general meeting, accepts or holds any office of profit under the Company other than that of Chief Executive or a legal or technical advisor or a banker; or
 - (ii) accepts a loan or guarantee from the Company in contravention of Section 195 of the Ordinance.
- (d) He/she fails to obtain the share qualification, if any necessary for his/her appointment, or ceases to hold share qualification necessary for his/her appointment.

55. ALTERNATE DIRECTORS

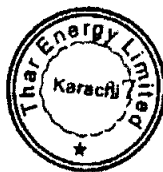
Subject to Section 192 of the Ordinance, a Director may with the approval of the Board, appoint any person to be his/her alternate Director during his/her absence, if not less than three months, from Pakistan and such appointment shall have effect and such appointee while he/she holds office as an alternate director shall be entitled to notice of meetings of the Board and to attend and vote thereat accordingly and generally to exercise all the rights of such absent Director subject to any limitations in the instrument appointing him/her. Any appointment or removal under this Article shall be effected by notice in writing under the hand of the Director making the same.

PART X - PROCEEDINGS OF DIRECTORS

56. MEETING OF DIRECTORS

The Board may meet together for the dispatch of business, adjourn, and otherwise regulate their meetings, as they think fit, provided that they shall meet atleast once in each quarter of a year. Such meetings may be held in such places in or outside Pakistan as the Board may determine. The Board may invite such persons as they may deem fit to attend the meetings of the Board of Directors as observers. Meetings of the Board may be held by teleconference, video conference or other electronic media facilities enabling Directors to participate in meetings without being in the same physical location.

57. POWER OF DIRECTOR TO SUMMON A MEETING; NOTICE OF MEETING



A meeting of the Board can be converted at any time on the requisition of a Director; provided that seven (7) clear days notice of the meeting shall ordinarily be given to all Directors including those who were/are not for the time being resident in Pakistan. In case of urgent business a meeting of the Directors may be called at shorter notice provided that notice of such meeting is sent to all the Directors by email, facsimile at the facsimile numbers or email address if any provided by the Directors, or by any other expeditious means. A notice sent to a Director through email, whether such Director is in Pakistan or outside Pakistan, shall be a valid notice.

58. CHAIRMAN

The Board may from time to time elect one or more of their body to be the holder of the office of Chairman and determine the period for which he/she is to hold office. The Chairman so elected shall preside over meetings of the Board. If, at any meeting the Chairman is not present within fifteen minutes after the time appointed for holding the same or is unwilling to act as chairman, the Directors present may choose one of their numbers to be the Chairman of the meeting

59. QUORUM

The quorum for a meeting of the Board shall be two (2) Directors or one third of their numbers, whichever is greater.

60. EFFECT OF QUORUM

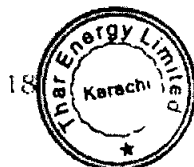
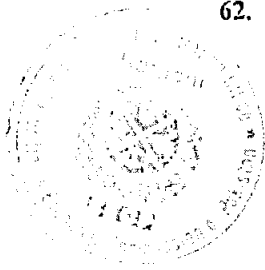
A meeting of the Directors for the time being at which a quorum is present shall be competent to exercise all or any of the authorities, powers and discretions by or under Articles of the Company for the time being vested in or exercisable by the Directors generally.

61. RESOLUTION WITHOUT A MEETING OF THE DIRECTORS

A resolution in writing signed by all Directors for the time being in office shall be valid and effectual as if it had been passed at a meeting of the Board duly called and constituted. For this purpose, it shall be permissible to circulate the text of the proposed resolution duly signed by the Chief Executive and obtain signatures of all the other Directors thereon.

62. DIRECTOR MAY ACT NOTWITHSTANDING ANY VACANCY

The continuing Directors may act notwithstanding any vacancy in their body, but if their number falls below the minimum fixed by or under these Articles the Directors shall not, except for the purpose of filling vacancies on the Board or summoning a general meeting, act so long as the number is below the minimum.



PART XI - POWERS OF DIRECTORS

63. POWERS OF DIRECTORS

- 63.1 The business of the Company shall be managed by the Directors who may pay all expenses incurred in promoting and registering the Company and may exercise all such powers of the Company as are not by the Ordinance or these Articles required to be exercised by the Company in a general meeting, provided that no regulation made by the Company in general meeting shall invalidate any prior act of the Board which would have been valid if that regulation had not been made.
- 63.2 The Directors shall exercise all powers enumerated under Section 196 of the Ordinance, including issuance/execution of cheques, promissory notes, drafts, bills of exchange and other instruments whether negotiable or transferable or not, and all receipts for moneys paid to the Company, shall be signed, drawn, accepted, endorsed or otherwise executed, as the case may be, in such manner as the Board shall from time to time by resolution determine.
- 63.3 The Board shall cause minutes to be made in books provided for the purpose:
- (a) of all appointments of officers made by the Board;
 - (b) of the names of the Directors present at each meetings of the Directors and of any committee of the Board; and
 - (c) of all resolutions and proceedings at all meetings of the Company, and of the Directors, and of committees of the Board.

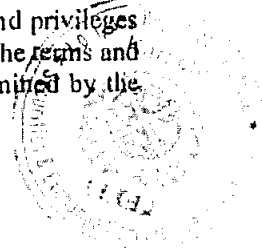
PART XII - CHIEF EXECUTIVE

64. APPOINTMENT OF CHIEF EXECUTIVE

- 64.1 The Company shall have a Chief Executive appointed in accordance with the provisions of Section 198 and 199 of the Ordinance.
- 64.2 The terms and conditions of appointment of the Chief Executive shall be determined by the Board.

65. CHIEF EXECUTIVE DEEMED TO BE A DIRECTOR

The Chief Executive shall if he/she is not already a Director elected under Article 53 be deemed to be one and be entitled to all the rights and privileges and subject to all the liabilities of that office. Subject as aforesaid the terms and conditions of appointment of the Chief Executive shall be determined by the Board.



66. REMOVAL OF CHIEF EXECUTIVE

The Board by resolution by not less than three-fourths of their total number for the time being or the Company by a Special Resolution may remove a Chief Executive before the expiration of his/her term of office.

PART XIII - SECRETARY

- 67.** The Board may appoint (or remove) a Secretary and/or a deputy Secretary.
- 68.** The Secretary (if appointed) shall be responsible for all secretarial functions and shall ensure compliance with respect to requirements of the Ordinance concerning the meetings and record of proceedings of the Board, committees and the general meeting of members, ensure that all notices required by these Articles or under the Ordinance are duly sent and that all returns required under the Ordinance are duly filed with concerned Company Registration Office.

PART XIV - THE SEAL

69. CUSTODY OF SEAL

- 69.1** The Board shall provide for the safe custody of the Seal and the Seal shall not be affixed to any instrument except by the authority of the Board or a committee authorized by the Board itself.
- 69.2** Every instrument to which the Seal shall be affixed shall be signed autographically in any of the following manners.
- (i) By two Directors; or
 - (ii) By a person duly authorized by the Board either generally or in relation to specific instruments or instruments of specific descriptions.
- 69.3** Notwithstanding the provisions of Article 69.2, the Board may resolve to dispense with autographic signatures of all or any person referred to in that paragraph in relation to specific instruments or instruments of specified descriptions, and in substitution therefore to authorize signatures to be affixed by some method or system of mechanical signature approved by the Board.

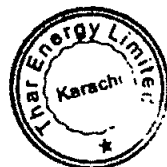
PART XV - DIVIDENDS AND RESERVES

70. RESERVES

The Board may, before recommending any dividend, set aside out of the profits of the Company such sums as they think proper as a reserve or reserves which shall, at the discretion of the Board, be applicable for meeting contingencies or for equalizing dividends or for any other purpose to which the profits of the



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Company may be properly applied and pending such application may, at the like discretion, be employed in the business of the Company or be invested in such investments, as the Directors may, subject to the provisions of the Ordinance, think fit.

71. DECLARATION OF DIVIDENDS

The Company in general meeting may declare dividends, but no dividends shall exceed the amount recommended by the Board.

72. PAYMENT OF DIVIDENDS

No dividend shall be paid otherwise than out of the profits of the Company.

73. INTERIM DIVIDENDS

The Board may from time to time declare and pay to the Members such interim dividends as appear to the Board to be justified by the profits and position of the Company.

74. TIME FOR PAYMENT OF DIVIDEND

Any dividend declared pursuant to Article 71 shall be paid within the period laid down in Section 251 of the Ordinance.

75. DIVIDEND TO JOINT HOLDERS

Any one of several persons who are registered as the joint holders of any shares may give effectual receipt for any dividend payable in respect of such shares.

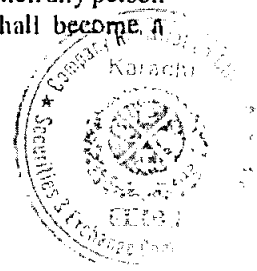
76. EFFECT OF TRANSFER

A transfer of shares shall not pass the right to any dividend declared thereon before the registration of the transfer.

77. RETENTION OF DIVIDEND

The Directors may retain the dividend payable upon shares in respect of which any person is under Article 20 entitled to become a Member or which any person under that Article is entitled to transfer until such person shall become a Member in respect thereof or shall duly transfer the same.

78. UNCLAIMED DIVIDENDS



Subject to the applicable provisions of the Ordinance, all dividends unclaimed after having been declared may be invested or otherwise made use of by the Board for the benefit of the Company until claimed.

79. DIVISION OF DIVIDEND

All dividends of the Company shall be apportioned and paid pro rata among the Members in proportion to the number of shares held by them respectively during any portion or portions of the period in respect of which the dividend is paid.

PART XVI – MINUTES AND BOOKS

80. MINUTES TO BE RECORDED

The directors shall cause a fair and accurate summary of all proceedings of general meetings and meetings of its Board and committees along with the name of those participating in such meetings to be entered in properly maintained books.

81. BOOKS OF ACCOUNTS TO BE KEPT

81.1 The Board shall cause to be kept proper books of accounts as required under Section 230 of the Ordinance.

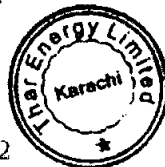
81.2 The Directors shall from time to time determine whether and to what extent and at what time and place and under what conditions or regulations the accounts and books or papers of the Company or any of them shall be open to the inspection of members not being Directors, and no member (not being a Director) shall have any right of inspecting any account and book or papers of the Company except as conferred by law or authorised by the directors or by the Company in General Meeting.

82. BOOKS OF ACCOUNTS TO BE KEPT AT OFFICE OF THE COMPANY

The books of accounts shall be kept at the office of the Company or at such other place in Pakistan as the Board may decide and when the Board so decides the Company shall within seven (7) days of the decision, file with the Registrar a notice in writing giving the full address of that other place.

83. ANNUAL ACCOUNTS AND BALANCE SHEET

The Directors shall as required by Section 233 and 236 of the Ordinance cause to be prepared and to be laid before the Company in general meeting such profit and loss accounts and balance sheets duly audited and reports as referred to in the above referred Sections.



PART XVII - AUDIT

84. APPOINTMENT OF AUDITORS

Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 255 of the Ordinance. The auditors shall be entitled to attend any general meeting of the Company and to receive all notices of and other communications relating to any general meeting which any Member is entitled to receive and be heard there at, on any part of the business of the meeting which concerns him/her as auditor.

PART XVIII - NOTICES

85. PROCEDURE FOR GIVING NOTICES

A notice may be given by the Company to any Member either personally or by sending it by post to him/her at his/her registered address or if he/she has no registered address in Pakistan, to the address, if any within or outside Pakistan, supplied by him/her to the Company for the giving of notices to him/her.

86. NOTICE SENT BY POST

Where a notice is sent by post, service of the notice shall be deemed to be effected by properly addressing, preparing and posting a letter containing the notice and, unless the contrary is proved, to have been effected at the time at which the letter would have been delivered in the ordinary course of post.

87. NOTICE TO JOINT HOLDERS

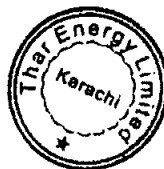
A notice may be given by the Company to the joint holders of a share by giving the notice to the joint holder named first in the Register in respect of the shares.

88. NOTICE TO PERSON ENTITLED BY TRANSMISSION

A notice may be given by the Company to the person entitled to a share in consequence of the death or insolvency of a Member by sending it through the post in a prepaid letter addressed to them by name or by the title of representatives of the deceased or assignees of the insolvent or by any like description at the address if any in Pakistan, supplied for the purpose by the persons claiming to be so entitled or until such an address has been so supplied by giving the notice in any manner in which the same might have been given if the death or insolvency had not occurred.

PART XIX - SECRECY

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89. SECRECY

Every Director, manager, advisor, auditor, member of a committee of the Board, officer, servant, agent, accountant or other person employed in the business of the Company shall, if so required by the Board, before entering upon his/her duties, sign a declaration pledging himself/herself to observe a strict secrecy respecting all transactions of the Company with its customers and the state of accounts with individuals and in matters relating thereto, and shall by such declaration pledge himself/herself not to reveal any of the matters which may come to his/her knowledge in the discharge of his/her duties except when required to do so by the Directors or by any applicable law or by any general meeting or by any court of law and except so far as may be necessary in order to comply with any of the provisions of these Articles.

PART XX – INDEMNITY

90. INDEMNITY

Every officer, Director or agent for the time being of the Company may be indemnified out of the assets of the Company against any liability incurred by him/her in defending any proceedings, whether civil or criminal arising out of his/her dealings in relation to the affairs of the Company whether the outcome of any such proceedings is in her/his favour or otherwise, except those brought by the Company against him/her, or in connection with any application under Section 488 in which relief is granted to him/her by the Court

PART XXI - WINDING UP

91. DISTRIBUTION OF ASSETS

91.1 If the Company is wound up, the liquidator may, with the sanction of a Special Resolution of the Company and any other sanction required by the Ordinance, divide amongst the Members, in specie or in kind, the whole or any part of the assets of the Company, whether they consist of property of the same kind or not.

91.2 For the purpose aforesaid, the liquidator may set such value as he/she deems fair upon any property to be divided as aforesaid and may determine how such division shall be carried out as between the Members or different classes of Members.

91.3 The liquidator may, with the like sanction, vest the whole or any part of such assets in trustees upon such trusts for the benefit of the contributories as the liquidator, with the like sanction, thinks fit, but so that no Member shall be compelled to accept any shares or other securities whereon there is any liability.



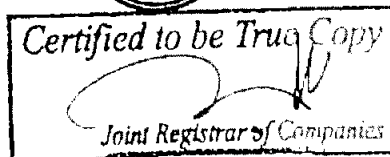
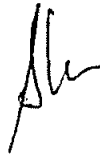
PART XXII – DISPUTE RESOLUTION AND ARBITRATION

92. DISPUTE RESOLUTION

In the event that a dispute, claim or controversy arises between the Company, its management or its shareholders, or between the shareholders inter-se, all steps may be taken to settle the dispute and resolve the issue through mediation by an accredited mediator before taking recourse to formal dispute resolution as such as arbitration or litigation

93. DIFFERENCES TO BE REFERRED TO ARBITRATOR

Whenever any difference arises between the Company on the one hand and any of the Members, their executors, administrators and assigns on the other hand touching the true intent or construction or the incidents or consequence of these presents or of the statutes or anything then or thereafter done, executed, omitted or suffered in pursuance of these presents, or any of the statutes, or touching any breach or alleged breach of these presents or any claim on account of any such breach, or statute affecting the Company, every such difference, shall as a condition precedent to any other action at law, be referred in conformity with the Arbitration Act 1940 or any statutory modification thereof or any rules made there under to the decision of an Arbitrator to be appointed by the parties in difference, or if they cannot agree upon a single arbitrator, to the decision of two arbitrators of whom one shall be appointed by each of the parties in difference or in the event of the two arbitrators not agreeing thereto, an umpire to be appointed by the two arbitrators in writing before proceeding on the reference and such decision shall be final and binding on the parties.



28/07/2016



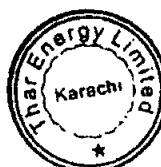
We the several persons, whose names and addresses are subscribed, are desirous of being formed into a company, in pursuance of this Articles of Association and we respectively agree to take the number of shares in the capital of the Company set opposite to our names

Name and Surname (Present & Former) in full (in Block Letters)	Father's/ Husband's Name in Full	CNIC/ Passport No.	Nationality with any former Nationality	Occupation	Address	Number of Shares taken by each Subscriber
The Hub Power Company Limited Through: Khalid Mansoor	Mansoor Ul Haq	42301-4000955-5	Pakistani	Subscriber	House No. 124/1, Street No. 12, Khayaban-e-Rahat, Phase 6, Karachi, Pakistan	4,999,996 (Four million, nine hundred and ninety nine thousand, nine hundred and ninety six)
Khalid Mansoor	Mansoor Ul Haq	42301-4000955-5	Pakistani	Director	House No. 124/1, Street No. 12, Khayaban-e-Rahat, Phase 6, Karachi, Pakistan	1 (One)
Tahir Jawaid	Jawaid Ahmed Mirza	61101-7696043-5	Pakistani	Director	Khayaban-e-Muslim, Off 29 th Street, House No. 94/11, Phase VIII, DHA, Karachi.	1 (One)
Abdul Nasir	Mohammad Haroon	42201-7725707-7	Pakistani	Director	House No. 12/3, Jinnah Housing Society, Shaheed-e-Millat Road, Karachi	1 (One)
Iqbal Alimohamed	Ali Mohamed	42201-2214140-7	Pakistani	Director	K.D.A, Scheme 1, House No.B-84/1-A, Karachi	1 (One)
						Total: 5,000,000 (Five Million Shares)

Dated the 2nd day of May 2016

Witness to the above signatures:

Name: NIFT (Pvt.) Limited
Address: 5th Floor, AWT Plaza, I.I. Chundrigar Road
Karachi- 74200, Pakistan

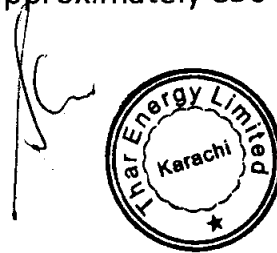




Type of Technology

TEL will install one unit of Three Hundred and Thirty Mega Watts (1x330MW) Gross Output. The Plant will be of sub-critical technology and will use lignite coal of Thar Block-II as fuel.

- 1) The Project will have CFB technology boiler that has low furnace temperatures of 800° to 900° C plus staging of air feed to the furnace produces very low NOX emissions. The Project will meet the National Environmental Quality Standards (NEQS) and recommendations of ESIA. NOx limits in stack will be approximately 510 mg/Nm³.
- 2) Sulfur is captured with limestone in the combustion chamber. CFB boilers will be equipped with in-furnace sulphur removal technology consisting of pneumatic conveying lines with limestone feeding points located in the lower furnace. SOx limit in stack will be approximately 850 mg/Nm³





Thar Energy Limited

(A wholly owned subsidiary of The Hub Power Company Limited)

Feasibility Study Report

1x330 MW Coal Fired Power Plant Project

Thar Block-II

July, 2016

Prepared by

Thar Energy Limited (TEL)

(Wholly Owned Subsidiary of The Hub Power Company Limited)

&

China Machinery Engineering Corporation

(CMEC)

A handwritten signature in black ink, appearing to be 'SL' or similar, written over the text '(CMEC)'.

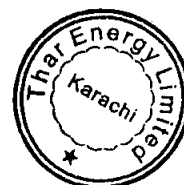
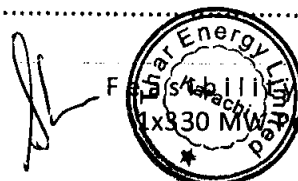




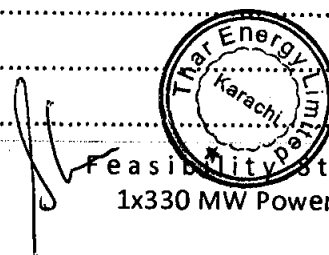
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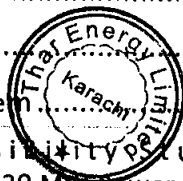


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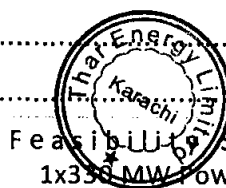


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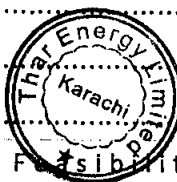


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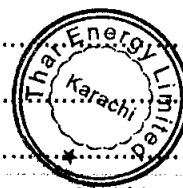


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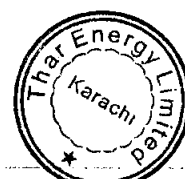
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1. Introduction of Project

1.1 Project Background

The installed power generation capacity of Pakistan has grown by about 16 percent in recent years from 2008 to 2012, while electricity shortages have increased sharply by 242 percent. The supply and demand gap is still increasing and in 2014, the power shortage peak reached ~5,384MW. To deal with power supply shortage and to maintain economic stability and fast development, The Government of Pakistan has developed mid-term (2011-2015) and long-term (2030) development plans for power sector. Focus is given to development of large hydropower and coal power projects. It actively seeks foreign fund and technical supports.

In May 2013, Chinese Premier Li Keqiang visited Pakistan and proposed building China-Pakistan Economic Corridor (CPEC) and suggested cooperation in major project, energy and resource, agricultural irrigation, information communication and other fields to bring economic and trade relation between the two countries closer and promote joint development of both countries.

This project is being developed as part of China Pakistan Economic Corridor (CPEC) and will be completed under the Power Policy for investment in Power Projects in Pakistan for which this Detailed Feasibility study is being conducted.

Pakistan has lignite reserves of around 186 Bt. With these huge reserves Pakistan is at the 7th place amongst the lignite (coal) rich countries of the world. The biggest parts are located at Thar-parker District in south-eastern province of Sindh, where about 176 Bt of total lignite (95%) has been explored. The extension of entire lignite bearing area is about 9100 sq. km. The Thar lignite is recognized as a major energy source, which has the potential to support the energy production from indigenous resource substantially. The Government of Pakistan (GoP), Government of Sindh (GoS) and Sindh Engro Coal Mining Company (SECMC) have undertaken enormous efforts to increase the lignite production considerably to accelerate industrialization and improvement in the standard of living of the people of Pakistan. The Hub Power Company (HUBCO) also supported the initiative and made investment of approximately 8% in the project equity of SECMC. Lignite throughout the world is mostly used for mine mouth power generation.

The Hub Power Company, Largest IPP, is in business of power generation for the last 20 years has intended to avail this opportunity by building 1x330 MW mine mouth Power Plant.





1.2 Objective of this study

The main objective of this study is to investigate the feasibility of 1x330 MW coal fired power plant based on Thar coal.

This study would also serve as a baseline document for project development and execution, as this feasibility study will lead to a bankable feasibility study, which would affirm the investor confidence in this power project.

Since this project is an expansion of the Energy Park, where mining and 2x330 MW units are well into execution phase, it is a prudent decision to design the next unit(s) with same technology and take advantage of the synergies in all areas of the project.

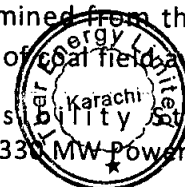
1.3 General Information of Project Sponsor

Thar Energy Limited (TEL) is a wholly owned subsidiary of The Hub Power Company Limited ("HUBCO") which is the first and largest Greenfield Independent Power Producer (IPP) in Pakistan to be financed by the private sector in Southern Asia and is one of the largest power projects in private sector. HUBCO was established about 20 years ago when a consortium of international investors, governments and commercial banks came together to finance a major infrastructure project in a developing country like Pakistan. Today HUBCO stand at a distinctive position where its growth leads to the development of Pakistan.

The HUBCO's biggest power plant is of 1292 MW Gross (4x323 MW) capacity and is located near Hub, Baluchistan. HUBCO decided to expand by setting up a 213 MW plant at Narowal in Punjab province. HUBCO is also the majority owner of Pakistan's first renewable energy IPP, namely Laraib Energy having capacity of 94 MW Gross, which is a run-of-the river hydel based power project.

With the combined production capacity of over 1600 MW, and a firm commitment to provide long-term solution to the energy challenges in the country, HUBCO and its subsidiaries are well positioned to emerge as the "Hub of Power" for Pakistan. To continue pioneering company's role in the power sector of Pakistan, HUBCO's Board of Directors has given management the mandate to develop a 2 x 660 MW Imported Coal Based power plant at Hub site to not only help the country in overcoming the current power crisis but also to provide the people of Pakistan with cheap electricity using optimum energy mix. A Joint Venture Company (China Power Hub Generation) between China Power International Holding (CPIH) and The Hub Power Company has been formed and the work to develop 2x660 MW Coal fired Power Project with its associated 4MTPA Coal unloading Jetty has been started with the completion in year 2020.

Through Thar Energy Limited (TEL), HUBCO is planning to build another project of 1x330 MW mine mouth plant based on indigenous coal to be mined from the coal fields of Thar Block II, which is a 95.5 square kilometer (km²) area of coal field awarded to Sindh





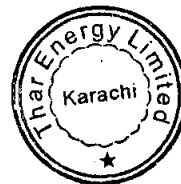
Engro Coal Mining Company (SECMC) for exploration and mining of lignite primarily for power generation projects.

1.4 Scope of Feasibility Study Report

The feasibility study is based on 1 x 330 MW power plant. It is done keeping in view the potential limitations of mine mouth power plant. It includes an over view of infrastructure and natural resources required for the power plant as well as the alternatives that can possibly be considered (if any). Moreover, measures to overcome the hurdles in project execution are also being considered with insight to the potential solution.

This feasibility study includes, but not limited to the following items:

- Site & Site conditions
- Description of Plant size and technology selection
- Plant Availability
- Technical description of proposed plant and equipment
- Review of available infrastructure
- Plant Mechanical /Electrical / Instrumentation and control System
- Civil Scope of the project
- Assessment of Environmental Impact.
- Financial and Economic feasibility.
- Cost estimates and financial analysis
- Project implementation and scheduling
- Recommendations and conclusions.





1.5 Power Industry Review

1.5.1 Power Sector Structure

Pakistan's Power Sector is a regulated market – effectively regulated by National Electric Power Regulatory Authority (NEPRA) constituted in 1997. Pakistan's power sector is still passing through a transition phase of structural changes and reforms. The erstwhile vertically integrated Water & Power Development Authority who used to control all the functions in the country (except Karachi) of Transmission, Distribution, and Generation has been confined to development and maintenance of hydro power projects and works. Its power wing has been restructured and unbundled to form new entities of (a) National Transmission and Development Company, (b) GENCO Holding Company Limited (c) nine independent Distribution Companies (DISCOS). The Pakistan Electric Power Company (PEPCO) which was a management company to oversee the reforms of restructuring WAPDA is now non-functional.

National Transmission & Dispatch Company (NTDC) Limited was incorporated on 6th November, 1998 and commenced commercial operation on 24th December, 1998. It was organized to take over all the properties, rights and assets obligations and liabilities of 220 KV and 500KV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA). NTDC operates and maintains twelve 500 KV and twenty-nine 220 KV Grid Stations, 5077 km of 500 KV transmission line and 7359 km of 220 KV transmission line in Pakistan. NTDC is also the system operator of centralized national grid.

NTDC was granted Transmission License No.TL/01//2002 on 31st December 2002 by National Electric Power Regularity Authority (NEPRA) to engage in the exclusive transmission business for a term of thirty (30) years, pursuant to Section 17 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

GENCO Holding Company Limited (GHC) manages the five (5) public sector thermal Generation Companies (GENCO)s i.e. (a) GENCO I i.e. Jamshoro Power Generation Company, (b) GENCO II i.e. Central (Guddu) Generation Company, (c) GENCO III i.e. Northern (Muzzafargarh) Generation, (d) GENCO IV i.e. Lakhra Generation C Company and GENCO V i.e. Nandipur Generation Company.

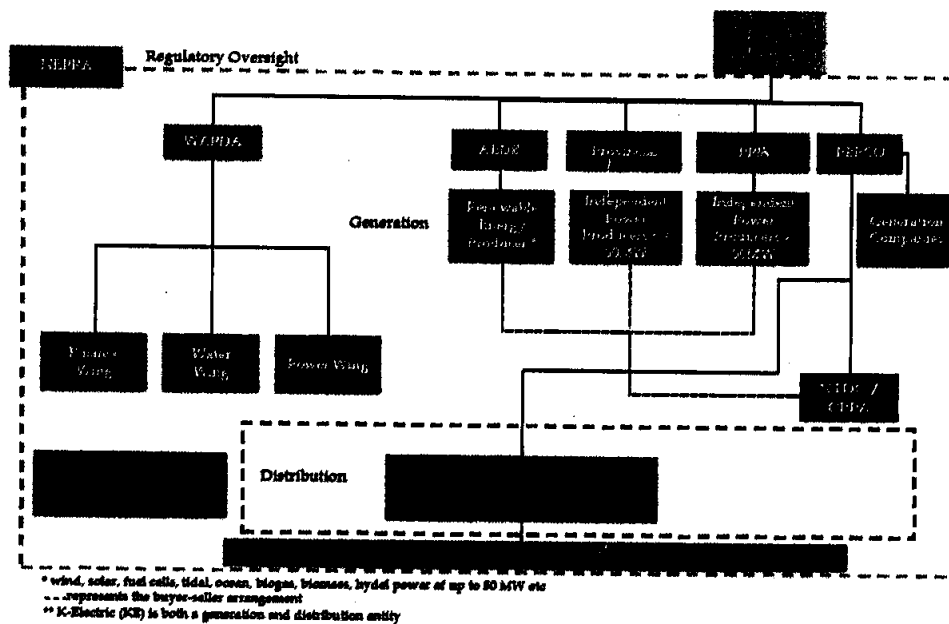
The distribution network in Pakistan (excluding Karachi) is managed by ten Distribution Companies (DISCOs) i.e. (1) FESCO – Faisalabad Electric Supply Company, (2) GEPCO – Gujranwala Electric Supply Company, (3) HESCO – Hyderabad Electric Supply Company, (4) IESCO– Islamabad Electric Supply Company, (5) LESCO– Lahore Electric Supply Company, (6) MEPCO– Multan Electric Supply Company, (7) PESCO– Peshawar Electric





The functions of generation, transmission, and distribution of power in the metropolitan city of Karachi and some of its surrounding areas are being managed by the privatized K-Electric (KEL), whose earlier name was Karachi Electric Supply Corporation – KESC.

Besides, the public sector entities, there is noticeable presence of private sector, especially in power generation. There are around 27 IPPs (private sector) and the electricity produced by them is sold to NTDC / CPPA (G). In addition, Pakistan Atomic Energy Commission (PAEC) is responsible for the execution of development projects involving nuclear power stations. At present, there are two nuclear power plants, Karachi Nuclear Power Plant (KANUPP) and Chashma Nuclear Power Plant (CHANUPP) in Pakistan.

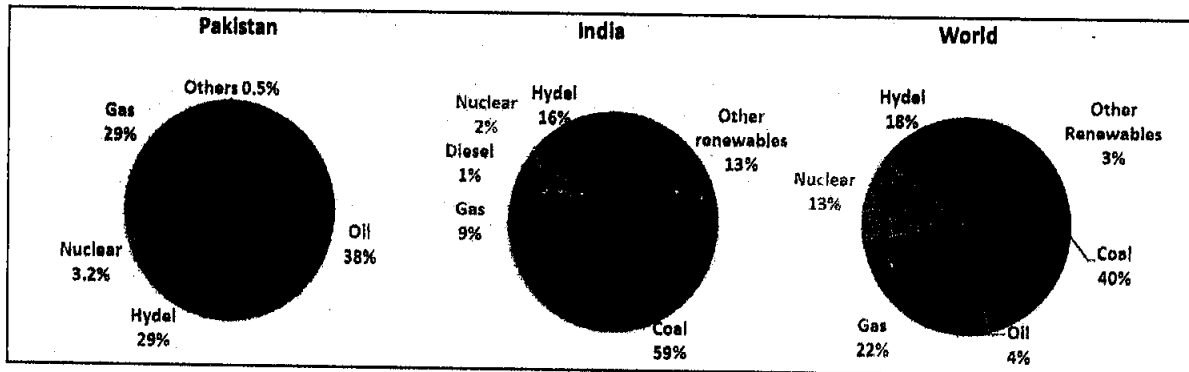


1.5.2 Sources of Power Generation in Pakistan

1.5.2.1 Electricity Generation by Source

The current energy mix of the country shows heavy reliance on natural gas as a primary source of energy in Pakistan, followed by oil (the bulk of which is imported). Nuclear, hydro and renewable (insignificant at present) energy together form only 13% of the total energy mix. Moreover, the country's reliance on hydrocarbons has increased from

just under 80% to 82% in 2013-14. Pakistan's energy mix (2013-14) is illustrated below in comparison to India and the global average:



Source: NEPRA State of Industry Report 2014, Energy Information Agency(EIA)

Oil imports are a significant burden on the national exchequer and the increasing import bill continues to deplete the foreign exchange reserves. With gas reserves also depleting, import of gas is a viable option to overcome the pressure on domestic reserves, but gas import has significant issues- mainly the need for substantial capital investment in infrastructure, security difficulties and physical terrain concerns. With such high reliance on oil imports, Pakistan is left susceptible to price volatility in associated fuel costs (due to uncertainty over future supply) and foreign exchange effects. Indeed, if Pakistan does not move toward a more integrated energy plan, or the development of its own indigenous resources, it is certain to face a large and growing energy deficit over the upcoming years. Alternatives to fuel imports for electricity generation are generation from renewable sources (such as hydel, biomass and wind power) and other indigenous resources such as coal. The government is focusing more on the development of renewable and indigenous resources of energy which are underutilized till date. The incumbent administration has shown great zeal in its aim to eradicate the energy woes of the country for which significant work is under progress. Favorable policies and incentives offered by the government to investors for development of coal power sources in Pakistan portray their seriousness in achieving their goal.

1.5.3 Power Crisis in Pakistan

Pakistan faces chronic electricity shortage due to demand growth and no addition in generation capacity. High system losses and seasonal reductions in the availability of hydropower, circular debt and ever increasing load shedding are common. Pakistan's power sector, currently afflicted as it is, faces a crisis due to the following:

- Highly expensive electricity generation due to increased dependence on expensive thermal fuel sources including furnace oil and high speed diesel.



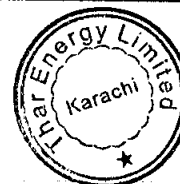
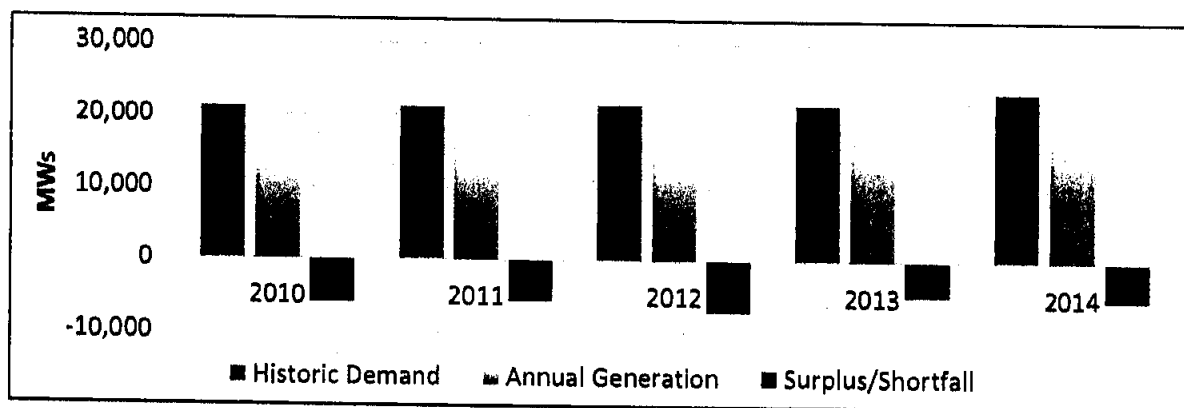
Dependence on such expensive fuel sources has forced Pakistan to create electricity at rates that are not affordable.

- Leakages in power transmission and distribution system that currently records losses of 23-25% due to poor infrastructure, management issues, and alleged theft of electricity.
- The aforementioned alleged inefficiencies, theft, and high cost of generation are resulting in high levels of subsidies and circular debt. It is believed to be pertinent to note that Pakistan's power sector is a mixed industry of thermal, hydro and nuclear power plants. At present, hydel to thermal installed generation capacity ratio is about 30/65 and the country's power production is dominated by private sector thermal power plants running on oil and gas. Indeed, the increasing share of thermal electricity generation over the years has increased Pakistan's financial burden, specifically in terms of foreign exchange; the need to expedite the use of indigenous coal and renewable energy has never been as acute as it is presently.
- Population in Pakistan has grown at a compound annual rate of 1.7% over the past five years and is expected to grow even more rapidly in the future. Growth in power generation has not caught up due to lower investment in new power generation units

1.5.3.1 Peak Season Shortfall

There is a **5,000 – 7,000 MW** shortfall in the country during peak hours resulting in almost 8-12 hours of load shedding in various parts of the country

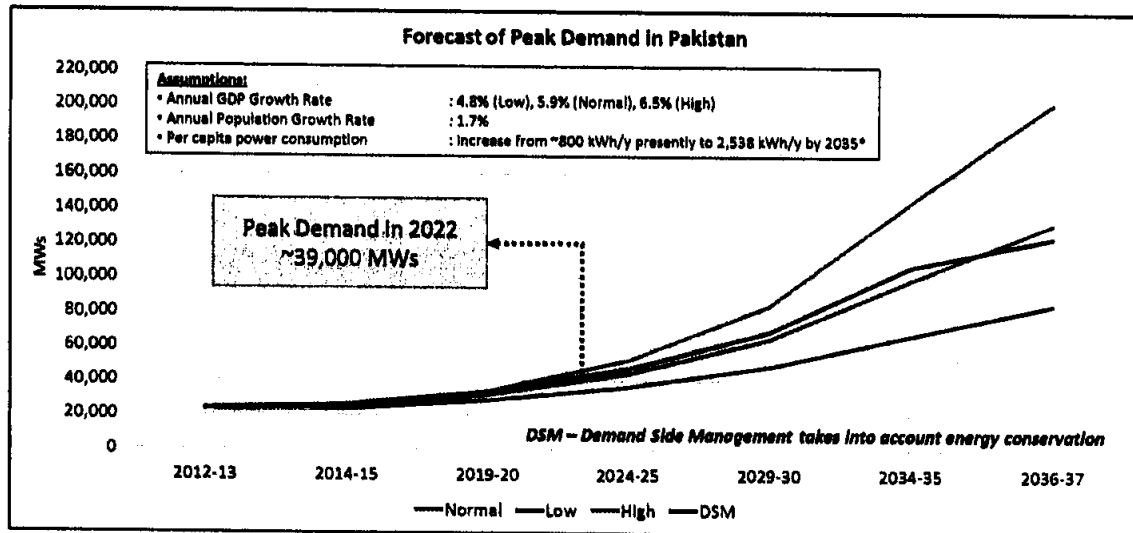
- Consumers rely on inefficient back sources (UPS, gas/diesel generators) putting extra burden on electricity and gas grid
- Shortfall has caused significant slowdown of the economy and resulted in job losses





1.5.3.2 Long Term Power Demand Forecast

Demand for power is expected to rise substantially in the coming years, as displayed in the graph below:



Source: National Transmission & Distribution Co. (NTDC), Pakistan (March 2014)

1.5.4 Promoting Coal

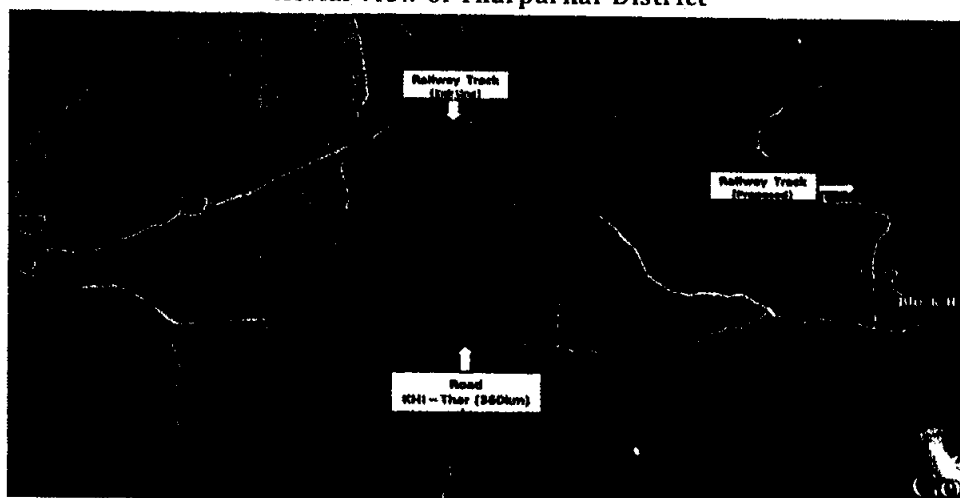
Pakistan's largest coal reserves (approximately 184.623 Bn tonnes) are found in the province of Sindh. The largest deposits of coal (95%) within that province are located at the Thar coalfields, located in the Thar Desert, Tharparkar District. The deposits were discovered in 1991 by Geological Survey of Pakistan (GSP) and the United States Agency for International Development (USAID). It is pertinent to note that the quality of lignite at Thar is characterized by sulfur content below 2% and a LHV based calorific value of approximately 11198 KJ/kg (2676 Kcal/kg) (dry basis) which is highly suitable for power generation. Furthermore, the cost benefits of electricity generated on coal as compared to other sources of fuel are significant as well: coal is and will continue to be an affordable fuel for generating electricity. Unlike other fossil fuels used for generating electricity, coal prices have changed little since the 1980s. In 20 years, the price of coal has increased only 4%, while crude oil prices increased 51% and natural gas prices increased 211%.

1.5.5 Imminent Way Forward

As mentioned above, Pakistan has significant lignite coal resources yet these sources have never been fully utilized due to domestic coal power projects having long lead times due to a lack of infrastructure and the time required for coal mining.

However, given the problems in Pakistan's existing energy mix and given the tremendous coal reserves available in the country, it is important that coal based

Aerial View of Tharparkar District

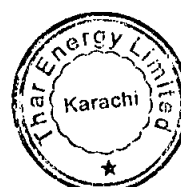


1.6.1 SECMC Block-II

Considering the huge potential of Thar Coal (i.e. the coal reserves of Tharparkar), Sindh. In 2008 Government of Sindh (GoS) initiated an International Competitive Bidding (ICB) process to select a private sector partner for development of coal reserves in Thar Coal Block II. As a result of ICB, Engro Powergen Limited (EPL) was chosen as the preferred Joint Venture (JV) partner and Sindh Engro Coal Mining Company (SECMC) was incorporated as a public unlisted company on October 15, 2009 under a Joint Venture Agreement (JVA) (dated September 8th 2009) between GoS and Engro with a shareholding of 40% and 60% respectively; this was subsequently revised to GoS (51%) and Engro and other private sector investors (49%).

Thar Coal Block II alone has total coal reserves of 2 Bn tons, out of which 1.57 Bn tons are exploitable as assessed by the Competent Persons Statement (CPS), the required professional assessment, conducted by RWE – Germany (which is one of the leading consultants in the world having significant expertise in lignite mining and associated power generation). It is estimated that exploitable reserves of 1.57bn tons can be used to produce 5000MW for 50 years.

SECMC has already initiated the overburden removal for mining of 3.8 Mt/a lignite coal from Block-II which is for EPTL's 2x330 MW plant. By increasing the box-cut size, and without need of opening a new mine, SECMC can increase the mining capacity to 7.6 Mt/a as next step to supply coal for additional 2x330 MW units. It is estimated that this quantity (7.6 Mt/a) of coal, based on average calorific value of Thar Block II lignite, can power a total of 4x330 MW Subcritical units.



As per these guidelines, "Coal Resource is that portion of a deposit in such form and quantity that there are reasonable prospects for eventual economic extraction. The location, quantity, quality, geological characteristics and continuity of a Coal Resource are known, estimated or interpreted from specific geological evidence or knowledge. Coal Resources are subdivided, in order of increasing geological confidence, into Inferred, Indicated and Measured categories."

These categories can be determined by the distance between "Points of Observation".

- Inferred confidence level – Points of Observation up to 4 km apart
- Indicated confidence level – Points of Observation less than 1 kilometer apart
- Measured confidence level – Points of observation less than 500 meters apart

In the case of the Block II, till date 119 drill holes have been cored.

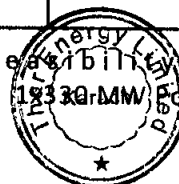
The table below provides key details of the result from aforementioned Competent Person Statement by RWE:

Classification	Tonnage x 1000	Qnet as received (Kcal/kg)	Moisture as Received (%)	Sulphur (%)	Ash AR (%)
Measured	414,282	2,814	48.06	1.06	6.65
Indicated	1,369,061	2,881	48.46	1.07	6.20
Inferred	256,341	2,753	48.63	1.03	7.13
Total	2,039,684	2,851	48.40	1.06	6.41

1.6.2 Thar Block-II Coal Quality

Thar lignite is perfectly suitable for power generation & compares favorably with other lignite being used all over the world for power generation, as shown below:

Deposit	Heating Value (Net) (Kcal/kg)	Sulphur (%)	Ash (%)	Moisture (%)	Stripping Ratio (m ³ /t)
	<i>Higher is better</i>	<i>Lower is better</i>	<i>Lower is better</i>	<i>Lower is better</i>	<i>Lower is better</i>
Thar Block - II	2770	1.07	7.8	47.46	6.12
Gujarat, India	2600-3000	3.4-5.9	9-12	38-40	9-14
Hambach, Germany	1911-2747	0.2-0.4	2-5	48-52	6.3
Maritza East - Bulgaria	1550	4.5	19-35	54	1.7





The aforementioned mines in India, Germany and Bulgaria produce aggregate power of more than 12,900 MW from lignite being produced by mines whose quality, on an overall basis, is inferior or equal to Thar Lignite. By using properly designed desulphurizers and ash removal units, Thar Coal can produce cheap electricity while meeting the most stringent international environmental standards.

Coal quality results based on multiple samples from mine are summarized in the following table:

Coal Quality Ranges				
Parameter	Unit	Average	Min	Max
Total Moisture	%-raw	49.50%	44.00%	50.20%
Ash	%-raw	7.00%	5.10%	10.80%
Volatiles	%-raw	24.50%	23.80%	25.50%
Fixed Carbon	%-raw	18.00%	18.50%	19.70%
C	%-daf	71.01%	70.80%	74.20%
H	%-daf	8.10%	4.40%	6.40%
N	%-daf	1.01%	0.85%	1.20%
S	%-daf	2.48%	1.85%	3.30%
O (by difference)	%-daf	19.42%	17.50%	20.20%
NCV	MJ/kg raw	11.198	10.312	12.771

1.7 Global Coal Industry Overview

1.7.1 Coal and its Types

Coal is a combustible rock consisting of carbonized plant matter, found mostly in underground seam sand used as fuel. Coal is classified into four general categories.

- Anthracite: Anthracite is coal with the highest carbon content, between 86 to 98 percent, and a heat value of nearly 15,000 BTUs per-pound. It is most frequently associated with home heating.
- Bituminous: This is the most plentiful form of coal and is primarily used to generate electricity and make coke for the steel industry. Bituminous coal has a carbon content ranging from 45 to 86 percent carbon and a heat value of 10,500 to 15,500 BTUs-per-pound.
- Sub-bituminous: Ranking below bituminous is sub-bituminous coal with 35-45 percent carbon content and a heat value between 8,300 and 13,000 BTUs-per-pound. Although its heat value is lower, this coal generally has a lower sulphur content than others which makes it attractive as a relatively cleaner fuel.
- Lignite: Lignite coal has the lowest carbon content, 25-35 percent, and a heat value ranging between 1,500 and 8,300 BTUs-per-pound. Sometimes called brown coal, it is mainly used for electric power generation.



1.7.2 Global Coal Reserves

Coal is one of the world's most abundantly available fossil resources. As per the German Federal, Institute for Geosciences and Natural Resources (BGR) global coal reserves are estimated at 1,038 Bn. tones and are sufficient for 132 years of consumption. In contrast, oil and gas reserves are significantly low and, at current output, sufficient for a mere 46 and 54 years of consumption respectively.

Compared to oil and gas reserves which are predominantly concentrated in specific regions (with Russia, Iran and Qatar controlling 53.2% of the world's gas reserves and over 50% of the world's oil reserves being located in the Middle East) coal is much more widely prevalent globally. Although its biggest reserves are in the USA, Australia, Russia, China, India, South Africa, coal remains a global industry with reserves present in most countries and recoverable reserves in approximately 70 countries.

Most coal producing countries use the fuel for their domestic needs leaving a mere 15% of coal production available for trade in the international coal market. In a number of countries coal is also the only domestically available energy fuel and its use is motivated by both economic and energy security considerations- such is the case in Europe, China and India, where coal reserves are much higher than oil or gas reserves.

The main coal producing countries are highlighted in the table below:

Top Coal Producers			
PR China	3,549 Mt	Russia	359 Mt
USA	935 Mt	South Africa	259 Mt
India	595 Mt	Germany	197 Mt
Indonesia	443 Mt	Poland	144 Mt
Australia	421 Mt	Kazakhstan	126 Mt

Since the year 2000, coal consumption has significantly increased relative to other fuels. The largest users of coal are China, USA, India, Russia and Japan which collectively account for 76% of total global coal consumption. Asia represents the largest market for coal consumption accounting for approximately 67% of global coal use. This consumption is mainly driven by China which has a dominant share in the coal industry.

On the other hand, countries lacking sufficient energy resources import fuels to meet their domestic requirements e.g. Japan, China, Taiwan and Korea etc., all of which import significant amounts of coal.

1.7.3 Uses of Coal

Coal has multiple uses being employed globally, the most important of which are: electricity generation, steel production, cement manufacturing and its use as a liquid



fuel. However, coal, depending on its type, also has individual uses. For instance, power generation typically employs lignite (as opposed to other types of coal) as fuel and, in Germany and other European states, approximately 30-35% of power generation is based on lignite. Furthermore, coal is also used for various other purposes such as in alumina refineries, paper manufacturers, and chemical and pharmaceutical industries. Many chemical products can be produced from by-products of coal along-with products like soap, aspirins, solvents, dyes, plastics and fibers, etc.

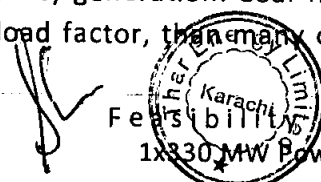
1.7.3.1 Why is Coal a Globally Preferred Option?

Over the last decade, almost half of the world's additional energy demand has been provided by coal whereas all other fuels including oil, natural gas, renewables and nuclear energy, accounted for the other half. Coal is perhaps the most significant fuel in the global energy mix today and is considered the 2nd largest fuel in terms of energy consumption accounting for almost a third of the world's primary energy consumption. Power generation is the key driver of growing coal demand, followed by industry and transformation processes such as blast furnaces and coke ovens. Coal provides around 30% of global primary energy needs and generates 41% of the world's electricity (Source: <http://www.Worldcoal.org/resources/coal-statistics/>). It is the key fuel for generating electricity on almost all continents, with an overwhelming majority of both developing and developed countries relying on coal for a stable and secure supply of electricity.

Indeed, China's extraordinary economic growth can be partially attributed to the use of coal for power generation as, over the last ten years, most new coal-fired power plants were built in China, thus, providing a cheap and stable source of electricity to that country. This has resulted in numerous benefits to the Chinese people as well as countries enriched by Chinese exports.

Globally, coal is used for Power Generation due to the following reasons:

- It is the most abundant fuel source of energy- As per the International Energy Agency (IEA), coal resources are around 17 times larger than oil reserves and account for over two thirds of all nonrenewable energy sources, including conventional and non-conventional hydrocarbons, such as oil and gas. Coal is simply the world's most abundant energy fuel.
- It is the most affordable source of electricity – As per the IEA, cost of electricity generation in terms of USD/MWh is lowest for coal as compared to any other source (gas, nuclear, oil or renewables). Furthermore, compared to many other energy sources which are heavily subsidized, subsidies for coal extraction are almost non-existent.
- It is the most reliable source of electricity generation: Coal-fired plants have a much higher availability, or average load factor, than many other alternatives





which are exposed to weather variations. Typically, coal-fired power plants provide base-load 24/7 electricity supply – as opposed to the more specific peak-load supply provided by more expensive and intermittent technologies.

1.7.4 Key fuel for the future

The IEA estimates that global electricity demand could double by 2035 as more people get basic access to electricity around the world and household energy consumption grows in the developing world. During the same period, global steel demand is likely to go up by around 60%, as a result of rapid urbanization in Asia and the increase in steel consumption by the construction sector. All scenarios indicate that, with growing energy demand around the world, coal will continue to play an important role in the global energy mix through to 2035.

1.8 Legal Framework

1.8.1 Power Policies

Historically, the generation, transmission, and distribution of electricity has been handled by two vertically integrated utilities: WAPDA and K-Electric (previously KESC). The private sector was allowed to enter into power generation under the 1994 Power Policy, whereby 14 IPPs were inducted into the system, in addition to the pre-1994 plants; Hubco and Kot Addu Power Co. (Kapco), which was created through privatization.

WAPDA and KESC have entered into long-term power purchase agreements (PPAs) with the IPPs to purchase power from them. The PPAs are for up to 30 years from the corresponding commercial operation dates (CODs). The PPAs are on a Build, Own, and Operate (BOO) basis or a Build, Own, Operate, and Transfer (BOOT) basis.

With KESC privatization, WAPDA is in an advance stage of being unbundled into successor entities such as the National Transmission and Dispatch Company Ltd (NTDC) and various distribution companies and generating companies. NTDC is the relevant entity for IPPs as it will enter into agreements with the IPPs for purchase of electricity. The pace of the unbundling process has accelerated with the recent changes in WAPDA administration. While at the same time WAPDA, after a gap of about two decades has started work on two new, one thermal and one hydel plants.

Following from the initial success of the 1994 Policy, and after settling the subsequent issues, the Government of Pakistan (GoP) prepared the regulatory framework under which the National Electric Power Regulatory Authority (NEPRA) was formed in 1997 to assist the PPPIB and regulate the increasing role of the private sector in power generation. It was followed by the 2002 Power Policy. Because of a variety of factors, the first power projects under the 2002 Policy did not come online till 2008.



The GoP's focus on an increased role for the private sector in power generation has been well received by the private sector, especially after the amendments to the Power Policy 2002. In response to the GoP initiatives, the private sector has shown its interest in projects covering the full range of power generation technologies: gas, heavy oils, hydropower and coal.

The GoP has decided, in principle, to withdraw from the business of power generation, leaving the power generation to the private sector exclusively. Although the private sector is again taking a lead in power generation in the hydro and coal sectors, but WAPDA has changed its stance and is now working on two projects

1.8.2 Draft Power Purchase Agreement

The Project Company and the Power Purchaser (WAPDA/NTDC) or any such agency will enter into a Power Purchase Agreement (PPA). The PPA will include the tariff along with the related parameters approved and duly notified by the National Electric Power Regulatory Authority (NEPRA) to establish guidelines for the delivery of and compensation for the Project's capital providers. The tariff structure outlined in the PPA will give the Power Purchaser the flexibility in the operation of the facility and its components, so as to meet the needs and specifications of the national grid, while providing the Project Company with the potential to generate revenues that adequately cover costs and provide an acceptable return. The PPA will also summarize the technical aspects, for example the interconnection communications and all such foreseeable issues. The tariff part of the PPA will be defined over the term of the PPA and will have several components that can be broken into two categories: Capacity Charge and Energy Charge.

The PPA will also specify a series of conditions to deal with plant availability and outages which will be in-line with the prudent utility practices and generally acceptable industry practices for this technology platform under the specific local conditions as recommended by the OEM.

Capacity Charges include fixed O&M costs, cost of working capital, insurance, debt service, return on equity (ROE), and return on equity during construction (ROEDC); Energy Charges include both fuel cost and variable O&M. Adjustments to these standard items will include the debt service component, principal repayment, interest cost, guarantee costs, and interest during construction. The debt cost will cover for indexations applicable to the relevant foreign currency/ currencies of the loans in question.

Pass through items generally include income tax on dividends, differences in withholding tax amounts for undeclared dividends, and income taxes on ROE.



1.8.3 Introduction to Government Agencies

1.8.3.1 Private Power and Infrastructure Board (PPIB)

PPIB was created in 1994 as "One Window Facilitator" to promote private sector participation in the power sector of Pakistan. PPIB facilitates investors in establishing private power projects and related infrastructure, executes Implementation Agreement (IA) with Project Sponsors and issues sovereign guarantees on behalf of Government of Pakistan.

Functions of PPIB include:

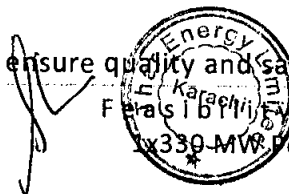
- Implementation of power policies, awarding projects to sponsors or private power companies, preparation of all necessary or appropriate documentation, execution of any of such documentation with private power companies, their sponsors, lenders and, whenever necessary or appropriate, other interested parties
- Recommendation and facilitating development of power policies
- Decision making on matters pertaining to power and related infrastructure projects set up by private sector or through public-private partnership, and other issues
- Coordination and facilitating of sponsors in obtaining consents and licenses from various agencies of the Federal/Provincial/Local
- Working in close coordination with power sector entities for implementation of power projects in private sector or through public-private partnership as per power system requirements
- Functioning as a one-stop organization in relation to private power companies, their sponsors, lenders, etc
- Draft, negotiate and enter into security package documents or agreements and guarantee the contractual obligations of entities under the power policies
- Prescribing and receiving fees and charges for processing applications, and deposit and disburse or utilize the same, if required
- Obtaining from sponsors or private power companies, as the case may be, security instruments and en-cash or return them, as deemed appropriate

1.8.3.2 National Electric Power Regulatory Authority (NEPRA)

NEPRA was created to introduce transparent and judicious economic regulation, based on sound commercial principals, to the electric power sector of Pakistan.

Main responsibilities of NEPRA are:

- Issuance of licenses for generation, transmission and distribution of electric power
- Establish and enforce standards to ensure quality and safety of operation





- Supply of electric power to consumers
- Approve investment and power acquisition programs of the utility companies
- Determine Tariffs for generation, transmission and distribution of electric power

1.8.3.3 Water and Power Development Authority (WAPDA)

Pakistan Water and Power Development Authority (WAPDA) was established through an Act of Parliament in 1958. It is an autonomous and statutory body under the administrative control of the Federal Government. The Authority consists of a Chairman and three Members (Water, Power and Finance). Wapda was unbundled in the year 2007 whereby the functions of its Power wing were redefined as Hydel Power Generation and Operation & Maintenance (O&M) of power houses. Following unbundling of its power wing, WAPDA's mandate is now development of water and hydropower resources in an efficient manner.

In order to meet the requirements of the country in both water and hydropower sectors with an ultimate object to put Pakistan on the track of development, WAPDA has planned to construct five multi-dimensional water storage dams during the next 3-12 years. The building of these dams will not only help address acute water challenge but also produce cheap and clean hydroelectricity.

1.8.3.4 National Transmission and Dispatch Company Limited (NTDC)

NTDC was incorporated on 6th November, 1998. It was organized to take over all the properties, rights and assets obligations and liabilities of 220 KV and 500KV Grid Stations and Transmission Lines/Network owned by WAPDA. The NTDC operates and maintains twelve 500 KV and twenty nine 220 KV Grid Stations, 5077 km of 500 KV transmission line and 7359 km of 220 KV transmission line in Pakistan.

NTDC was granted Transmission License on 31st December, 2002 by NEPRA to engage in the exclusive transmission business for a term of 30 years. Under the regime set out in the License, the NTDC is entrusted to act as:

- Central Power Purchasing Agency
- System Operator
- Transmission Network Operator
- Contract Registrar and Power Exchange Administrator

Recently however, NTDC's function to act as Central Power Purchasing Agency has been rescinded.





Pursuant to the Commercial Code, and a new independent company with the name and style of Central Power Purchasing Agency (Guaranteed) Limited has been established. The CPPA (G) has started operating as the designated Power Purchaser for IPPs from its office located at 6th floor, Shaheed -i-Millat Secretariat building Blue Area Islamabad.

1.8.3.5 Central Power Purchasing Agency (Guaranteed) Limited.

CPPA (G) is established by Government of Pakistan as a non-profit independent company under the Companies Ordinance, 1984 and solely responsible for implementing and administering the "Single Buyer Plus" market mechanism (ultimately leading to competitive market operations). The CPPA (G) has started operating as the designated Power Purchaser for IPPs from its office located at 6th floor, Shaheed -i-Millat Secretariat building Blue Area Islamabad. NEPRA has also recognized CPPA(G) as Market Operator with the vision of its being responsible for the development and implementation of Competitive Power Market. The main objectives of the CPPA (G) are:

- To acquire, take over and / or assume the functions and business of settlement and development of competitive power market from CPPA of NTDC and to carry on these functions and business;
- Procurement of electric power on behalf of the DISCOs, including import of power from other countries;
- Generation invoice verification on the basis of meter reading or dispatch scheduling report and terms of the respective Power Purchase Agreements;
- Billing to the DISCOs, based on the meter readings at Common Delivery Points as per the procedure defined in the Commercial Code;
- Collection from the DISCOs and settlement to the Market Participants as per the Commercial Code; and
- Management of cash flow, treasury management of cash flow, treasury management and other relevant banking functions for the purposes of collection and disbursement as per the Commercial Code

1.8.3.6 Coal Authorities

Mines and Minerals Department (MMD)

MMD was formed on January, 22nd, 2001 in pursuance of National Mineral Policy (NMP) 1995.

MMD responsibilities include assistance, guidance and facilitation for world class quality mining operations in the province; to attract Foreign and domestic investment for the sector and sustainable development of these resources



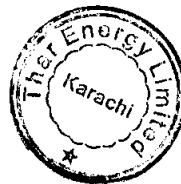
MMD is responsible to provide necessary infrastructure to support accessibility and availability of coal/lignite, which includes roads/transport, communication, water and energy utilities, etc.

Coal and Energy Development Department (CEDD)

CEDD deals with strategic management of coal & energy sector, determining policies in respect of exploration and development of coal and lignite reserves, sanctioning of important projects and deciding all related issues in Sindh.

Its main functions are:

- Development of Coal Resources
- Grant of licenses, permits, leases for coal mines
- Regulation & Monitoring of Coal Mining operations, Coal Gasification, Coal Gas extraction & collection of royalties
- Negotiations of agreements
- Serve as Secretariat of Mineral Investment Facilitation Authority (MIFA), Thar Coal & Energy Board.
- Geological Surveys
- Import, purchase, distribution and price fixation of Coal & Coke
- Coal based energy development





2 Project Details

2.1 Project Site Selection

The identification of potential project site is discussed in this section and is one of the key aspect of project feasibility study.

2.2.1.1 Project Site Selection Criteria

The criteria used for site selection comprised of following domains:

- Availability of Adequate Land
- Fuel Supply
- Water Availability
- Equipment Transportation
- Power Evacuation
- Air Emissions
- Waste Disposal
- Social Impacts
- Other Environmental and Social Issues

2.1.1 Identification of Potential Project Site

2.1.1.1 Basis for Main Site Selection

The site selection investigation basically revolved around the expansion plan of Thar Block-II Energy Park. Following are the features which are considered for the suitability of the project in Thar block II as the selected site.

- **Thar Coalfield:**

Power Plant located next to the Coal Mine providing a readily available fuel supply with minimum coal supply complexities and synergies in power plant project.

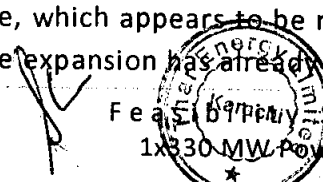
The discussion in the next sections is based on the relative advantages and disadvantages of site based on above criteria elements and is followed by conclusion regarding final project site identification

2.1.1.2 Discussion

Availability of Adequate Land

Availability of land for the installation of power plant at lower cost is the primary factor for site selection, along with the provision for future expansion.

Adequate land is available at Thar near mine, which appears to be more favorable. A land for potential plant site along with future expansion has already been marked and





termed as Energy Park by SECMC. The acquisition / lease of land will be relatively easy and economical for this project

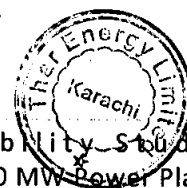
Fuel Supply

Guaranteed fuel supply and ease of the supply are the most important factors in the site selection criteria. Having a mine mouth power plant ensures that the fuel supply is ensured with fuel delivery guarantees from the mining company. Coal reserves are at the depth of 150-180 meters. SECMC as a first step for 3.8 Mt/a mining will create a box cut size of 600 x 1000 meters and will expand this size to approximately 800 x 1200 meters for additional 3.8 Mt/a mining.

The expected COD for first stage of 3.8 Mt/a mining will be in June 2019 and for additional 3.8 Mt/a is expected in Mid 2020.

Installation of a power plant away from the mine site would mean that the coal has to be transported a considerable distance. This would lead to a number of issues:

- **Coal Drying:** Thar lignite consists of about 48% moisture. In order to make transportation of lignite economically feasible, the lignite will have to be dried. However, this would lead to increasing the scope of the Project and increase in the energy cost of the lignite. Coal drying process usually utilizes low pressure steam to evaporate water from finely ground coal. This would require additional installation of crusher, power generating system and boilers which burn lignite to produce steam. This results in increasing the initial cost and final energy price of lignite by 6 – 7%.
- **Spontaneous Combustion:** Thar lignite is susceptible to spontaneous combustion posing a risk during the long transportation. If such coal is to be transported to long distances, after drying the lignite powder is usually converted into briquettes to decrease its surface area and make it less susceptible to combustion during transportation. Moreover, arrangements to reduce the contact with excess oxygen would also be required.
- **Transportation Cost:** Currently there is no functioning railway network close to the mine site. Until a proper railway network is established,
 - coal will have to be transported by trucks. It is estimated that truck transportation cost may result in increase in the lignite energy price by about 20%-25% and higher if the distance between mine and power plan increases like in case of Thar mines to Port Qasim.
- **Project Risk:** Transportation of coal to long distances would increase the Project susceptibility to external variables including quality of road network, traffic conditions, accidents, strikes and many other variables.





Based on the above mentioned reasons, it will be highly feasible to build a mine mouth plant to avoid high transportation cost and to reduce its subsequent risks of safety and reliability of supply chain.

Water Availability

The main supply for water for this 1x330 MW will be the LBOD water after treatment and an allocation of at-least 8.75 cusec out of 35 cusec of RO treated water shall be done by SECMC for this project, for which the construction is underway and is expected to be completed by year 2017.

The power plant water demand can be significantly reduced if project uses Air Cooling instead of Wet Cooling Tower. However, employing air cooling in the hot climate will result in decreased net efficiency as well as net output of the power plant (due to increase in auxiliary load). This will be further discussed under the section talking about the selection of cooling system.

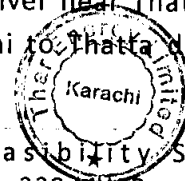
Thar coalfields are located in a desert and as such there is no large body of water supply. Underground water is available in three layers of aquifers at 50, 120 and 210 meters, but the water of these aquifers are brackish in nature. It needs to be treated by Reverse Osmosis (RO) to decrease its salinity to an acceptable level. During mining activities large quantities of groundwater will be pumped out to keep mine dry. This water can be used after treatment by the power plant but its quantity available for the 1x330 MW project will depend on scheme finalized with SECMC and EPTL in design phase. This water however cannot be regarded as the primary source of water supply for this project and shall be backup source of variable supply (if considered).

LBOD treated water of 8.75 cusec (892 m³/hr) as the main source of water supply will be sufficient to satisfy the needs of 1x330MW plant water consumptions at all loads and in peak summers (792 m³/hr). Detailed water balance will be done in design phase, however, preliminary water balance is attached as ANNEX-1 (AF2016022-S02 WATER BALANCE)

Equipment Transportation

Thar coalfield is located about 400 KM from the port city of Karachi. The cost of transportation of equipment is the significant part of project cost and it can be optimized. Load bearing road network approximately till the project site has recently been built by the Govt. of Sindh to support Thar projects, and the same roads will be used to transport heavy equipment and for to and fro movements of manpower.

Widening and rehabilitation of road from Thatta to Thar coal fields are almost completed and construction of new bridge on Indus River near Thatta is in progress with the completion target of end 2016. Also Karachi to Thatta dual carriage way construction has been initiated.





Power Evacuation

According to the proposed scheme in load flow study, power generated from this plant shall be evacuated to NTDC grid system through two 500kV transmission lines. Interconnection scheme recommended is looping in-out of 500kV circuits between Thal Nova CFPP and NTDC's Matiari Converter Station. Steady state analysis demonstrates that this proposed scheme is adequate to evacuate maximum output of the plant under normal as well as emergency conditions.

Air Emissions

Major air pollutants from a coal power plant are SO_x, NO_x and PM. Technologies are available which can control the air emissions in stack to keep the parameters limits within NEQS and to keep the project impact on ambient air quality parameters to the minimum.

For SO_x reduction direct lime dosing in case of CFB boiler can help meeting the SO_x limits. For NO_x the combustion section temperatures in CFB boiler are low enough to control NO_x levels within NEQS and even within more stringent limit, if defined for the project

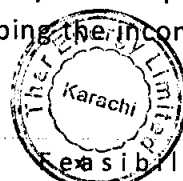
In Thar the PM level is high because of sandy area and frequent dust storms which require special focus on the equipment selection and stack height for control of PM and also for PM control during coal and ash handling activities.

The Thar Coalfield is located in a sparsely populated area with no industries present. For this reason the dispersion of the emissions is less likely to have an impact on the population. Details of emission control equipment are mentioned later in this report and also in ESIA study report.

Wastes Disposal

Quantity and nature of the solid waste (ash) produced from the coal power plant depends on the boiler technology employed. With CFB boiler, the ash is produced as ash-gypsum residue and the product can be used as landfill or to some extent for road construction. With PC boiler, the fly ash can be used as raw material for cement plants and gypsum can be produced separately from lime based FGD and can be dumped or sold out.

Coal mining in the Thar coalfield will involve removal of large quantities of overburden (earth material above coal). Ash or Ash-gypsum residue produced from the power plant can be used for mine refilling after overburden removal. An intermediate ash yard for ash residue storage may be required for few initial years of plant operation until a significant mine area becomes available for dumping the incoming ash into the mine cavity.





The Liquid effluent from the power plant has two possible options for disposal. One is to send it towards evaporation ponds which can be built within Block-II by the Power Plant Company and other is to inject the effluent water in the deepest aquafer (3rd aquafer) after necessary study. The option of directing the plant effluent along with the mine water towards the salt lake (rann of kutch) is not being considered as part of this feasibility.

As mentioned above, in case the power plant is installed at Port Qasim, it can be directly cooled by sea water. The heated sea water can be returned directly into the sea or may need to employ a natural draft cooling tower to reduce the sea water effluent temperature and flow. As the quantity of the rest of the effluent is much lower, it can be mixed into the condenser return sea water stream and may still be within NEQS limits.

The ash or ash-disposal site selection can be a major issue although selling of ash and gypsum will be much easier from Port Qasim (if PC technology is selected) due to its proximity to cement industries. With CFB technology ash-gypsum residue will have no sale potential and its disposal will be a major challenge.

Social Impacts

As mentioned above, the Thar region is a remote area with virtually no industry. Developing a power plant in the Thar region offers an advantage of development of the skills of the local population by getting an opportunity to work in power production facility.

Details of social impacts are covered in ESIA.

Other Environmental and Social Issues

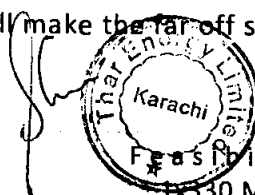
A separate Environmental and Social Impact Assessment (ESIA) Report of the 1x330 MW project has been carried out which covers related impacts and their mitigation plan in more detail

For Thar, the ESIA related issues are likely to be controllable due to virtually no industry and dense population around.

2.1.2 Conclusion

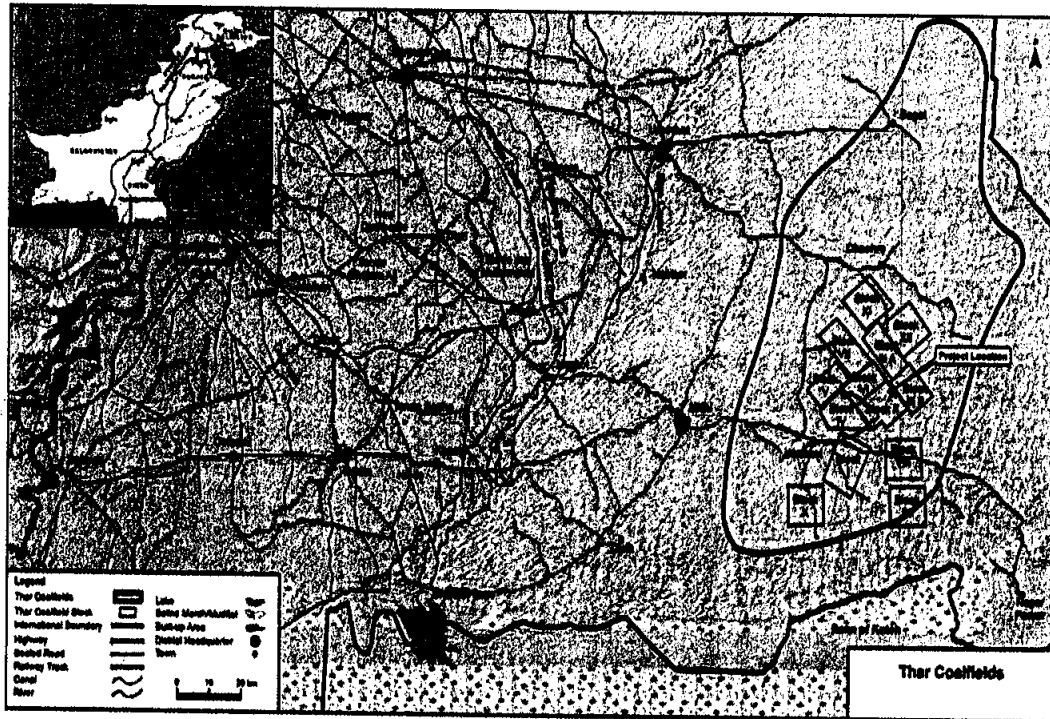
Based on the factors discussed above it has been decided that a Mine Mouth Power Plant will be the most suitable option for utilizing of Thar Lignite. The TEL's 1x330 MW power plant will be located within the Block-II, which is one of the thirteen blocks identified and marked in Thar Coal Fields by SECMC.

The following are the key reasons which will make the far off site like Port Qasim, non-feasible for the said 1x330 MW project



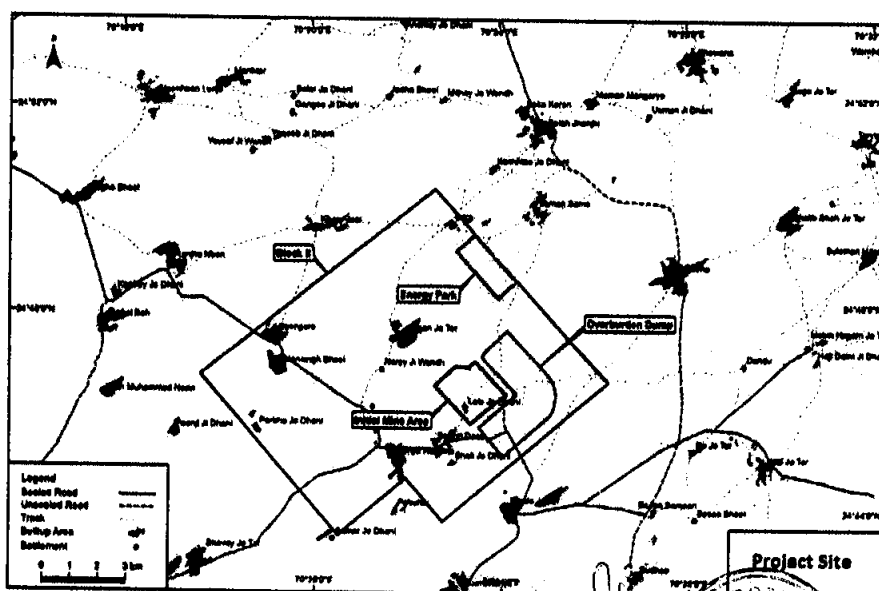
- Significant increase in lignite energy price due to coal drying and transportation will ultimately result in increasing the final power tariff
- Large risk associated with continuous supply of coal inland covering a distance of 400 KM.

Thar Coal Fields with 13 Blocks Identified



2.1.3 Plant Location Selection With-in Block-II

As discussed in previous section, SECMC has already identified an area for power plants construction in Block-II and has termed it as "Energy Park".



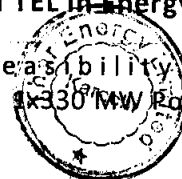


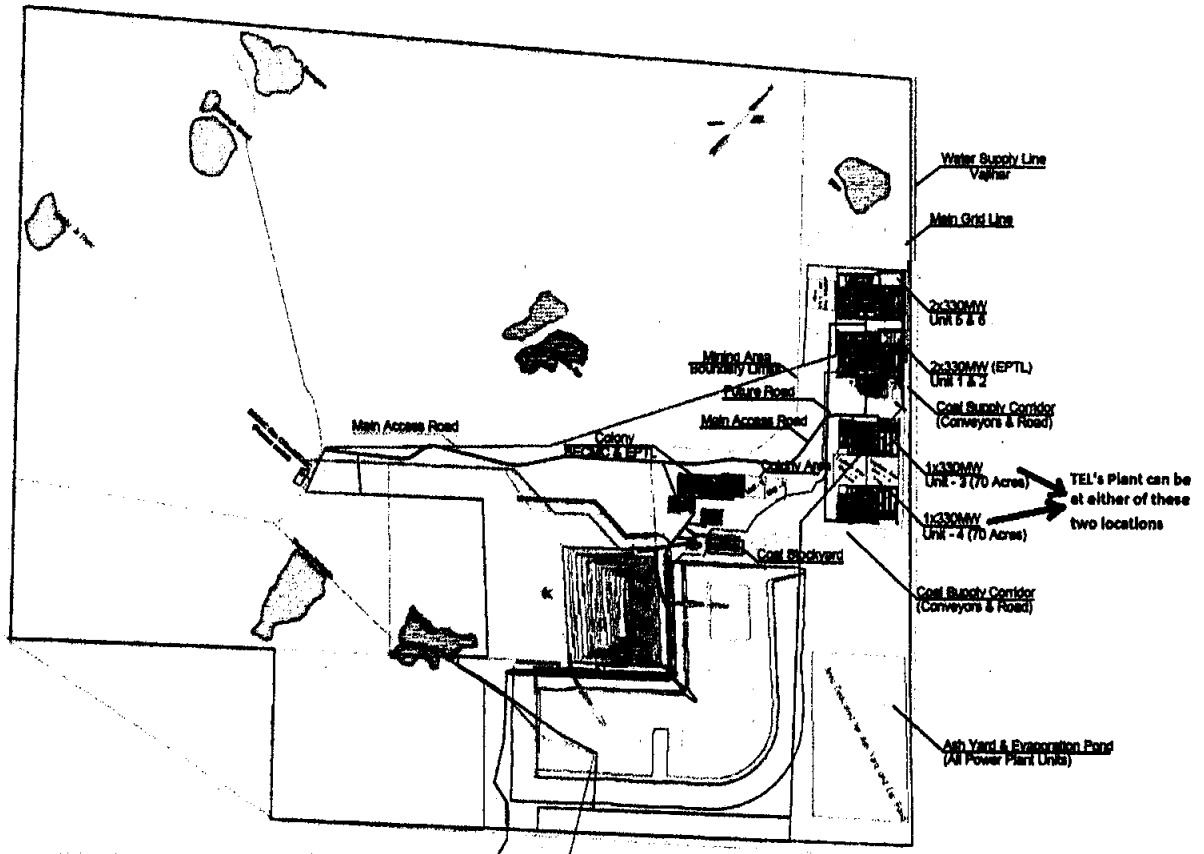
The location of the Energy Park is finalized based on the following considerations:

- **A flat topography as far as possible**
This will facilitate construction of the power plant as comparatively less ground leveling and backfilling work will be required
- **Short transport distances for lignite transport from the mine to the power plant**
The Energy Park selected is about 5 km from the mine facility and even closer to mine services facility and mine coal stock yard.
- **Economical ash transport**
Ash residue transport from the power plant to the ash yard area and for mine backfilling from plant (or ash yard) in near future is economical. Option of dumping ash in the mine could potentially reduce the cost of transportation. However, ash yard for approx. 2 years capacity will be constructed within the 5 km distance from power plant.
- **The Power Plant does not block potentially economic lignite reserves**
In Energy Park area the mining stripping ratio (cubic meter of overburden to be removed per ton of coal extracted) is greater than 10, in comparison to 6.6 in the initial mining area. Also, the division of land between mining and Energy Park has been carried out keeping in view the future mining expansion and plants within the Thar block-II.
- **To allow for a connection to raw water supply from water source (s)**
Can get water access through pipeline for treated LBOD water from Vajihar pumping station and from piping network designed by SECMC for mine dewatering
- **To allow for possible discharge of plant effluent based on various options**
Plant effluent can be routed to the evaporation ponds that can be constructed within 3 km of Energy Park, or through pipeline after high pressure pumping to inject in the 3rd aquifer at suitable location after study
- **Relocation of villages are avoided**
The Energy Park area selected will not require any relocation of villagers
- **Minimum influence of noise and dust on neighboring villages**
The nearest village, Bitra, is located at a distance of about 600 m from the power plant in the North-Western direction. However, the prevalent wind is in North-Eastern direction. The mitigation measures to control air emissions, dust from coal and ash handling are possible.

Based on the factors discussed above the site selected for TEL's 1x330 MW plant will be within the Energy Park and is shown in following diagram. The location of TEL's 1x330 MW plant may be on either of the two locations mentioned in the diagram.

Location of Proposed 1x330 MW Plant of TEL in Energy Park

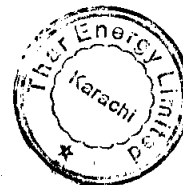


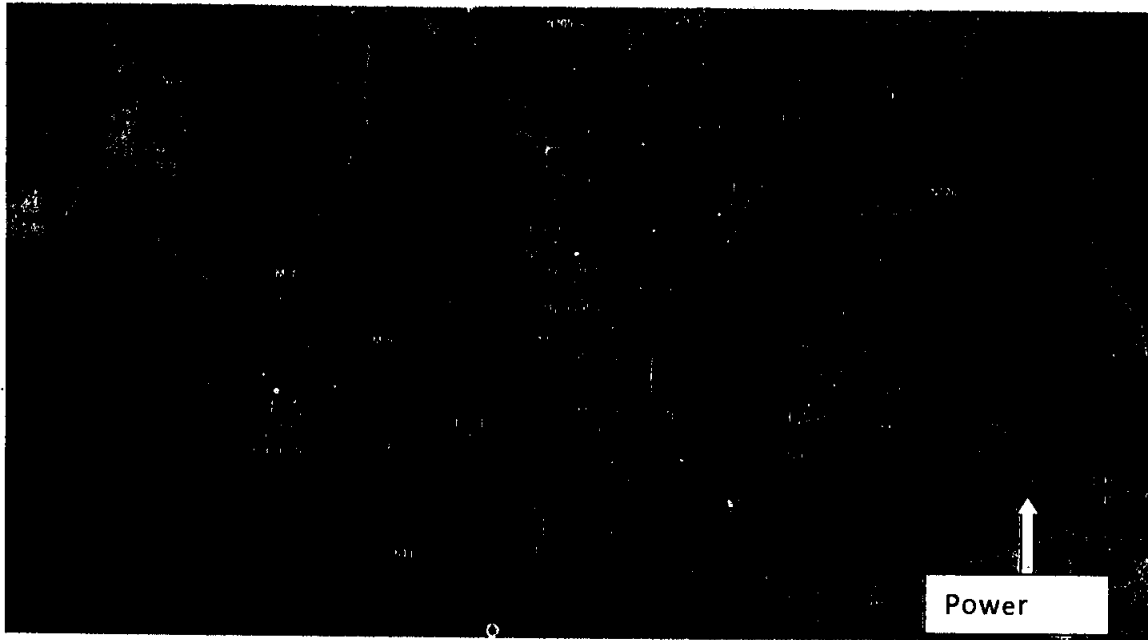


2.2 Site Description

The project site is located in Sindh province of Pakistan, Karachi City 450km southeast of Islamabad, close to the border with Pakistan about 30km, from Hyderabad approximately 300km, from Islamabad city approximately 25km.

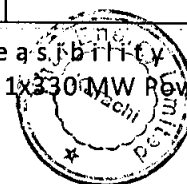
Around the power plant, there only exists Metaled road access (except for a small patch of 5~7 km of earthen track). Further, an airport is being constructed near Islamabad i.e. around 27 km from power plant.





2.2.1 Meteorological and Site Conditions

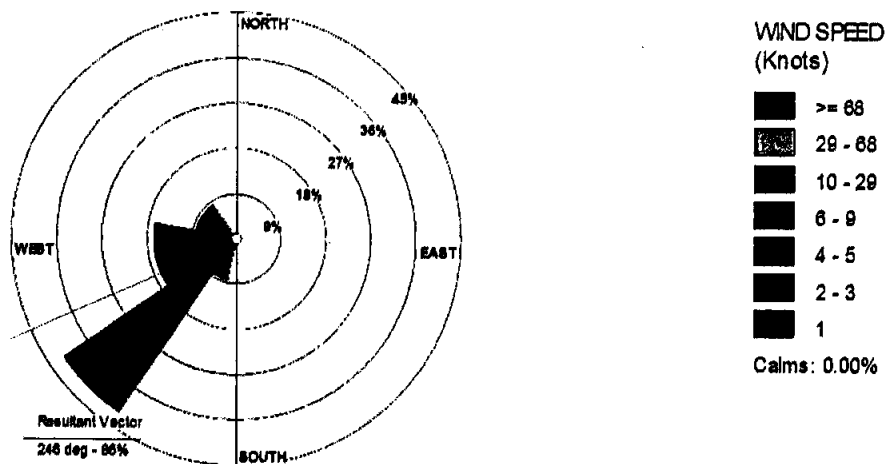
• Elevation	About +100 m above the sea level	
• Air Temperature	extreme maximum	50°C
	extreme minimum	2°C
	design temperature	27°C
• Relative Humidity	design relative humidity	50%
• Rainfall	History maximum in 24 hrs.	250mm
	design maximum (year)	800mm
• Wind speed	average	6m/s
	maximum	15 m/s
	Complex design maximum (associated with 50- year mean recurrence interval and 3-s gust wind speed at 10 m	44 m/s





	above ground in above relatively open and plain ground.)	
• Wind direction	Summer (Prevailing)	South West to North East
	Winter	North to North East

Wind Rose



NOTE: More details and analysis of Meteorological data has been shared along with sources in ESIA Report of the 1x330 MW project.

2.2.2 Design Basis

2.2.2.1 Coal Analysis:

Thar coal

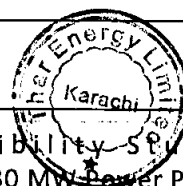
PARAMETERS	Design Coal
Total Moisture (% by weight)	49.5
Ash (% by weight)	7.0
Volatile Matter (% by weight)	24.5

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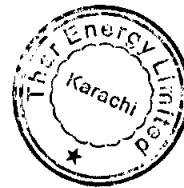
Fixed Carbon (% by weight)	19.0
Carbon (% by weight)	30.89
Hydrogen (% by weight)	2.65
Oxygen (% by weight difference)	8.35
Nitrogen (% by weight)	0.44
Sulfur (% by weight)	1.07
Lower Heating Value (kJ/kg)	11198
SiO ₂ (% by weight)	25.45
Al ₂ O ₃ (% by weight)	15.20
Fe ₂ O ₃ (% by weight)	12.85
MgO (% by weight)	4.86
CaO (% by weight)	11.8
Na ₂ O (% by weight)	3.85
MnO(% by weight)	-
TiO ₂ (% by weight)	1.81
P ₂ O ₅ (% by weight)	-
SO ₃ (% by weight)	11.59
K ₂ O (% by weight)	0.41
Others	12.18
Base / Acid Ratio	0.84





Initial Deformation (°C)at Reduced Atm	1220
Softening temperature (°C)	1284
Fusion Temperature (°C) at Reduced Atm	1412
Hardgrove grindability index (HGI)	75

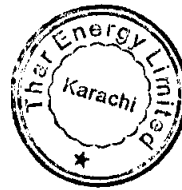
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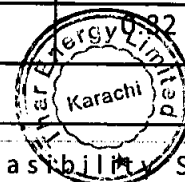
Indonesia coal

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PARAMETERS	Design Coal
PROXIMATE ANALYSIS (As Received)	
Total Moisture (% by weight)	45.9
Ash (% by weight)	5.2
Volatile Matter (% by weight)	25.8
Fixed Carbon (% by weight)	23.1
ULTIMATE ANALYSIS (DAF)	
Carbon (% by weight)	68.62
Hydrogen (% by weight)	6.58
Oxygen (% by weight difference)	22.79
Nitrogen (% by weight)	1.26
Sulfur (% by weight)	0.76
CALORIFIC VALUE (As Received)	
Lower Heating Value (kJ/kg)	12121
PARTICLE PROPERTIES	
ASH ANALYSIS (As dry basis)	
SiO ₂ (% by weight)	49.95
Al ₂ O ₃ (% by weight)	19.48
Fe ₂ O ₃ (% by weight)	12.5
MgO (% by weight)	3.41
CaO (% by weight)	5.41
Na ₂ O (% by weight)	0.83
MnO (% by weight)	0.75
TiO ₂ (% by weight)	0.98
P ₂ O ₅ (% by weight)	-
SO ₃ (% by weight)	5.95
K ₂ O (% by weight)	0.65
Base / Acid Ratio	
ASH FUSIBILITY CHARACTERISTICS	





Initial Deformation (°C) at Reduced Atm	1120
Softening temperature (°C)	1140
Fusion Temperature (°C) at Reduced Atm	1220
Hardgrove grindability index (HGI)	68

2.2.2.2 Limestone analysis

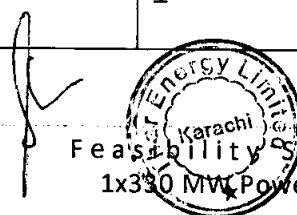
NO.	Composition	Unit	Test results
1	Total Calcium as (CaO) min	%	54.00
2	Magnesium Oxide (MgO) max	%	1.50
3	Silica (SiO ₂) max	%	0.55
4	Alumina (Al ₂ O ₃) max	%	0.30
5	Iron (Fe ₂ O ₃) max	%	0.55
6	Phosphorous (P) max	%	0.05
7	Sulphur (S) max	%	0.31
8	Sodium (Na ₂ O) max	%	0.10
9	Potassium (K ₂ O) max	%	0.05
10	Moisture Content max	%	2.00

2.2.2.3 Auxiliary Fuel (HSD)

HSD will be used for boiler start-up and flame stabilization during low-load operation.

HSD specification are as follow:

Characteristic	Unit	Date
Specific Gravity at 15 °C	—	0.82-0.87
Kinematic viscosity at 40°C	mm ² /sec	1.5-6.5
Sulfur content (max.)	%mass	1



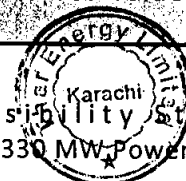


Ash (max.)	%mass	0
Flash point (max.)	°C	66
Pour point	°C	3
Carbon residue (max.) of 10% distillation residue	%mass	0.2
Water content	% vol	0.05
Sediment (max.)	%mass	0
Cetan Index (min.)	—	45
Copper strip corrosion 3 hrs. at 100 °C	—	1
Cloud Point (max.)	°C	600
Total Acid Number (max.)	mgKOH/g	0.5
Calorific Value (min.)	BTU/lb	19000
GCV	MJ/kg	44.2
NCV	MJ/kg	41.8

2.2.2.4 Raw Water

Raw water supply will be LBOD water supplied by SECMC, for lack of the detailed information about the water analysis, following has been assumed for feasibility stage:

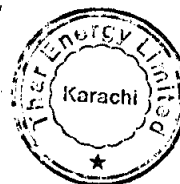
Design Parameter	Unit	Measured Value





pH	-	4.8
Colour	H.U	<5.0
Turbidity	NTU	0.55
Conductivity	μ S/cm	205
Total Dissolved Solids (TDS)	mg/l	98
Total Suspended Solids (TSS)	mg/l	<0.1
Total Alkalinity	mg/l	20
Total Hardness	mg/l	50
Nitrate	mg/l	6.3
Nitrite	mg/l	0.005
Ammonia	mg/l	0.04
Chloride	mg/l	37

Additionally, alternate source of raw water is mine dewatering and the mine dewatering water analysis is given as follow:





GROUNDWATER QUALITY OF THAR BLOCK-II

				Cumulative Water Quality		
				Min	Max	Avg
pH		0.1	EPA 150.1	7.1	7.8	7.3
EC	µS/cm	1	EPA 120.1	7610.0	9028.8	8428.5
Sodium	mg/l	0.1	USEPA 6010 B	1349.1	1717.5	1477.8
Magnesium	mg/l	0.1	USEPA 6010 B	91.9	122.5	108.4
Calcium	mg/l	0.1	USEPA 6010 B	144.3	186.6	167.7
Potassium	mg/l	0.1	USEPA 6010 B	20.5	41.3	26.9
Sulphate	mg/l	0.1	EPA 9056 A	206.9	281.3	242.7
Chloride	mg/l	0.1	EPA 9056 A	2070.1	2953.8	2625.1
Fluoride	mg/l	0.1	EPA 9056 A	0.3	1.1	0.7
Bicarbonate Alkalinity	mg/l	1	EPA 310.1	141.4	192.8	173.8
T. Hardness	mg/l	0.1	EPA 130.2	737.9	967.4	865.1
Silicate as SiO2	mg/l	0.1	USEPA 6010 B	7.3	18.6	14.4
Total Dissolved Solids	mg/l	1	EPA 160.1	4265.7	4965.6	4631.3
Sulphide S2	mg/l	0.01	EPA 376.2	BDL	BDL	BDL
Total Metals						
Total Iron	µg/l	10	USEPA 6020 A	24.4	8542.7	1661.9
Dissolved Metals						
Aluminum	µg/l	10	USEPA 6020 A	4.7	302.8	66.3
Arsenic	µg/l	1	USEPA 6020 A	BDL	BDL	BDL
Cadmium	µg/l	1	USEPA 6020 A	1.9	1.9	1.9
Chromium	µg/l	1	USEPA 6020 A	3.9	3.9	3.9
Cobalt	µg/l	10	USEPA 6020 A	BDL	BDL	BDL
Copper	µg/l	1	USEPA 6020 A	7.6	7.6	7.6
Lead	µg/l	1	USEPA 6020 A	8.4	8.4	8.4
Iron	µg/l	10	USEPA 6020 A	16.6	6932.1	789.5
Manganese	µg/l	1	USEPA 6020 A	77.7	429.8	228.9
Mercury	µg/l	0.5	USEPA 6020 A	BDL	BDL	BDL
Nickel	µg/l	1	USEPA 6020 A	1.9	2.0	2.0
Selenium	µg/l	10	USEPA 6020 A	BDL	BDL	BDL
Zinc	µg/l	5	USEPA 6020 A	6.9	316.7	49.3
On-site Tests						
pH		0	EPA 150.1	6.9	8.0	7.6
Temperature	°C	1	EPA 170.1	30.3	35.6	33.6
Electrical Conductivity	µS/cm	1	EPA 120.1	6655.1	8759.0	7699.8
Salinity	‰	0.1	**	3.8	350.1	88.7
TDS	mg/l	0.5	**	3497.2	4586.3	4086.3
DO	mg/l	1	EPA 360.1	4.4	6.4	5.5
Ammonia	mg/l	0.01	Hach 8155	0.1	0.4	0.2
Nitrate	mg/l	0.1	Hach 8192	1.0	1.5	1.2

BDL= Below Detectable Limit

**= Analyzed with Conductivity Meter

2.2.3 Emission

According to IFC (International Finance Corporation) EHS guidelines for Coal-fired Power Plant, the emissions for boiler as follow:

Parameter	Emission Limit Values (mg/Nm3, dry)
PM (Dust)	50





Nox	510
SO2	850

Note: Emission limit values are evaluated by taking the volumetric oxygen ratio in flue gas as 6 %.

2.2.4 Soil Conditions

According to the Geotechnical data available for THAR block-II (adjacent to the this project)', the soil condition of the project site is as follow:

The subsurface deposits up to the explored depth consist of silty fine sand with mica and silty clayey shale.

Silty fine grained sand was encountered in all the boreholes from existing ground surface up to the explored depth of around 60m while these deposits were encountered up to a depth of 16 meters in the borehole. The in-situ state of compactness of these deposits is in the medium to very dense state. The silty sand is poorly graded silty fine grained sand and the interlocking between the particles is low.

Silty clayey shale was encountered in borehole No 01 only at the depth range of 31.5m to 34m. The in-situ state of compactness of these deposits is hard.

Ground water was not encountered in any of the boreholes up to explored depth of 60m. The content of chloride and sulphate in soil is negligible.

2.2.5 Site Area Requirement

The total area of Thar Block-II is 9550 Hectares (95.5 square km) and that of 1x330 MW power plant shall be approximately 28 Hectares (0.28 square km). A residential colony would be constructed in the South-West of power plant at about 3 km distance from Energy Park. Consideration shall be made to construct the colony adjacent to EPTL's colony for better management and easy access to utilities and other facilities. A road would be constructed to connect the township with the power plant.

2.2.6 Topography

Thar Desert stretches for about 200 km from north to south and has a width of 200 km at its widest point (at the southern end) and about 80 km at its narrowest point (near





the northern end). The dominant feature of this vast expanse of land is the sand dunes aligned in the northeast-southwest direction. However, the area is not uniform as both the size and frequency of the sand dunes vary.

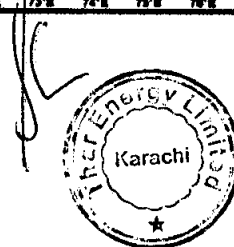
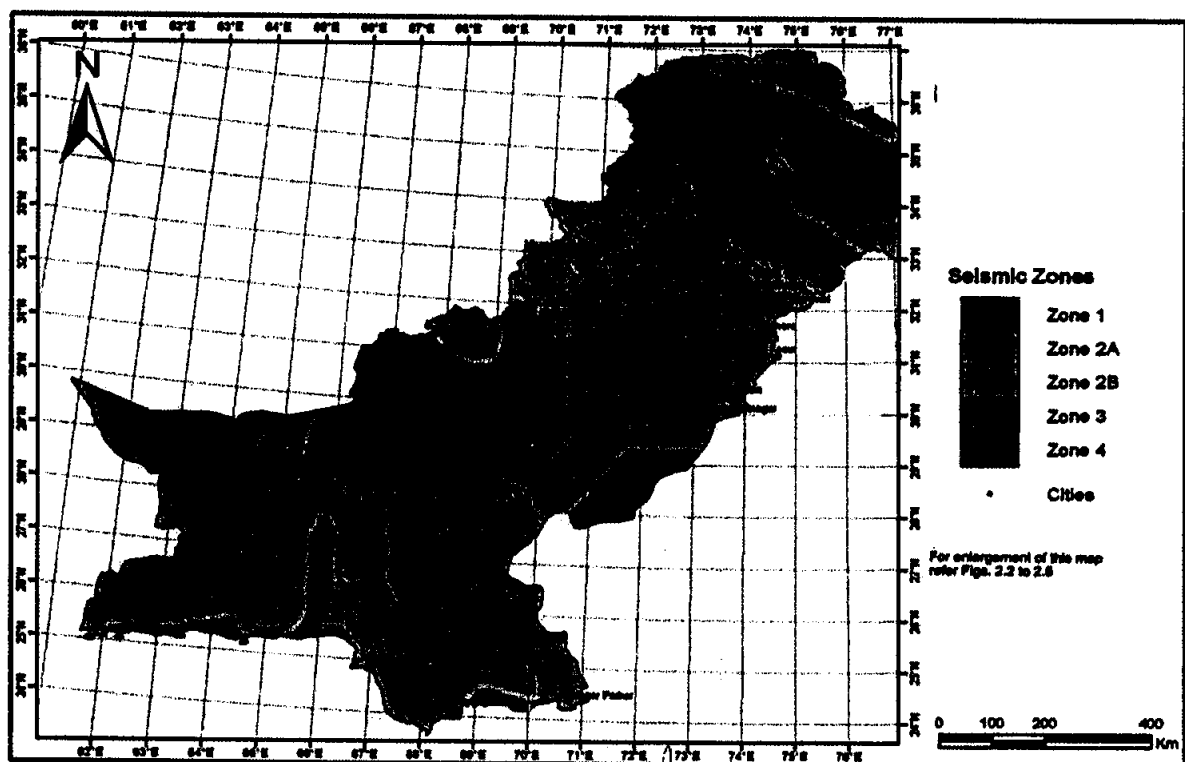
The ground elevation in Block-II region varies from 80 to 100 m above mean sea level (AMSL). The sand dunes (or bhits as they are locally called) typically rise 30-40 m from the foot of the dune which makes the top of the dune as high as 140 m.

The Energy Park area is relatively flat and its elevation ranges between 80 to 95 m from MSL. The proposed location for this 1x330 MW project is even flat and varies between 80 to 85 m.

2.2.7 Seismic Intensity

The Project site falls in Zone 2B according to the 2007 classification. This zone corresponds to peak horizontal ground acceleration of 0.16 to 0.24 g (acceleration due to gravity). The seismicity zoning map of Pakistan is given below

Seismic Zones Map of Pakistan





2.2.8 Hydrology of Thar Desert

2.2.8.1 Surface Water

Surface water is not present in the Thar Desert. Upon heavy rainfalls however water collects in intra-dune depressions and in larger flat areas. There the water can remain up to several weeks as the soil in these areas is rather impermeable. It is also reported that e.g. after the heavy rainfalls during the year 2003 and other years parts of the city of Mithi and other Thar locations were extremely flooded.

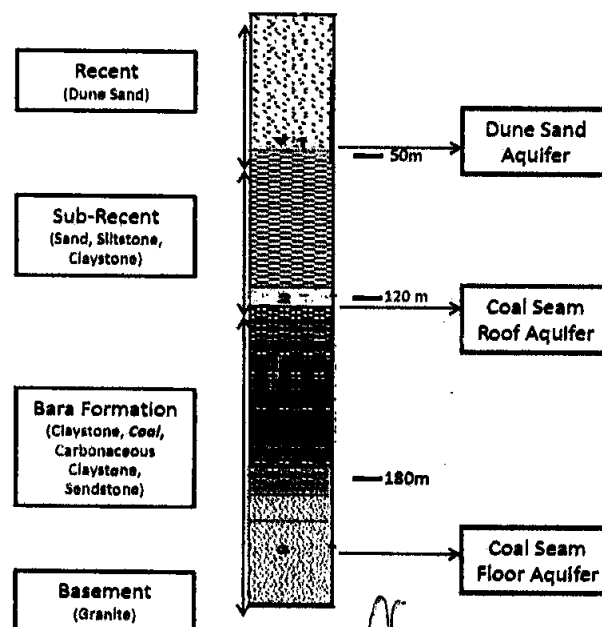
2.2.8.2 Groundwater

Groundwater in Coal Fields of Thar is present in three horizons:

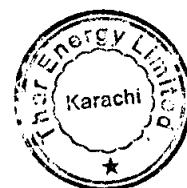
- Top Aquifer: Dune Sand Aquifer (Phreatic)
- Middle Aquifer: Coal Seam Roof Aquifer (confined)
- Bottom Aquifer: Coal Seam Floor Aquifer (confined)

The groundwater is brackish with TDS values in the order of around 2000 to 9500 mg/l. The quality varies with different aquifers and is given in table below. The main characteristic of all groundwater is a dominant sodium chloride content. Most of the Thar villagers depend on the Dune Sand aquifer for their water consumption both for domestic use and cattle. The other aquifers are used only to a limited extent.

Location of Various Underground Aquifers in Thar



Dune Sand Aquifer





The Dune Sand aquifer is present all over the Thar Desert and also at the Indian side. The water column in this aquifer is only around 1 - 5 meters at maximum. Groundwater fluctuations may rise to about 2 meters.

This aquifer is intensively used by the villagers and every village has got in general three to ten tube wells depending on the village size. The groundwater table is in general about 50 – 60 meters below ground surface just at the contact between Dune Sand Formation and Sub-recent.

Recharge of this aquifer is from precipitation which is highest in August-September time frame.

Coal Seam Roof Aquifer

This aquifer is spread out all over the Thar area and consists of silty to coarse sand. The aquifer is at a depth of about 120 m from the surface and has a thickness from almost 0 to about 12 m with an average of about 6 m. Recharge of this aquifer is from the Indian side.

Coal Seam Floor Aquifer

This aquifer covers the whole Thar area. It is at a depth of about 180 m and has a varying thickness about 30 – 50 m. The aquifer is made up of medium to coarse sand. This is the main aquifer in the region. Groundwater recharge is from the Indian side.

2.3 Resources Availability at Site

2.3.1 Space for Development

Thar Block II has the total area of about 95.5 sq. km with most of the area being designated for the mine. The Energy Park is the preferred land for the power plants construction and its location is selected keeping in view relatively flat topography, low mining potential due to high mining stripping ratio, optimum distance from mine, minimum effect on neighboring villages etc.

The Energy Park has enough area for future expansions and currently it is envisaged that it is enough to construct one 2x330 MW Plant, two 1x330 MW Plants and two 2x660 MW Plants, provided adequate resources (Water, Coal, Infrastructure etc) can be made available.

All the land requirements for plant, ash yard, evaporation ponds, housing colony, offsite facilities etc shall be considered within Block-II and shall be procured from SECMC by the Power Plant Company.





2.3.2 Lignite Coal as Main Fuel

The power plant shall be supplied with lignite coal from the adjacent mine operated by SECMC. Coal Supply Agreement shall be signed between the Power Plant Company and SECMC for the quantity of coal required to operate 1x330 MW plant. With CFB Boiler and Subcritical steam conditions, this quantity is envisaged to be about 1.9 Mt/a assuming 85% load factor.

Currently the overburden removal for the mining of 3.8 Mt/a lignite coal is in progress by SECMC. The mine capacity can be expanded to 7.6 Mt/a in June-2020 with Financial Close expected in June-2017. This will not require opening of a new mine area but the enhanced capacity (from 3.8 Mt/a to 7.6 Mt/a) can be achieved by increasing the box cut size from 600 m to 1000 m. This translates into total mining capacity of 1000 t/hr of lignite, enough to feed 4x330 MW CFB units.

A stockyard capacity of about 180,000 tons lignite (power plant demand of 30 days) shall be dedicated for this project at the mine. At plant site, the coal yard of up to 30 days equivalent capacity can be considered depending on the plant and mine outage plans.

The Raw Coal (without pre-drying) from mine with size < 350 mm shall be transferred at plant site through trucks. From underground hopper and coal conveyer system at plant, it shall be transferred either to the plant coal yard or directly to the boiler after crushing and screening. Design Coal, Design Coal Range and the Worst Coal for the project can be selected from multiple coal samples taken from the mine area.

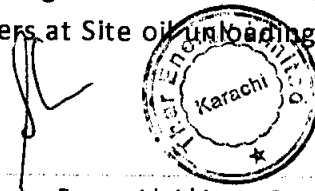
2.3.3 Alternate Coal Fuel

Size of power block should match the mine production schedule so as to start using coal as early as possible from the mine to reduce mine development costs (which would be ultimately borne by the power plant and the consumer).

In this regard, alternate coal fuel will be arranged to make sure that the plant is started and operated even if the mine schedule is delayed. This coal will be arranged from Indonesia by the power plant company. The Indonesian coal quality will be selected within the flexibility available in the design of the power plant based on design coal range.

2.3.4 Ignition and Support Fuel

High Speed Diesel (HSD) can be used as the power plant ignition fuel. Alternatively Light Speed Diesel (LSD) can also be considered depending on economics and ease of supply. HSD or LSD shall be supplied through road tankers at Site oil unloading station under fuel supply agreement.



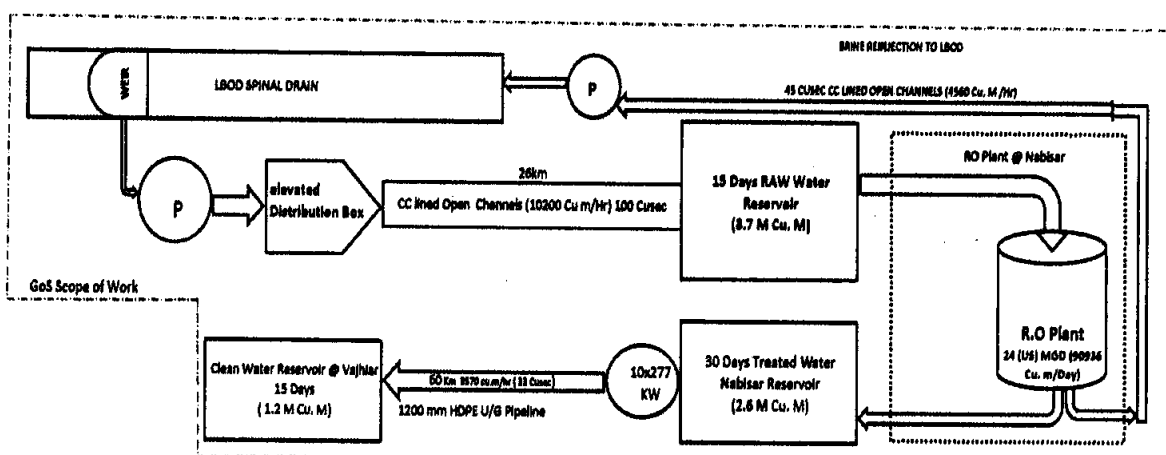


High Sulfur Furnace Oil (HSFO) shall be considered as a support fuel, after ignition, during startup until the power plant shifts completely on lignite. HSFO shall be supplied through road tankers at Site oil unloading station under fuel supply agreement.

2.3.5 Water Supply

The LBOD water supply and treatment scheme is planned by GoS to supply 35 cusec ($\sim 3,570 \text{ m}^3/\text{h}$) of < 500 TDS water to clean water reservoir at Vajihar which should cater the needs of 4x330 MW units. Out of 35 cusec, 8.75 cusec water shall be designated for this 1x330 MW project. The overall plan of the supply of LBOD water, its treatment and transfer to Vajihar Reservoir is shown in below. From Vajihar the pumping of water to plant will be by Power Company.

Primary Water Supply Scheme for Up-to 4x330 MW Units at Block-II



Groundwater from three aquifers will be pumped out from the mining area to keep the mine dry. In the first phase of mining total 29 bore holes and associated pumps and piping will be installed to remove the mine water. About 5000 m^3/hr of groundwater will be pumped out during the initial years of the mining which is envisaged to be reduced to about 2,500 m^3/h during the later years of the Project. In case this water is not taken by power plant, it will be pumped through a 50 cusec piping network to the salt lake at Rann of Kutch area, for which the construction is in progress.

The initial agreement of SECMC is done with EPTL which has the first right of using the mine water for their power plant. It is thus assumed that the back-up option of using the mine water for this 1x330 MW project may not be available. However the option of procuring the mine treated water from EPTL and storing enough quantity in tanks within project area shall be considered to avoid power plant unavailability due to water shortage.



2.3.6 Limestone

Sulfur in the coal results in production of sulfur dioxide (SO_2) during the combustion process. Due to the high environmental impacts of SO_2 , environmental laws call for the removal of most of the SO_2 from the flue gas before it is vented in the atmosphere.

With CFB technology the limestone after necessary preparation can be fed directly into the boiler firebox to absorb most of the SO_2 produced in the combustion. With PC boiler, FGD using limestone slurry as absorbent will be the preferred choice.

The major use of limestone in Pakistan is in the cement industry and they are located close the limestone rocks or mines. Many cement industries own limestone quarries for these sources. The limestone supply for this Project will have to be from any of the near quarry

There are Limestone quarries near Hyderabad as well as Thatta both of which are approximately 300-320 km from power plant location. Supply of limestone via trailers having a capacity of 60-70 tons is possible.

2.3.7 Infrastructure

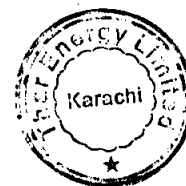
As a part of the large scale development of the Thar Coalfields, GoS is currently working on the development of key infrastructure in the area.

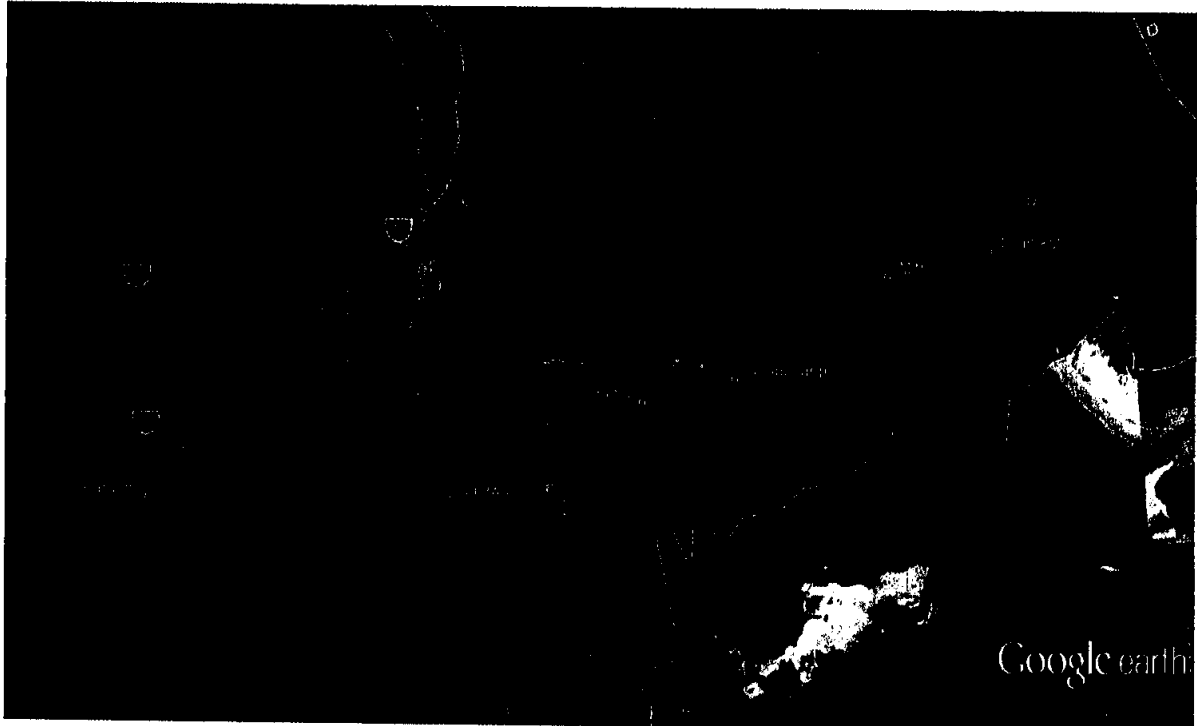
2.3.7.1 Site Access

Thar Block II can be approached through black top metaled roads from port city of Karachi, by a route of Karachi to Sajawal (~130 km) to Badin (~80km) to Shadilarge (~40 km) to Mithi (~70 km) to Islamkot (~40 km). The major road construction is complete and is fit for movement of heavy vehicles and equipment. Alternate route from Hyderabad -Mirpur Khas -Naukot -Islamkot is also under improvement plan.

The site is connected by road to Islamkot (~28 KM away from site) where there are GoS guesthouse, gas station, power grid and houses for the locals.

Road Infrastructure from Karachi to Thar Block-II





A railway track exists around 150 km from Thar block II at Chor Railway station. No railway

Connection with Thar Coal Fields is planned for near future but may be considered in later years.

Airport is under construction at Islamkot which can be of great help during development and operation of the mine as well as power plant.

2.3.7.2 Raw Water Supply

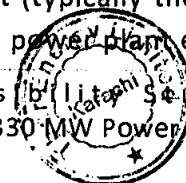
LBOD is a drainage system developed in the Sindh Province for disposal of saline effluent from Industries and Storm Water into the Arabian Sea. This water supply scheme will include the following:

- Construction of CC Lined Channel from RD-362 LBOD to Nabisar to carry 50 CUSEC (5100 m³/h) of saline water
- Pretreatment System and RO plant for saline water and interim storage at Nabisar
- Pumping of upto 35 CUSEC (3570 m³/h) of canal water through underground pipeline from Nabisar to Vajihar clean water storage.

From Vajihar, it will be in Power Plant scope to pump the water through underground pipeline to the project site.

2.3.7.3 Effluent Disposal

Effluent to be disposed-off will include the mine effluent (typically the groundwater extracted during mining operations to keep mine dry) and power plant effluent.





For mine effluent disposal Sindh Irrigation Development Authority (SIDA) has developed a scheme which will involve:

- Effluent disposal pipeline from Thar Block II to Salt Lake (~ 40 KM) in the south of Sindh Province.
- For this purpose 48 inch diameter High Density Polyethylene Pipeline of 50 CUSEC (5100 m³/h) capacity would be used.

For plant effluent disposal there are two options

- Construction of evaporation ponds after acquiring land from SECMC within Block-II. For this project a location on the south-east of Energy Park is suggested for consideration and is near the location for evaporation ponds of EPTL's 2x330 MW project
- Re-injection of Plant effluent water into the deepest aquifer (3rd Aquifer) after necessary study. A location within Block-II shall be preferably chosen for reinjection.

The pumping system along with piping network for the transfer of plant effluent to evaporation ponds and/or for re-injection to 3rd aquifer shall be in the scope of Power Plant Company. For effluent re-injection to the 3rd aquifer, effluent quality shall at least meet the NEQS parameters. More stringent limits may be defined based on the results of the study for the particular location.

2.3.7.4 Ash Disposal

The ash or ash-gypsum residue formed shall be dumped in the ash yard for about 2 years till adequate mined area becomes available for dumping the ash in the mine cavity. The ash yard can be constructed in the south-east of Energy Park within 5 Km of the power plant and mine area and ash residue will be carried through trucks/loaders and compacted by use of dozers. The ash yard location is selected based on the fact that future mining will not be extended to that location.

The Environmental and Social Impact Assessment (ESIA) will suggest the mitigation measures to be taken to control the environmental hazards associated with ash handling and dumping.

Necessary flood protection, if necessary, will be considered for the drainage of flood water from the power plant. The smooth slope style of vertical layout will be adopted. The floor level of main block and auxiliary building will be higher than outside by +0.3m.

2.3.7.5 Electrical Transmission Network

500 kV transmission lines for power evacuation from Thar Block II will be constructed by National Transmission and Dispatch Company (NTDC). These lines are planned to be





connected to Matiari grid, 230 km away, from where the power will be transported to the load center of Pakistan in Punjab through HVDC transmission network.

2.4 Technology Selection

The technology, steam conditions and unit size selected for the Project is typical of modern coal-fired units, and the major equipment is available from several suppliers. There are many similar installations worldwide, which will facilitate EPC Contractor selection.

2.4.1 Methodology

The technology selection is based on the following factors:

- Capital Cost
- Efficiency and Aux load
- Operation & Maintenance (O&M) Issues
- Commercial Demonstration
- PPA and upfront tariff requirements

2.5 Investigated Alternatives

2.5.1 Subcritical Vs Supercritical Technology

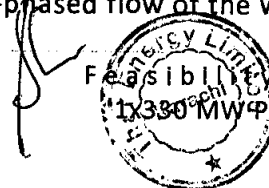
The conventional method of generating electricity from coal is to burn it in a thermal power plant, which will raise steam for power generation. Depending on the steam pressure and temperature conditions following technologies can be categorized as either:

- Subcritical Pressure Boiler
- Supercritical Pressure Boiler

The terms "subcritical" and "supercritical" refer to steam operation conditions being either below or above the critical pressure of water (220 bars or 22 MPa, 3,200PSI-a). The significance of the critical point is the difference in density between steam and water. Above the critical pressure, there is no step increase in the density between water and steam.

2.5.1.1 Subcritical Pressure Boiler

In the standard design subcritical boiler, water is heated in the waterwalls of the furnace and the two-phase flow of boiler water/steam goes up to the steam drum. The steam is separated in the steam drum with water being re-circulated to the waterwalls for further heating. In the low-pressure boiler, the circulation can be prompted by the difference in specific gravity between the two-phased flow of the water and the steam





(natural circulation boiler). For boilers that operate at higher-pressure the slight difference in specific gravity is insufficient to assist the flow and so circulation pumps are required.

2.5.1.2 Supercritical Pressure Boiler

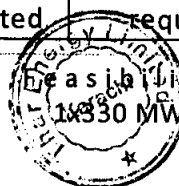
Higher steam temperature and pressure of the boiler improves the thermal efficiency of the plant. Super-critical pressure boiler generates steam at a pressure exceeding 22 MPa. Above the critical point there is no differentiation in state between liquid and gaseous form. Accordingly the steam drum for steam separation is not necessary, which means that all supercritical boilers are of once-through design. The lack of a steam drum means a decrease in the holding water quantity in the boiler and thus quicker response time to load fluctuations.

However, prompt control while ensuring safe operation requires highly automated control system. In addition, it requires strict water quality control. Sub-critical units typically use "All Volatile Chemistry", however, at the elevated pressures of a supercritical unit this is not practical because the chemicals are prone to coming out of solution therefore a water chemistry regime called "Oxygen Treatment", has to be used.

The increased steam conditions of higher temperature and pressure requires thicker pressure-resisting parts and material upgrade, which will increase material costs, however this is partially compensated by reduced amount of material required due to greater efficiency in generating power.

2.5.1.3 Boiler Type Comparison

Type	Subcritical (drum)	Supercritical (once-through)
Pressure	< 22 MPa	> 22MPa
Plant Generating Efficiency (Net) – Based on Lignite Coal	Up to 37%	Up to 39 %
Initial cost	~ 2~4% lower than supercritical	~ 2~4% higher than subcritical
Fuel Cost	5 – 7 % higher than supercritical	5 – 7% lower than subcritical
Advantages	• Simple system enabling easier operation and maintenance • Globally proven design • Lower initial investment	• Higher efficiency • Reduced emissions/MWh • Suitable for large capacity
Disadvantages	• No plant larger than 900 MW has been constructed	• Skilled O&M staff required





		• Strict water quality control required • Sophisticated automatic control system and high-grade materials are required

2.5.1.4 Conclusion

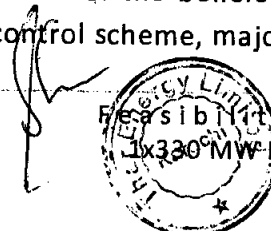
There are many supercritical units in operation in the United States, Europe, Korea, and Japan and a few in the developing countries. American, European, Japanese, and recently Chinese suppliers have standardized on supercritical designs for units larger than 600 MW. Due to renewed interest in large coal fired plants in the United States, the American suppliers have revived the debate over subcritical versus supercritical steam cycles. Most recent coal plants now under design and construction are large and supercritical technology. However, on the other hand subcritical technology has vast industrial footprints with proven and standardized design. Subcritical unit sizes are usually small and reliable with high reliability and availability, if operate and maintain as per the best recommended practices.

After comparing the two technologies on technical, economical and risk standpoints, it has been concluded that proven subcritical technology is the preferred design for this Project and the specific reasons for this selection are mentioned below:

- Engro's 2x330MW project, which is adjacent to this project in same energy park, has also considered sub-critical design. Therefore, subcritical technology has been feasible for this project also in order to take advantages in operation and maintenance services, technical staff requirement, spares availability etc.
- Estimated initial cost is 2~4% lower than that of supercritical technology.
- Subcritical technology is well proven for smaller units like 300 ~ 600 MW and has vast industrial footprints.
- Subcritical units are more resistant to instable grid conditions and can handle more surges in frequency than supercritical technology.
- As the availability of water is dependent on many constraint for this project, so meeting the water chemistry for supercritical plant would be a great challenge.
- Pakistan have no experience in supercritical technology and the required skill set to operate and maintain the plant is not available.

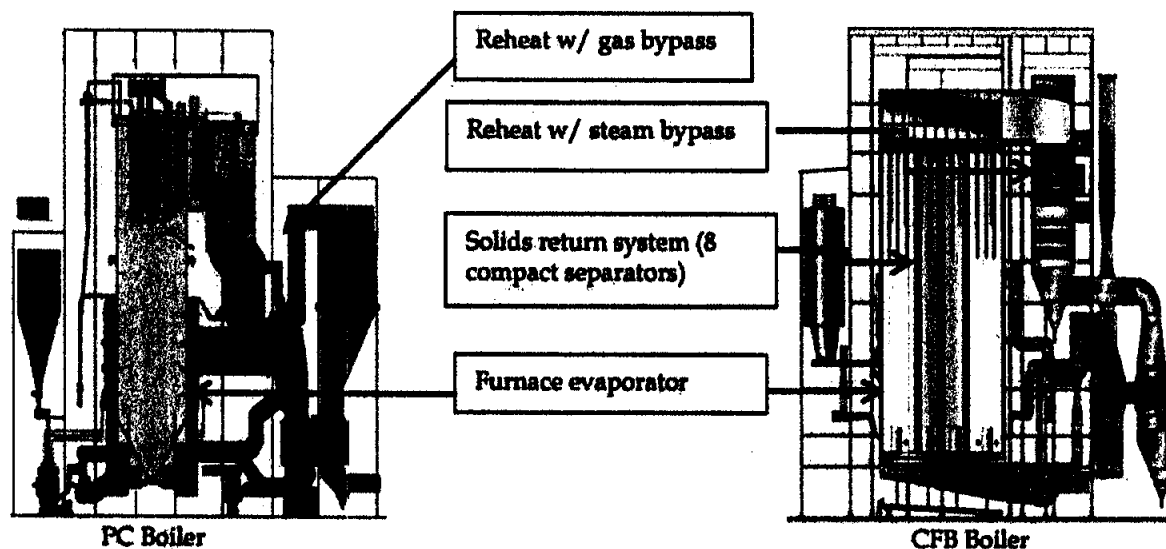
2.5.2 PC-Fired vs. CFB Technology Comparison

There are couple of significant differences in PC versus CFB boilers and are shown in below diagram. Although the heat recovery areas of the boilers are similar with the exception of the reheat steam temperature control scheme, major differences can be





seen in the furnace sections. One major difference is the CFB utilizes a continuous hot solids return system to the furnace which offers many advantages. The CFB hot solids circulating system acts as a thermal “flywheel” which increases solids retention time resulting in good carbon burnout and homogeneous heat flux throughout the furnace and return system. A couple of key benefits of this thermal flywheel effect are: a) Capability of burning a wider range of fuel and b) Ability to tolerate variations in fuel quality on an “real time” basis. This alone favorably affects the variable O&M economics. While the PC uses rotating mills and transport air to deliver fuel to multiple levels of burners to fire the pulverized fuel, the CFB boiler uses startup burners for initial warm up then when reaching a solid fuel temperature permit the solid fuel is gravity fed to the units with virtually no flame present. The combustion temperature remains fairly constant between 875–925°C.



The following comparisons are based on the assumption that the capture of CO₂ is not envisaged.

Issue	CFB	PC
EPC Cost	Approximately equal to subcritical PC boiler with FGD	Approximately equal to subcritical CFB
Net Unit Efficiency	Up to 37% ¹	Up to 37 – 38 % ²
Auxiliary Power Demand	4 – 6%; Potentially lower than other options as no FGD systems	7%; slightly higher than base case
Proven Unit Size	300 MW ³	Up to 1000 MW
Turndown Ratio	35%	40%
Ramp Rate	3 – 5% per minute	2 – 3% per minute
Availability	85 – 90%	85%
Fuel Flexibility	Very wide	Limited fuel flexibility



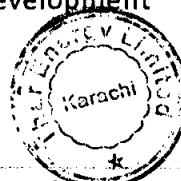


Environmental – NO _x levels	Inherently low NO _x due to staged combustion – SNCR add on simple	Achieving reasonable NO _x levels but require low NO _x burners with SCR
Desulfurization	Direct limestone injection into the boiler, however this produces a solid waste that cannot be recycled and also contaminates the fly ash	Limestone FGD will be required which produces gypsum. Gypsum marketing is possible, otherwise land-filling is necessary
Ash Disposal Area	Ash disposal area needs to be larger due to unmarketable solid waste produced by FGD If FGD is not required then the fly ash is more readily recycled, however there is a higher % of bottom ash, which is inherently less easy to recycle	Reduced due to higher efficiency Possible to market gypsum to some industries
Combustion Temperature	850-900°C	1300- 1400°C
Furnace Slagging	No furnace slagging and furnace soot blowing required	In furnace soot blowers normal practice Melting ash could cause potential slagging in furnace
Residence time	Long residence time for good carbon burn out	Fast burn in open flame
Sudden change in coal quality	Insensitive to sudden changes in fuel quality	Sensitive to sudden changes in fuel quality
Flue gas temperature profile	Homogenous profile throughout the furnace. lowers stress due to reduced differential temperature between gas and water side	Greater possibility of heat related tube damage due to higher temperature Differentials between water and flame and high heat flux in the burner zone

¹Assuming sub-critical steam parameters

²Higher efficiencies are achievable with supercritical PC fired technology

³Unit size of 600MW and 800MW are currently under development





2.5.2.1 Conclusion

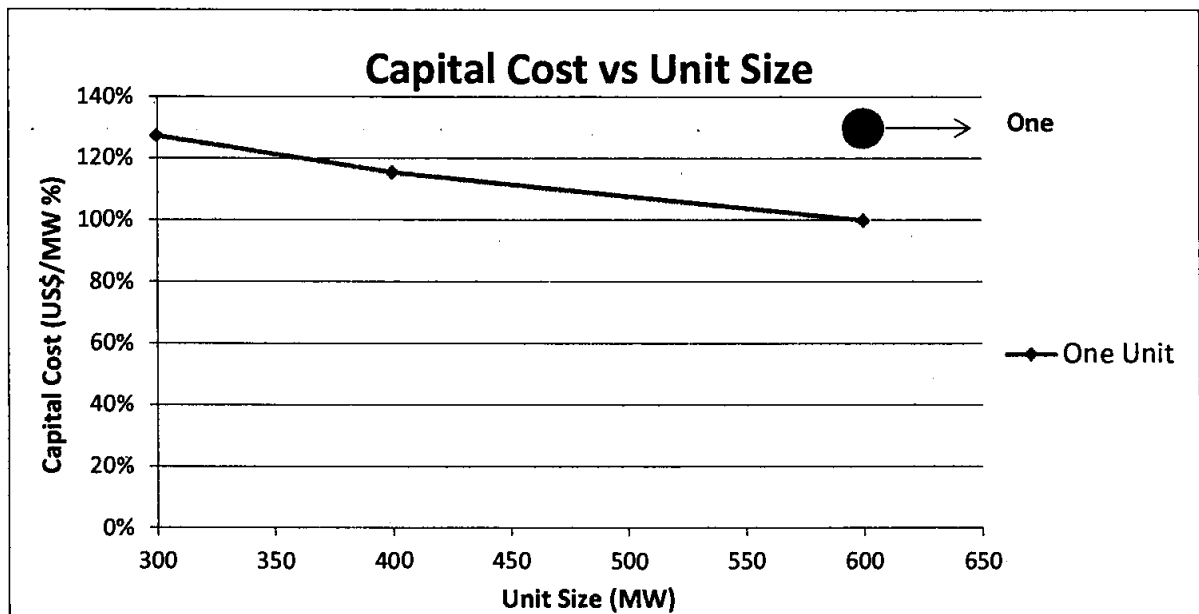
Based on the above comparison information, CFB Sub-Critical is preferable for this plant; due to optimum efficiency, higher availability, less emissions and ability to burn a wider range of fuels which favorably impacted the life cycle economics.

2.5.3 Unit-Size Selection

The general trend in recent coal-fired power plants is to build larger size units, and most of the new coal fired units built in the last five years have been in the 600 MW to 1,000 MW size range. Some smaller units (200 MW to 500 MW) have been built, but in most of those cases, the small size was selected due to grid or transmission limits. The economies of scale, including lower capital cost in \$/kW and lower operating costs(\$/MWh), favor the larger sizes.

The largest fossil fuel based steam turbine in Pakistan is AES Pak Gen 365 MW followed by the AES Lalpir 362MW. The Hub Power Plant Project has four steam turbines of 323 MW each. The largest turbine generators in Pakistan are the approximately 432 MW at Tarbela. These are the large generators on NTDC's grid. Based on the current maximum generator size and the NTDC grid.

The relative capital cost of a coal fired unit, expressed in \$/kW, decreases as the size increases, as shown in the following figure.



The typical capital costs are based on a new site, with site development costs, administration buildings, warehouse, etc. included. The capital cost for two units is always lower on a \$/kW basis because of synergies available in Balance of Plant section like water treatment, Chimney, tanks etc.



Competitive pricing is a significant factor in the cost of a unit. In the size range of 300 MW to 1,000 MW, there are several suppliers of all major equipment, with the most competition in the 300 MW to 660 MW size range. Most boiler and turbine suppliers have standard or reference designs that they prefer to offer. If they can duplicate an existing design, they can reduce costs and can be more competitive. For this reason, the most competitive prices can be obtained by in this size range if going for their standardized design rather than a specific unique size.

The efficiency of a coal-fired unit increases slightly with size due to improvements in turbine efficiency, boiler efficiency, and auxiliary power consumption. Larger turbines are more thermally efficient, and one factor contributing that the higher efficiency is that as turbine blades increase in length, leakage past the end of the blades becomes a smaller percentage of the total flow.

Boiler efficiency increases slightly with unit size because the heat loss from the boiler casing becomes a smaller percentage of total heat generated. The auxiliary power, as a percentage of gross output, also decreases with unit size.

Based on the above description, larger size units such as 600, 660MW or above is beneficial to use due to lower \$/MW values, higher efficiency and lower emissions. However, due to the following reason 1x330MW size is recommended for this project:

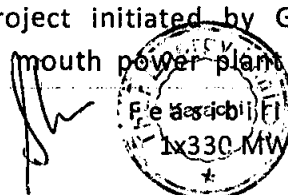
- Large references available for CFB subcritical boiler of this range in international market of both European and American suppliers.
- Constraint of capital available for this project.
- Greater redundancy available in energy park region of Thar block-II in terms of spares, workshops equipment, skilled workforce etc. as ENGRO has also considered the same size for their project (i.e. 2x330MW).
- Third unit of same technology in the same area will be an added benefit. Additionally, it will improve the quality of design and constructions activities in case same Owner's Engineer and the EPC Contractor are considered.
- Good compatibility of 330 MW power plant with the grid conditions of Pakistan.

2.5.4 Wet Cooling vs. Air Cooled Condenser (ACC)

2.5.4.1 Wet Cooling option

Thar District is a semi-arid desert, currently having no surface water source in the area. Groundwater is saline and will require RO treatment before it can be used for power generation. This process will result in about 40 ~ 50% of the groundwater being wasted as brine, and handling of brine as an effluent will also be a challenge for this project.

The water supply through the large project initiated by GoS to facilitate the development of Thar Coalfields and mine mouth power plant is considered as the





feasible solution for this project. GoS has guaranteed the water supply to the Project Development companies. Currently, GoS is working on Left Bank Outfall Drainage (LBOD) project and almost 50% of the work has been completed. Provision of water from LBOD will require pre-treatment and Reverse Osmosis (RO), which is also part of GoS water supply project. The whole LBOD scheme is expected to be completed by the end of 2017.

In case LBOD water is not available, treated mine (ground) water can be considered as a backup option for Project make-up water as per the conditions mentioned in above section (water supply).

There are three levels of underground aquifers available based on the recent data.

- Level 1 = 50 meters
- Level 2 = 120 meters
- Level 3 = 190 ~ 210 meters

Complete dewatering of the first two and depressurization of third aquifer are in the scope of SECMC for their mining project. Dewatering is the key challenge for this project and SECMC have identified two sites for mine water disposal; one is at Gurano - 26 Km and another site 36 Km away.

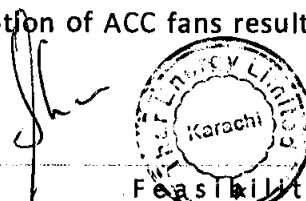
According to the available information, mine water of phase-1 mining will be sufficient to meet the requirement of approximately 600MW power plant. SECMC, EPTL and TEL (Subsidiary of HUBCO) are in discussion to finalize the consumption of mine water as a back-up option.

2.5.4.2 Air Cooled Condenser

Major use of water in a conventional power plant is for condensing the exhaust steam from the turbine. Conventionally, such a cooling system uses Wet Cooling Towers which requires significant volume of water. For this reason, the option of utilizing Air Cooled Condensers (ACC) for condensing steam was investigated. In an ACC (dry) the exhaust steam from turbine is passed through condenser tubes. Ambient air through fans is passed over the tubes to dissipate the heat from the exhaust steam and condense it to water. The condensate is re-circulated in the feed water system for steam generation.

However, using ACC would result in having an adverse effect on the final power tariff due to the following reasons:

- Higher Capital Cost of ACC system in comparison to Conventional Wet Cooling
- Higher auxiliary power consumption of ACC fans resulting in power output and efficiency losses





- Higher backpressure in turbine due to condensing of steam at higher temperatures (especially during the summer months in the desert) resulting in output and efficiency losses.
- Plant tripping risk during peak summer months

2.5.4.3 Conclusion

It was concluded that as part of the feasibility study Wet cooling option with the possible back-up option of mine water is considered for this project. However, ACC option has not been considered for feasibility stage because of the above mentioned disadvantages.

2.5.5 Equipment Redundancy

2.5.5.1 Function

The purpose of this discussion is to summarize the redundancy included in the design to ensure a high availability of the units.

The design of the Project will provide reasonable operational flexibility for the production of electricity. The Project will be designed for safety, easy accessibility and maintainability to allow for fast and efficient maintenance of equipment at minimum cost to the organization. The EPC Contract will be structured to provide design features, equipment, and tools required to achieve these goals. The requirement for a high level of reliability and availability for this Project will be met through a high degree of redundancy in components and systems.

2.5.5.2 Design Basis

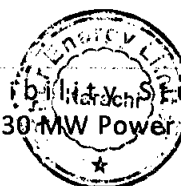
Maximum single point failure will be avoided in the designing phase of power plant and the equipment excluding the power train (boiler, steam turbine, and main power transformer) will be designed with an N+ 1 criterion¹ except where noted. Where exceptions are taken, it is due to sufficient reliability with the availability of respective spares or the failure effect of a single component being out of service is deemed acceptable.

2.5.6 Vendor List

Potential vendor list for major equipment is mentioned below:

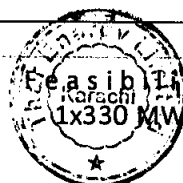
No.	Equipment	Vendor
1.	Boiler	ALSTOM Harbin Boiler Company Limited Shanghai Electric
2.	Steam Turbine	ALSTOM

¹ Where N represents the number of equipment required.





		Harbin Boiler Company Limited Shanghai Electric
3.	Steam Turbine Generator	ALSTOM Harbin Boiler Company Limited Shanghai Electric
4.	Main Transformer	TEBA Shenyang Changzhou Toshiba Baoding Tianwei Xi'an XD Transformer Co., Ltd
5.	HGIS	ABB (Xiamen) High Voltage Switchgear Suzhou AREVA T&D High Voltage Switchgear Xi'an XD High Voltage Apparatus Co., Ltd.,
6.	DCS	Shanghai Foxboro Co., Ltd ABB Emerson Process Management
7.	ESP	Fujian Longking Environmental Protection Zhejiang Feida Environmental Science& Tech. Lanzhou Electric Power Equipment Manufacturer
8.	BFW Pumps	Shanghai Power Equipment Manufacture Co., LTD KSB Shanghai Pump Co., Ltd. Ebara Boshan Pumps Co., Ltd Flowserve Sulzer
9.	UPS	Emerson Gutor BORRI
10.	Boiler Make-up Water System	Metito Chongqing Yuanda Water Service Wuhan Kaidi Water Service Nanjing CEC Environmental Protection Co. Ltd.
11.	FGD System	Beijing Guodian Longyuan Environmental Eng. ALSTOM Technical Services (Shanghai) Co., Ltd. Doosan Lentjes
12.	Circulating Water Pump	KSB Shanghai Pump Co. ltd Hunan XEMC Changsha Pump Works Co. LTD EBARA BOSHAN PUMPS CO.,LTD
13.	Main Condenser	ALSTOM Shanghai Electric
14.	Stacker-Reclaimer	Thyssen Krupp PWH





		Shanghai Generation & Environment Protection Co., Ltd. DHI. DCW Group Co., Ltd

2.6 Interfaces / Terminal points

2.6.1 Grid Connection 500 kV

The boundary of responsibility will be at the top of outgoing gantry. With regard to the system connection, the design will satisfy the requirements of Pakistan National Grid code.

2.6.2 Communication

1) Terminal points to telecommunication and internet system

The exchange lines from the local public telephone network to power plant will be the available. The terminal points of telephone lines will be 2m inside the boundary wall.

2) RTU signal Interface to the NTDC

The interface point will be at the remote communication panel in 500kV relay room.

2.6.3 Coal supply

Coal with a guaranteed size less than 350mm will be transported with trucks to power plant by SECMC under CSA. Terminal point will be coal unloading trench near the coalyard.

2.6.4 Auxiliary Fuel

Auxiliary fuel will be arranged by tanker. Terminal point will be unloading facility located at the oil storage area.

2.6.5 Fly Ash

Fly ash will be loaded in tank cars and trucks and then transported outside. Terminal point will be truck loading facility located at the fly ash storage facility.

2.6.6 Bottom Ash

Bottom ash will be loaded in tank cars and trucks and then transported outside. Terminal point will be truck loading facility located at the bottom ash storage facility.

2.6.7 Limestone

Limestone with a guaranteed size less than 50mm will be transported to power plant by trucks. Terminal point will be unloading area in the dry limestone shed.





2.6.8 Discharge of Waste water

Industrial Waste Water and sewage water will be collected in the power plant. The disposed industrial waste water and sewage water, after re-use (to the extent possible) at the plant will be connected to the re-injection well / lined evaporation ponds.

The effluent generated from mine dewatering water treatment plant will be discharged to the re-injection well / evaporation pond.

Effluent water will be re-injected into the third aquifer at a location that is around 15 Km away from the power plant. The terminal points are at 2m out of the re-injected system station fence.

2.6.9 Bed material

Bed material (sand) with a guaranteed size meeting boiler requirements will be transported to power plant by trucks. Terminal point will be unloading area near the bed material bin.

2.6.10 Water supply

Raw water supply will be provided by the Govt. of Sindh under water supply agreement. Additionally, there will be an alternate source of raw water which is mine dewatering. Required amount of raw water will be supplied at 2 m outside the battery limit of power plant site.

2.6.11 Chemicals

Chemicals will be delivered by lorries/articulated vehicles. Terminal points are relevant storage facilities which are within the plant boundaries.

2.7 Technical Data

2.7.1 Water Balance

Refer to ANNEX-1 (AF2016022-S02 WATER BALANCE) for complete water balance.

2.7.2 Plant Layout

2.7.2.1 Basis for Plant Layout Design

The Plant is located at Islamkot in Karachi of Pakistan, around 5 km distance from the open pit mine. This phase will consist 1x330 MW Lignite CFB Boiler.

The coal will be supplied from the mine and the transportation to the Power plant will be carried out by trucks. The unit will be cooled by the mechanical draft cooling tower. The main water supply will be from LBOD water and the alternate water source can be



mine water supplied from adjacent dewatering facility after treatment. The treatment plant can be within the 1x330 MW premises depending upon mine water allocation.

All the buildings and structures can be divided into three parts. The first part includes steam turbine, boiler house, electrostatic precipitator, central control building, bottom ash silo and other facilities, located in the west of the site. The second part includes administration building, workshop & stores building, sanitary waste water treatment facilities, comprehensive water pump house, chemical water treatment plant, mine dewatering water treatment, evaporation pond, oil tank, oil pump house, hydrogen generating station, boiler make-up water treatment, and other facilities, will be arranged in the middle of the site. The third part includes coal yard, transfer tower, coal handling building & bulldozer garage, truck scale, coal unloading ditch, limestone milling house, will be settled in the northeast of the site, to protection the coal from strong wind /sand storm, wind dust network will be constructed around coal yard based on the annual prevailing wind direction. The mine dewatering water treatment will be settled in the power plant. The unit step-up transformers will be located in the southwest of the power plant.

The site is covered of sand, silt and clay, sand dunes. The width of the access road and the main ring roads is 7m. The turning radius of the roads will generally be 9~15m.

The smooth slope style of vertical layout will be adopted. The floor level of main block and auxiliary building will be higher than outside by +0.3m. The area within the wall of the power plant is about 26.5 ha.

The plant layout/plan is based on the following principles:

- Allow for future expansion of the power plant
- Make efficient use of site topography and geological conditions by placing the main power units, cooling system and major buildings in better foundation condition. Plant layout designed to achieve smooth operation with good access to all key locations.
- Evident distinction between different facilities
- Vertical layout planning to estimate amount of earth work, etc
- Rational planning of water ditches and piping system
- Good conditions for construction facilities
- Rational planning of plant's entrance; environmental protection and soil & landscape conservation

2.7.3 Detailed Plant Layout

The layout of the plant is given in ANNEX-2 (AF2016022-Z01 GENERAL LAYOUT)





The layout is designed keeping in mind the site topographical conditions and interface point, e.g. water, coal and ash. Different area are separated to ensure smooth operation.

The site is divided into 5 sections:

- Main Power Generation Facility
- Cooling Facility
- Electrical Facility
- Coal Handling Facility
- Auxiliaries Facility

Main Power Generation Facility

This area consists of the Boiler building, Steam Turbine building, Control Room, Slag & Ash Silos and Air Compressor Unit. This area is arranged in the centre of the power plant to make it most accessible.

Cooling Facility

This section consists of the Cooling Towers and is arranged in the Northwest of the plant. Main equipment in this section are the Cooling Towers, Water Pumps, Water Dosing Units and Effluent Ponds.

Electrical Facility

This section mainly consists of the Transformers, Distribution Equipment and Electrical Control Building.

Coal Handling Facility

This area consists of the Coal Feeding Conveyor, Stacker-Reclaimer, Stockyard, and Coal Testing Laboratory etc. The area is polluted due to coal particles and for this reason is located in the North of the Plant.

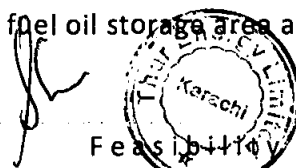
Auxiliaries Facility

This area is arranged in the West of the Plant and houses the Water Workshop, Water/Sewage Treatment Systems.

Coal Conveyors are arranged in the East of the Coal Crushers. Fuel Oil and Start-up Boiler System are arranged close to the Furnace. Offices and Workshops are arranged close to the main entrance.

2.7.4 Plant Layout Safety Features

Biggest safety risks of the power plant are the fuel oil storage area and coal stockyard.





Due to the safety distance requirement, the fuel oil storage area is located in the southeast of the site, with ash silos in the north and start up boiler in the west. The oil storage tank is surrounded by a 1.8 m high fence.

Coal stockyard is located in the north of the plant having good access for firefighting trucks by roads.

The plant has two main roads and three secondary roads arranged around the power producing units. These roads provide good access for firefighting. Roads, having at least 4 m width, are arranged around main power building, oil storage area and stockyard.

2.7.5 Landscaping and Construction Area

The construction facilities for the plant will cover an area of about 10 hectares and will be located in the center of the plant area. Temporary accommodation facilities for Contractor during construction facilities will cover an area of about 2~3 hectares and will be located in the west side of the plant.

Total area for power plant is ~ 28 hectares. Greening will be carried out in 3-4 hectares of land.

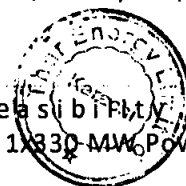
More details are provided in the Civil Section.

2.8 System and Equipment

The generation capability of the unit will be 330 MW (Gross). The net power production for system with Wet Cooling will be approximately 301 MW and will depend on the vendors selected for the steam turbine and steam generator. Vendors have units or building blocks that are optimized for their design. To maximize the capacity and reduce costs, the final design needs to remain flexible until the final vendor selection is made.

The scope of the Project will include complete engineering, procurement, transportation, construction, erection, installation, commissioning and testing of 1x330MW lignite based power plant at Thar site with CFB boiler technology. Following is the list including, but not limited to the equipment/systems installed in the power plant to make it a reliable and efficient power plant for at least 30 years:

- 1) Circulating Fluidized Bed Boiler with steel structure and related auxiliary equipment.
- 2) Steam Turbine Generator Set (STG) and its excitation system.
- 3) STG's Exhaust Vacuum System Steam Surface Condenser.
- 4) Boiler Feed Water preheating "LP heating, Deaerator, BFW pumping, HP heating.
- 5) Electrostatic precipitator (ESP) for Flue gas.



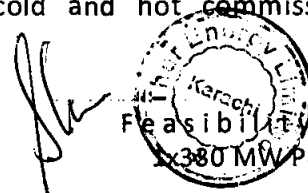


- 6) Auxiliary start-up liquid fuel supply system (storage and pumping station).
- 7) One set of stacker/re-claimer for the coal handling system.
- 8) Coal transportation after coal unloading trench in the power plant, crushing& Feeding System.
- 9) Limestone transportation after dry limestone shed in the power plant, milling, pneumatic conveying& Feeding System.
- 10) Bottom Ash discharging, transporting system to bottom ash silo.
- 11) Fly Ash discharging, transporting system to fly ash silos.
- 12) Bed material transportation after storage bin in the power plant, pneumatic conveying& Feeding System.
- 13) Circulating water system which will be composed circulating water pumps, cooling towers, filtration systems, automatic condenser cleaning system, filters valves, pipes, and other necessary instruments.
- 14) Boiler make-up water treatment system
- 15) All piping, insulation of necessary equipment and pipes, cabling, cable trays, tubing etc.
- 16) Miscellaneous such as power plant's water and steam sampling, chemical dosing, field instruments.
- 17) Condensate Polishing System.
- 18) DCS for the unit and PLC network for the auxiliary workshop.
- 19) Generator circuit equipment including IPB, CT,PT/LA cubicle, neutral point earthing transformer.
- 20) Step up transformer, unit auxiliary transformer, start-up/stand by transformer.
- 21) 500 kV switchgear including indoor GIS, PT, LA equipment, control and protection.
- 22) Non-segregated bus, MV & LV cubicle and LV dry transformer for auxiliary electrical system.
- 23) DC and UPS system.
- 24) Generator and transformers protection.
- 25) MV/LV switchgear control and protection.
- 26) Measuring system.
- 27) Synchronizing system.
- 28) Emergency diesel generator unit.
- 29) Lightning & Grounding System.
- 30) Lighting & Maintenance system.





- 31) Cable and cable trays.
- 32) Communication system.
- 33) Fire alarm system in the fence of Power Plant.
- 34) SCADA/RTU system.
- 35) Compressed service air.
- 36) Dry instrument air.
- 37) Ventilation and Air Conditioning of whole power plant
- 38) All instrument air piping and fittings within the scope of supplies.
- 39) All kinds of cables (including control cables), cable trays, field boxes and junction boxes within the scope of supplies.
- 40) The installation materials within the scope of supplies, which means that the materials constructing the permanent part of the power plant upon completion, such as pipes, valves, insulating materials, cable tray, cable & wires, fire resisting materials, all necessary refractory, painting, steel structure for main building etc.
- 41) All cranes or monorail hoists for maintenance purpose where necessary as well as the main crane in the Main Building.
- 42) Chemical extinguishing stationary and mobile tubes or tanks.
- 43) CO2 / IG or equivalent automatic extinguishing system (CO2/ IG gas bottles).
- 44) Circulation Cooling water treatment system.
- 45) The site distribution LV panel, compensation panel and cable from transformer 380V side to LV panel will be made by the EPC Contractor.
- 46) Fire-fighting water system.
- 47) Service and potable water, demineralization water discharging system within the plant.
- 48) Industrial waste water treatment system and sanitary sewage treatment system.
- 49) A raw water treatment plant
- 50) Concentrated brine re-injection system including brine emission water pipe and re-injection well.
- 51) Evaporation ponds
- 52) Ash storage yard
- 53) All kinds of special tools, devices, mounted or mobile instruments required during electrical and mechanical erection, cold and hot commissioning, trial runs, performance test runs up to the PAC.





54) Consumables (except coal, fuel oil, limestone, water and electricity etc) required during erection, cold and hot commissioning, trial runs up to performance test. Construction power and construction water.

55) Chemicals for first filling.

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3 TECHNICAL DESCRIPTION

3.1 Design Parameters and Standards

The latest Chinese national established codes and standards will be adopted in principle, however, some international codes and standards will be adopted as necessary.

The emission, waste discharge will be designed per the standards of Pakistan (NEQS, AAQS etc.).

Firefighting will be designed per the NFPA standards and Pakistan local regulations.

The Project Company reserves the right to adopt any of the international standards, wherever applicable. If any conflict exists between any code of practice or design standard, the more stringent document requirements will be used.

3.2 Technical Information

3.2.1 Flue Gas Emissions

The power plant shall be equipped with continuous emissions monitoring system that will measure the levels of solid particles and gaseous emissions.

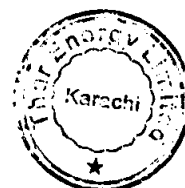
Flue gas emissions on dry flue gas with 6% of O₂ based on design fuel:

Parameter	Emission Limit Values
Dust (mg/Nm ³ , dry)	50
NO _x (mg/Nm ³ , dry)	510
SO ₂ (mg/Nm ³ , dry)	850

3.2.2 Waste Water Discharge Quality Requirements

The power plant will produce all kinds of Industrial Waste Water. The Waste Water Treatment System shall meet the requirement to treat the regeneration waste of the water treatment plant etc., the waste water after treated will be re-used.

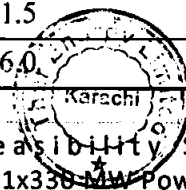
For industrial Waste Water to be drained into General Drainage System out of the power plant will be in accordance with the limits bellow:





NATIONAL ENVIRONMENTAL QUALITY STANDARDS

No	Parameter	Standards		
		Into Inland Waters	Into Sewage Treatment ¹	Into Sea ²⁾
1.	Temperature increase ³	$\leq 3^{\circ}\text{C}$	$\leq 3^{\circ}\text{C}$	$\leq 3^{\circ}\text{C}$
2.	pH value	6 to 9	6 to 9	6 to 9
3.	Five-day bio-chemical oxygen demand (BOD) ₅ at 20°C ⁴	80	250	80 ⁵
4.	Chemical oxygen demand (COD) ¹	150	400	400
5.	Total suspended solids (TSS)	200	400	200
6.	Total dissolved solids (TDS)	3,500	3,500	3,500
7.	Grease and oil	10	10	10
8.	Phenolic compounds (as phenol)	0.1	0.3	0.3
9.	Chlorides (as Cl')	1,000	1,000	SC ⁶
10.	Fluorides (as F')	10	10	10
11.	Cyanide total (as CN')	1.0	1.0	1.0
12.	Anionic detergents (as MBAS) ⁷	20	20	20
13.	Sulfates (SO ₄)	600	1,000	SC ⁶
14.	Sulfides (s')	1.0	1.0	1.0
15.	Ammonia (NH ₃)	40	40	40
16.	Pesticides ⁸	0.15	0.15	0.15
17.	Cadmium ⁹	0.1	0.1	0.1
18.	Chromium (trivalent and hexavalent) ⁹	1.0	1.0	1.0
19.	Copper ⁹	1.0	1.0	1.0
20.	Lead ⁹	0.5	0.5	0.5
21.	Mercury ⁹	0.01	0.01	0.01
22.	Selenium ⁹	0.5	0.5	0.5
23.	Nickel ⁹	1.0	1.0	1.0
24.	Silver ⁹	1.0	1.0	1.0
25.	Total toxic metals	2.0	2.0	2.0
26.	Zinc	5.0	5.0	5.0
27.	Arsenic ⁹	1.0	1.0	1.0
28.	Barium ⁹	1.5	1.5	1.5
29.	Iron	8.0	8.0	8.0
30.	Manganese	1.5	1.5	1.5
31.	Boron ⁹	6.0	6.0	6.0





No	Parameter	Standards		
		Into Inland Waters	Into Sewage Treatment ¹	Into Sea ²⁾
32. Chlorine		1.0	1.0	1.0

Explanations:

Applicable only when and where sewage treatment is operational and BOD = 80 mg/l is achieved by the sewage treatment system.

- 1) Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.
- 2) The effluent should not result in temperature increase of more than 3oC at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not define, use 100 m from the point of discharge
- 3) Assuming minimum dilution 1:10 discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent.
- 4) The value for industry is 200 mg/l
- 5) Discharge concentration at or below sea concentration (SC)
- 6) Methylene Blue Active substances assuming surfactant as biodegradable
- 7) Pesticides include herbicides, fungicides, and insecticides
- 8) Subject to total toxic metals discharge should not exceed level given at S. No. 25

Notes:

- 1) Dilution of liquid effluents to bring them to the NEQS limiting values is not permissible through fresh water mixing with the effluent before discharging into the environment.
- 2) The concentration of pollutants in water being used will be subtracted from the effluent for calculating the NEQS limits.

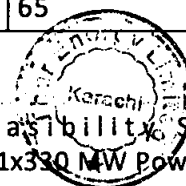
3.2.3 Noise Emission Limits

The noise emitted from its plant will not exceed the following values according to Pakistan regulation:

National Environmental Quality Standards for Noise

Category of Area/Zone	Effective from 1st July, 2012	
	Limit in dB(A) Leq*	
	Day time	Night time
Industrial area	75	65

Note:





1. Day time hours: 6 .00 am to 10.00 pm
2. Night Time hours: 10.00 pm to 6.00 am
3. dB(A) Leq: time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

3.2.4 Technical Data

Item	Unit	Date
Capacity		
Gross power output at THA	MW	330
Steam Data (for boiler) at BMCR		
Steam flow	t/h	1098
Steam pressure	bar(g)	174
Steam temperature	°C	540
Feedwater temperature	°C	282
Design Performance at THA		
Boiler efficiency	%	91.0
Turbine heat consumption rate	kJ/kW.h	7988.6
Design coal consumption	t/h	275
Design coal LHV	kcal/kg	2674
Net efficiency of the power plant	%	37.1
Net power output	MW	301.62

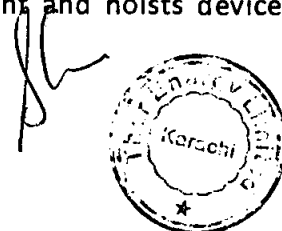
Note: above data is subject to change in the design phase based on the detailed information from OEMs.

3.3 Mechanical Equipment/Systems Description

3.3.1 General

There is 1x1098t/h subcritical boiler and 1x330MW steam turbines (condensing type) will be constructed for this project.

Design scope includes combustion system, thermal power system, oil system, and their equipment selection, main block arrangement and hoists device and other auxiliary devices.





3.3.2 Specification of Main Equipment

3.3.2.1 Boiler (at BMCR)

The boiler is of subcritical parameter boiler with single drum, with high temperature ash recycling, dry bottom ash discharging, balanced-draft, all steel structure type. Each boiler is equipped with one rotary air heaters.

The boiler main parameters are as follows:

Boiler maximum continuous rating	1098t/h
Main steam pressure at outlet of superheater	17.5MPa(a)
Main steam temperature at outlet of superheater	540°C
Reheat steam flow	907t/h
Reheat steam pressure at inlet/outlet of reheater	4/3.62MPa(a)
Reheat steam temperature at outlet of reheater	330/540°C
Feed water temperature	282°C
Coal consumption	275t/h
Boiler Efficiency (based on LHV)	91%

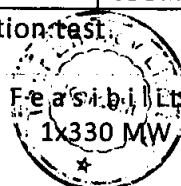
3.3.2.2 Steam Turbine (at THA)

Power rating	330MW
Main steam pressure (at the main stop valve inlet)	16.67MPa(a)
Main steam temperature (at the main stop valve inlet)	538°C
Main steam rated flow	1013t/h
Hot reheat /cold reheat steam pressure	3.36/ 3.73MPa(a)
Hot reheat /cold reheat steam temperature	538 / 322.7°C
Reheat steam flow	841t/h
Exhausting steam pressure	6.9 kPa (a)
Rated Rotate Speed	3000r/min

3.3.2.3 Generator

Rated active power	330 MW
Rated voltage	20kV
Power factor	0.85
Frequency	50 HZ
Cooling type	Water- hydrogen cooling

Note: above data is subject to change after combustion test.





3.3.2.4 Turbine Generator Design Condition

Turbine Generator and auxiliary systems shall be designed in accordance with all the following data.

THA condition:

Rated output at generator terminal exclusive of excitation load	300 MW
Initial steam pressure at inlet to main stop valve	16.67 MPa(a)
Initial steam temperature at inlet to main stop valve	538°C
Exhaust steam pressure at exhaust connection from turbine	6.9kPa
Circulating water temperature at inlet to condenser	27.6°C
Make up water rate	0%
Turbine speed	3000 rpm
Generator frequency	50 Hz
Generator power factor	0.85

3.3.3 Boiler Auxiliary System

3.3.3.1 Combustion, Air/Flue Gas System

1) Primary air system

Primary air system supplies fluidizing air for the boiler to make coal in fluidized state and delivering air for coal feeding system.

Under normal operation of the boiler, the primary air heated via air preheaters is divided into two parts. One part with larger quantity enters primary air box at the bottom of furnace and then passes through the air distributing plate as fluidizing air. Another part will provide coal swept air for coal feeding connections which are equipped at the front of furnace. During combustion support, a part of primary air will be designed to provide the necessary burning air for the oil burners which are arranged at the two sides of furnace.



The boiler will equip with two sets of centrifugal, 50 percent capacity of BMCR primary air fans with inlet guide vanes, two inlet silencers and dampers, etc. There is a connection air duct between the outlets of primary air fans.

2) Secondary air system

The secondary air at outlets of secondary air fans via air preheaters will supply hot secondary air required by boiler combustion.

The boiler will equipped with two sets of centrifugal, 50 percent capacity of BMCR secondary air fans with inlet guide vanes, two inlet silencers and dampers, etc.

3) Flue gas system

Combustion products enter the cyclones firstly. In the cyclones, the coarse fly ash is separated and returned to the furnace. The flue gas with fine fly ash passes through heat recovery area, is purified from dust in the ESP and discharges to the atmosphere via induced draft fans and stack.

One stack is installed in this project. Diameter and height of the stack is mentioned in ESIA report.

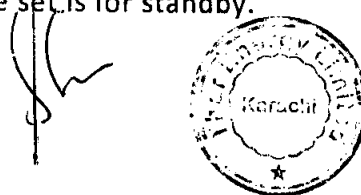
4) Material Circulating System

The function of material circulating system is to send high temperature coarse fly ash separated in the cyclone back to the furnace and increase combustion efficiency of the circulating fluidizing bed boiler. The system is composed of three sets of insulation cyclones, three sets of "U" valves and three sets of high pressure fluidizing air blowers, etc.

The coarse fly ash separated in the cyclone will enter into the "U" valves by gravity and be sent back to the furnace by the high pressure fluidizing air. The height of coarse fly ash in the "U" valves can prevent the flue gas and high pressure fluidizing air back to the cyclone. The high pressure fluidizing air blowers will provide fluidizing air and looseness air for the "U" valves and it also provide the necessary cooling air for the ignition air duct while in unit start.

The high pressure fluidizing air blowers will be centrifugal type with high pressure and small flow. The boiler will be equipped with three sets of high pressure fluidizing air blower. Two sets are in operation and one set is for standby.

5) Ash Cooling System





Five sets of 50 percent capacity screw type ash coolers with water-cooling will be installed for the boiler. The cooling water will be from the condensate water system. The temperature of bottom ash discharged from the ash coolers will not be more than 200°C. Then the bottom ash will be send to bottom ash silo.

6) Coal feeding system

After crushed, the coal with qualified size will enter into the coal bunkers by the coal feed belt, then through the coal feeders and coal piping, the coal will be delivered to coal feed connections.

The system consists of the following equipment: coal bunkers and coal feeders of gravimetric type.

The coal feeders of gravimetric type can measure boiler coal consumption exactly.

The coal feeding system adopts pressurized air distribution equipment to send coal into the furnace, and the coal distribution air is from hot preliminary air. The pressure of solid material is higher than that of furnace at the same height to prevent the returning of hot air from furnace.

3.3.3.2 Fuel Oil System for Boiler

1) Functions of the system

There are three functions, ignition, start-up and burning assistance.

When coal is used as the fuel for boiler, it is not proper to feed the coal directly during the start-up of the boiler. The furnace should be preheated to a certain temperature first and the coal can be fed then.

For coal fired boiler, the oil is needed to support the burning when the combustion is not stable during low load operation.

2) Criteria of system design

For ignition and burning-assistant, it is designed based on HSD.

The capacity of the start-up and burning-assistant system is determined according to the following principles:

a. Satisfy the requirement of cold start-up and hot start-up as well as burning-assistance at low load.

b. Two oil tanks, each with capacity of 500 m³ will be built in this Phase.

Two oil unload pumps will be built in this Phase.



Three oil supply pumps will be built for this Phase. Two pumps are used in operation and the other one standby. The capacity of each pump is designed to have 50% of the oil quantity.

On the oil supply pipeline and oil return pipeline as well as pipelines of each boiler house are installed with oil flow gauges.

On the oil supplying pipeline and oil return pipeline of each boiler are installed with quick isolating valve.

The contaminated oil is collected in the contaminated oil box for treatment.

3.3.3.3 Auxiliary Boiler

One 20t/h oil-fired auxiliary boiler which is indoor arrangement can provide steam during the start-up of boiler. The steam temperature and steam pressure are 350°C and 1.27MPa respectively.

3.3.4 Thermal System

3.3.4.1 Main Steam, Reheat Steam and Turbine Bypass System

Main steam system will convey superheated steam from the super-heater outlet to the HP main steam valve.

Reheat steam system will convey cold-reheat steam from HP casing exhaust spout to inlet of boiler re-heater and convey hot-reheat steam to IP main steam valve.

The HP/LP bypass system has 40% capacity, it can convey main steam bypass HP-casing to cold-reheat piping and convey hot-reheat steam bypass IP to condenser when unit start-up.

Main steam, reheat steam and bypass system is unit system. Main steam flow through single pipe from outlet of boiler super heater header both sides, and is then divided into two branches and connects to left and right main HP steam valve separately.

Two cold reheat steam pipes are connected from turbine HP casing exhaust pipe, joined together at front of turbine and divided into two pipes again at front of boiler, then connect to inlet of boiler reheater header.

Two hot reheat steam pipes are connected at two ends of outlet header of boiler reheater and join one pipe at front of boiler, and divided into two pipes again at front of turbine, then connect with left and right IP steam valve.

Hydraulic test blankets which are used to isolate pipes during boiler super heater or reheater hydraulic test are located at steam pipe.





3.3.4.2 Turbine Extraction Steam System

There are eight stages of non-regulating extraction steam be used to heat regenerative system. The first and third extraction steam and exhausting steam from the HP cylinder heats three HP heaters separately. The forth extraction steam supplies steam to deaerator, BFP turbines and auxiliary steam header, the No. 5,6,7,8 extraction steams to four LP heaters separately.

The purpose of heating the feed water by extraction steam is following:

- 1) To improve thermal cycle efficiency.
- 2) To reduce the oxygen and non-condensed gas content in the boiler feed water.

In order to prevent the turbine over-speed and water ingress, a motor drive stop valve and a pneumatic check valve installed on each extraction steam pipe (except the forth extraction steam and the No.7,8 extraction steam). Because the forth extraction steam providing steam to deaerator, BFP. Turbines and auxiliary steam system, two pneumatic check valves shall be installed on common pipe, and one check valve shall be individual installed on each branch. LP heater no. 7, 8 will be located in the neck of condensers. The seventh and eighth extraction steam pipes are short, so motor drive stop valve and pneumatic check valve will not be installed. To prevent water ingress and over-speed, they will be designed to minimize drain water of the heater shell, and the flash plate shall be placed in the heater shell.

3.3.4.3 Feed-water System

Boiler feed water system shall supply feed-water to the boiler with required quality and flow under all operating conditions.

To improve the thermal cycle efficiency, feed-water is heated by the extraction steam through HP heaters.

The system shall be designed in unit type. There are two 50% capability turbine-driven feed water pumps in system, during normal operation, two turbine-driven feed water pumps work and motorized feed water pump is standby. The motorized feed water pump with 30% capacity is used for unit start-up and for standby. Three horizontal high pressure heaters shall be employed with a common bypass pipe, which enabling the heaters to be taken out of service without turbine shut down.

3.3.4.4 Condensate System

The condensate system shall remove condensate water from the hot well and deliver it to the deaerator. In order to improve the thermal cycle efficiency, to assure unit safe and reliable operating, condensate water is heated and deaerated. The condensate water is deaerated in deaerator. Beside these, the system can also provide spraying water to reducing temperature, make-up cooling water and other miscellaneous water.



The condensate water is pressurized by the condensate pump (Two vertical condensate water pumps with each of 100% capacity of max. condensate water flow are installed, In normal operating condition one operating and one standby), via condensate polishing device, and heated in four low-pressure heaters, gland steam condenser, deaerator. The low pressure heater no.5, 6, 7, 8 are horizontal heaters, the low pressure heater 7&8 are horizontal heaters which are located in the neck of condensers.

A suitable temporary strainer shall be provided at pump suction to prevent foreign matter being drawn into the pumps, particularly during the initial commissioning period and subsequently after any maintenance work involving the condenser steam space.

To assure minimum flow through the condensate pump to prevent cavitation and through gland steam condenser, the recirculation system is provided.

Deaerator will operating under the sliding pressure, and use 4th extraction steam to heat at normal operating condition and use auxiliary steam to heat during start-up and low load condition. The water level of deaerator storage tank will be controlled by the regulating valve on condensate pipe.

The condensate makeup water pump will supply makeup water to condensate system and boiler and etc. before unit start-up, and supply demineralised water to hot well of condenser under normal operating condition. Regulating valve supplied will be employed in condensate makeup water pipe for adjusting water level of hot well. A condensate makeup water tank will be set for condensate water system.

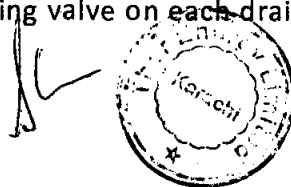
To increase the plant thermal efficiency, part of the condensate will be sent to boiler bottom ash cooler to recovery heat from the bottom ash. For bottom ash cooler, the condensate is extracted from the outlet of turbine gland steam condenser and is sent back to the inlet of NO.6 LP heater. It will be set two water transfer pumps to overcome the resistance of recovery system.

3.3.4.5 Heaters Drain and Vent System

Normal draining from three high pressure heaters is cascaded to the deaerator during high load. The emergency drain will be discharged into drainage flash vessels.

Normal drainage water of low pressure heaters will be directed step by step. Emergency drainage water from each low pressure heater will be discharged into the condenser.

Water flow is controlled by regulating valve on each draining pipe according to water level of each heater.





The overflowing piping of the deaerator storage tank will be directed and combined with discharge piping to condenser, and the other discharge piping of deaerator storage tank will be directed into drainage flash vessel during unit start-up.

Venting of high pressure heaters will be introduced into the deaerator. Venting of low pressure heaters will be introduced into the condenser separately. Venting of deaerator will be introduced into atmosphere.

The drainage water from gland steam condenser will be discharged to condenser through single stage water sealing device.

3.3.4.6 Condenser Vacuum System

Two water ringed vacuum pumps shall be employed to extract non-condensed gas from condenser to maintain required vacuum. One pump is working and the other is standby under normal operating condition. Two pumps are put into operation to set up vacuum quickly during unit start-up.

One electric vacuum-breaking valves will be set on the condenser shell to destroy the vacuum of the condenser when the turbine trips which can reduce the turbine idling time.

3.3.4.7 Closed Cycle Cooling Water System

Closed cycle cooling water system shall be designed. The auxiliary equipment shall be cooled by demineralized water; demineralized water shall be cooled by cooling water through closed cooling water heat exchanger. The quantity of cooling water supplied to the auxiliary equipment is almost 300t/h.

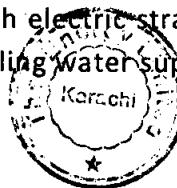
Two 100% capacity of closed cycle cooling water pumps shall be installed, in normal operating condition one operating and one standby. Two closed cooling water heat exchangers shall be installed.

One expansion water tank with 2 m³ capacity will located on high position, it shall assure system to be stabilizer pressure.

3.3.4.8 Circulating Water and Opened Cycle Cooling Water System

Circulating water is supplied for cooling condenser.

An opened cycle cooling water system in unit type will be adopted to supply cooling water to lube oil coolers, closed cooling water heat exchangers and etc. The cooling water source of the open cycle cooling water system is circulating water. Opened cycle cooling water shall be guided to equipment through electric strainer, and discharged to circulating water outlet pipe. The quantity of cooling water supplied to the auxiliary equipment is almost 1700t/h.





To keep the condenser working smoothly and cleaning the condenser tubes, sponge ball cleaning system shall be installed.

3.3.4.9 Turbine generator main auxiliary equipment for one unit

No.	Name	Type & Specification	Unit	Qty.
1	Condenser	~20700m ² , dual flow, single shell, surface condenser	set	1
2	Condensate pump	910m ³ /h, 270mH ₂ O	set	2
	Motor	1000kW, 6kV	set	2
3	Gland steam condenser	130 m ²	set	1
4	No.7 & No.8 LP heater	Heat exchanging area: 740m ² Heat exchanging area: 840m ²	set	1
5	No.6 LP heater	Heat exchanging area: 620m ²	set	1
6	No.5 LP heater	Heat exchanging area: 620m ²	set	1
7	No.3HP heater	Heat exchanging area: 1130m ²	set	1
8	No.2 HP heater	Heat exchanging area: 1350m ²	set	1
9	No.1 HP heater	Heat exchanging area: 1300m ²	set	1
10	Deaerator	Output: 1200t/h , Effective capacity : 150m ³	set	1
11	BFP. booster pump	665t/h, 100mH ₂ O	set	2
	Motor	250kW, 6 kV	set	2
12	Turbine driven feed water pump	665t/h, 2329mH ₂ O	set	2
	BFP. steam turbine	Double admission steam, Maximum output:6000kW	set	2
13	Motor driven BFP.	400t/h, 2329mH ₂ O	set	1
	Booster pump	400t/h, 100mH ₂ O	set	1
	Motor	3400kW, 6kV	set	1





	Hydraulic coupling		set	1
14	Vacuum pump	Extraction air flow:55kg/h	set	2
	Motor	160kW, 380V	set	2
15	Closed cycle cooling water pump	330t/h, 45 mH ₂ O	set	2
	Motor	75kW, 380V	set	2

Notes:

- 1)The quantity is for one unit.
- 2)The equipment specification is just information.

3.3.5 Main Block Arrangement

3.3.5.1 Turbine Hall

The span of turbine hall is 27 meter. Span from column A to centreline of turbine-generator is 12 meter. Column distance is 9 meter. Total length of turbine hall is 93 meter.

Turbine hall has three floors 0.00m, 6.30m and 12.60m. The arrangement of turbine-generator is longitudinal and turbine head towards fixed end of turbine hall. Deaerator bay has three floors as same level as turbine hall and has another two floors of 20m and 43m.

The distance between condenser and boiler's centreline is 4.5m.

One overhead-travelling cranes with the capacity of 75/20t shall be provided in the turbine hall to lift the parts of the turbo-generator, turbine driven feed water pumps and etc. during maintenance. Elevation of rail top of overhead crane is not lower than 25.5m.

Arrangement of major equipment is as following:

Turbine-driven feedwater pumps and BFP-turbine are symmetry located on 12.6m floor in turbine hall near the turbine.

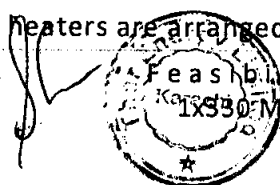
3.3.5.2 Deaerator and Coal Bunker Bay

Span of deaerator and bunker bay is 10m.

Motorized feedwater pump is located on ground floor.

Deaerator is arranged on 20.0m floor.

HP heaters are arranged on 12.6m and LP heaters are arranged on 6.3m floor.





The coal feeders shall be arranged at 20.0m level. The coal conveying belt level elevation is 43m. Four coal bunkers are set between the coal conveying belt level and 20.0m level.

The coal conveying belt shall be connected with the coal bunker bay from the fixed terminal.

3.3.5.3 Boiler front

There is a passage of 7m wide in the front of the boiler for examination and maintenance.

3.3.5.4 Boiler

The boiler will be outdoor type with steel structure. An elevator will be set for boiler, which is to lift and lower heavy plant components as well as persons.

The boiler length and width will be about 62.15m and 50.5m respectively.

There are two (2) sets of primary air fan, two(2) sets of secondary air fan, three(3) sets of high pressure air blower, ash and slag handling equipment arranged on the boiler ground floor. The drain water tank for periodic blown down flash vessel will be arranged to side of boiler.

3.3.5.5 Boiler Rear

There are two ESP with double chambers and five electrical fields, two sets of I.D fans and one stack.

3.3.5.6 Main Size of Main Block

No.	Item	Unit	Data
1	Turbine hall		
	Turbine hall column pitch	m	9
	Length of turbine block	m	93
	Span	m	27
	Elevation of operation floor	m	12.6
	Elevation of roof	m	34
2	Deaerator and coal bunker bay		
	Span	m	10
	Length of deaerator bay	m	93



	Elevation of deaerator	m	20
	Elevation of coal feeder	m	20
	Elevation of coal conveying belt	m	43
	Elevation of roof	m	49.7
3	Boiler		
	Width	m	50.5
	Depth	m	62.15
	Height	m	~60.8
4	Boiler rear		
	Boiler to center of stack(KF to stack)	m	83.3
5	From row "A" to the centerline of stack	m	189.45

3.3.6 Coal Handling System

The coal handling system will be designed and built for 1x330MW unit. The design scope include all necessary accessories from coal unloading trench to coal bunkers in boiler house, including coal unloading trench, coal storage yard, crushing device, belt conveying system, weighing scale, sampling equipment, control system and all the other necessary auxiliary devices inside the plant.

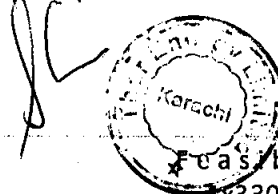
It is the SECMC's responsibility to transport the coal under CSA with the size less than 350mm to power plant coal unloading trench by trucks.

The dual-way belt conveyor will be equipped under the coal unloading trench and one rotary plow feeders will be set on each belt conveyor.

A open rectangle coal storage yard inside the plant will be provided with capacity of 30 days coal consumption for 1x330MW unit. The height of coal pile is 10m. The total capacity of the coal yard is 19.5x10⁴t.

One boom bucket-wheel stacker/reclaimer with rails will be installed in coal yard, shuttling arrangement. The capacity of stacker/reclaimer is 600/430t/h, slewing radius is 45m.

Two bulldozers and one wheel loader will be provided for coal yard auxiliary work.





Except the coal yard conveyor, all belt conveyors in power plant are dual ways. The capacity of conveyors is 430t/h(belt width: 800mm; belt speed: 2.5m/s), which is more than 150% of coal consumption for 1x330MW unit.

Two stages crushing system will be provided in the project. The first stage of crusher will be installed in the primary crusher house. The crusher will be toothed roller type which rating capacity is 500t/h. Coal will be crushed to a lump size of $\leq 30\text{mm}$ through the primary crusher. In secondary crusher house, two vibrating screens and two fine crushers will be installed. Coal with the size less than 30mm will be discharged to vibrating screen. The capacity of each vibrating screen will be 430t/h. Coal which granularity is more than 9mm will be separated and dropped to the fine crusher through the coal chute, and coal which granularity is less than 9mm will be sent to C-5AB belt conveyors directly. The fine crusher will be revisable hammer type fine crusher which rating capacity is 350t/h.

Plough trippers will be installed on conveyors in boiler bunker house to discharge coal to coal bunkers.

Sampling device for as-received coal which is used to monitor the coal characteristic will be installed in the plant.

The loaded truck weigher and empty truck weigher will be set in the plant. The loaded truck weigher will be set with the sampling device for as-received coal. The empty truck weigher with control room will be set near the doorway of the plant.

Belt scale and sampling system for coal as fired will be provided for certification of coal quantity and quality.

Magnetic separators are installed over the conveyors to prevent iron damaging the crushers and downstream equipment. Two stages iron removal system will be provided.

The coal handling system is controlled by Program logic controlling (PLC). PLC system will be adapted to remote and monitor the starting, stopping, operating etc. of equipment with the coal handling system. Vacuum dust suppression system will be provided for coal handling system. Refer to ANNEX-3 (AF2016022-M01 FLOW DIAGRAM OF COAL HANDLING SYSTEM) for more details.

3.3.7 Limestone Handling System

The limestone handling system will be designed and built for 1x330MW unit, the design scope include all necessary accessories from limestone shed to boiler furnace.

Limestone with the size less than 50mm will be delivered to limestone shed inside the plant by trucks.





One Limestone shed will be constructed. The valid capacity of dry limestone shed will be 14,000 tons, which could be used for 30 days for 1×330MW unit.

There are two sets of limestone handling systems in this project, one operating and one standby. The capacity of limestone handling system will be 35t/h which is maximum of 150% of limestone consumption for design coal of BMCR and 100% of limestone consumption for check coal of BMCR. Two lines belt conveyor which capacity is 75t/h (belt width: 500mm; belt speed: 1.25m/s) will be installed from vibrating feeders to milling system.

Limestone flows enter limestone milling house by belt conveyors. Limestone will be discharged into two limestone bins, limestone will be conveyed to the vertical roller miller by conveyor with scale. The rated capacity of miller is 35t/h, the qualified output granularity is less than 0.9mm. Milled limestone will be conveyed to the powder concentrator by bucket elevator and separated, the qualified limestone powder will be collected by the double cyclone separator and then conveyed to the limestone buffer hopper. The unqualified limestone will be conveyed through chute to the miller to be milled again.

In order to prevent blockage in limestone buffer hoppers, fluidizing plate will be set at the bottom of it, fluidizing blower sends air to the electric heater heating, fluidizing plate are mounted on the bottom of the hopper to ensure the limestone flowing freely. Two fluidizing blowers and two electric heaters will be set for limestone buffer hoppers.

Two stages positive pneumatic conveying system will be adopted for limestone feeding system. First stage is from limestone buffer hopper to limestone powder silo. Second stage conveying system is from limestone powder silo to splitters of boiler.

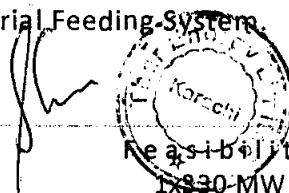
The boiler will be equipped with one limestone powder silo. The limestone powder silo can suit 24 hour limestone consumption of one boiler at BMCR.

In order to prevent blockage in the limestone powder silo, two sets of fluidizing blowers and one electric heater shall be equipped for the silo. Fluidizing blowers shall be one operating, one standby, and electric heater shall be continuous operating.

Refer to ANNEX-4 (AF2016022-C03 FLOW DIAGRAM OF LIMESTONE CONVEYING SYSTEM) and ANNEX-11 (AF2016022-M02 FLOW DIAGRAM OF LIMESTONE HANDLING SYSTEM) for complete details.

3.3.8 Ash Handling System

The ash handling system consists of three sub-system, i.e. Fly Ash Handling System, Bottom Ash Handling System and Bed Material Feeding System.





A dense phase positive pressure pneumatic conveying system will be adopted in fly ash handling system.

A mechanical conveying system will be adopted in bottom ash handling system.

A positive pressure pneumatic conveying system will be adopted in bed material feeding system.

3.3.8.1 Fly Ash Handling System

The fly ash system removes the ash that accumulates in the ESP and economizer using a pneumatic pressure conveying system. The capacity is approximately 150% of the expected as quantities under BMCR of design coal.

One vessel transmitter will be provided under each ESP and economizer hoppers. These vessels will be grouped to convey ash with a series or series-parallel connection by a mother ash conveying pipe.

In order to prevent blockage in hoppers of ESP, two fluidizing blowers and one electric heater will be equipped. Fluidizing blowers shall be one operating, one standby, and electric heater shall be continuous operating.

Six sets of air compressors and dryers shall be equipped in air compressor room to supply compressed air for the whole power plant, four operating, two standby. Capacity of compressors shall be $Q=69.2 \text{ Nm}^3/\text{min}$, $P=0.75\text{MPa}$.

Two concrete ash storage silos will be provided for storing the fly ash. They can store more than 72 hours fly ash production of 1 boiler based on BMCR operation (as per design coal).

Fly ash shall be discharged by dry ash unloaders into tank cars, or by dual-axle mixers into trucks, and then transported outside to landfill.

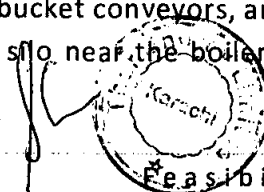
In order to prevent blockage in silos, three fluidizing blowers and two electric heaters shall be equipped. Fluidizing blowers shall be two operating, one standby, and electric heaters shall be continuous operating.

Refer to ANNEX-5 (AF2016022-C02 FLOW DIAGRAM OF FLY ASH HANDLING SYSTEM) for details.

3.3.8.2 Bottom Ash Handling System

There are four bottom ash coolers under the boiler furnace. The temperature of the outlet is not more than 150°C .

Bottom ash shall be directly sent to chain bucket conveyors, and then bucket elevators will transport bottom ash to bottom ash silo near the boiler area. The chain bucket





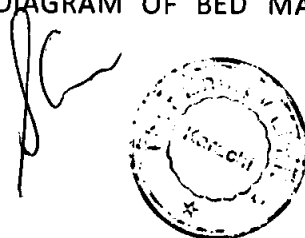
conveyor and bucket elevator will be set as two lines, and one operating one standby. The total capacity of mechanical system is based on 250% of the bottom ash quantity.

A steel cone bottom ash silo shall be set for the boiler. The valid volume can store more than 72 hours bottom ash production based on BMCR operation (as per design coal). Refer to ANNEX-6 (AF2016022-C01 FLOW DIAGRAM OF BOTTOM ASH CONVEYING SYSTEM) for details.

3.3.8.3 Bed Material Feeding System

One bed material bin shall be set for the boiler, which volume is 200 m³. The bed material is shipped by trucks to the plant, and then unload to underground hopper then lifted to the bed material bin by bucket elevator with capacity of 50t/h. One set of wheel loader with capacity of 3t shall be set for each material bin. There shall be two sets of vessel under each bed material bin, each vessel has one pipe, bed material shall be conveyed to the splitter of boiler, and then splitter divides three ways to the boiler chamber.

Refer to ANNEX-7 (AF2016022-C04 FLOW DIAGRAM OF BED MATERIAL FEEDING SYESTEM) for details.





3.4 ELECTRICAL

3.4.1 General

The electrical system in the power plant provides electrical service to safe and reliable operation for the power generation and distribution of the plant, it will includes the fellow sub-system and equipment:

- Generator and theirs outgoing system, including, IPB, PT& LA cubicle, bushing CT
- Step-up transformers (20/500kV), high voltage (20/6.3kV) unit auxiliary transformers(UAT)and HV (500/6.3kV) start-up/standby transformer
- 500kV switchyard including indoor 500kV GIS and 500kV PT & LA equipment
- Auxiliary electrical system including low voltage (6.3/0.4kV) auxiliary transformers, 6kV and 380/220V switchgear associated with relative control and protection system
- Emergency power system including diesel generator and relative electrical system
- Lighting system
- Cable and its raceway system
- Lightning and earthing system associated.
- DC and UPS system.
- Protections, Measuring and Synchronizing system
- Internal Communication system
- The delivery point at 500kV level is at the first outgoing transmission frame structure in fence of 500kV switchgear.

3.4.2 Principle Electrical Auxiliary Connection

The generator and its relative step-up transformer will be connected with isolated phase bus bar to form a unit and then be connected to 500kV HV switchgear in this power plant,

Breaker and half configuration will be adopted in 500kV switchgear of this project, it will include two complete 500kV 3/2 CB string equipment, which will be used for one generator-transformer incoming bay, one start-up/standby transformer incoming bay and two outgoing transmission line bay of this phase project.

For one unit, one high voltage (HV) unit auxiliary transformer (UAT)will be furnished, which LV winding will be connected to 6kV unit auxiliary bus to provide 6kV auxiliary power source of unit and common load of this project. The HV terminal of UAT will be branched to the IPB between generator and it's step-up transformer.

One HV startup-standby auxiliary transformer (SAT)will be furnished to provide 6kV auxiliary standby power source for this project, HV side power source of SAT will be obtained from 500kV switchgear of this project.





Two sets of 6kV unit Aux. bus will be furnished for one unit to supply power to 6kV motors (rated capacity above 200kW) and low voltage (LV) transformers of one unit, and other common load for this project. The HV unit auxiliary transformer will provide normal power source for auxiliary loads.

Some LV dry-type transformers will be installed, supplying power to LV auxiliary load in the power plant.

As an emergency AC power source, a set of diesel generator unit and 380/220V emergency bus for one unit will be installed for this project. It will ensure safe shutdown of unit when the power plant is tripped from the local power system. The emergency power (380V) including diesel generator unit and associated accessories, outlet circuit breaker, control panel, synchronizing device also installation etc.

3.4.3 Neutral Grounding Type of Each Voltage System

The generator neutral point will be grounded through single-phase grounding transformer with a resistance on secondary side of the grounding transformer.

The 500kV neutral point of step-up transformer will be grounded solidly.

The 6kV auxiliary power system will be grounded through resistance, while the LV 380 Aux. power system will be grounded solidly.

3.4.4 General Arrangement of Electrical Equipment

Based on the layout of the plant, electrical equipment will be arranged as follows:

Step-up transformers, UAT and startup/standby transformer will be arranged in front of turbine hall. The generator will be connected to its step-up transformer and HV unit auxiliary transformer through IPB and LV terminal of UAT and 500kV startup/standby transformer will be connected to 6kV auxiliary switchgear in main block through 6kV non-segregated bus.

500kV switchgear will be arranged in front of turbine hall, Overhead transmission line will be adopted to connect the HV terminal of step-transformer and startup/standby transformer to 500kV switchgear.

Indoor type 500kV GIS will be adopted for this project.

6kV auxiliary switchgear will be arranged in 6kV distribution room of turbine house, 380/220V switchgear of main block will be arranged in control building between two boiler, 380/220V switchgear of other auxiliary shop will be arranged in local 380/220V distribution room of shop which locate in center of auxiliary load.

Refer to ANNEX-8 (AF2016022-D01 ELECTRICAL SINGLE LINE DIAGRAM) for details.



3.4.5 Main Equipment and Conductor Selection

Parameters for main equipment

3.4.5.1 Generator

Rated capacity	330MW
Maximum continuous output power	match with turbine MCR
Rated power factor	0.8(lagging)
Rated voltage	20kV
Rated frequency	50Hz

3.4.5.2 Step-up transformer

Rated capacity	400MVA
Rated voltage and tap range	525±8×1.25%/20kV
Vector group	YN, d11
Impedance	Ud%=14
Cooling mode	ODAF

3.4.5.3 HV unit auxiliary transformer

Rated capacity	50/31.5-31.5MVA (preliminary capacity, match with demand of aux. load)
Rated voltage and tap range	20±2×2.5%/6.3-6.3kV
Vector group	D,yn1-yn1
Impedance	18%
Cooling mode	ONAF/ ONAN

3.4.5.4 HV startup-standby transformer

Rated capacity	50/31.5-31.5MVA (preliminary capacity, match with demand of aux. load)
Rated voltage and tap range	525±8×1.25%/6.3kV
Vector group	YN,Yn0-Yn0+d
Impedance	18%
Cooling mode	ONAF/ ONAN



3.4.6 Lightning Protection and Earthing System

Over-voltage Protection and Grounding System will provide equipment and personnel safe in the plant during ground fault and lightning strike.

3.4.6.1 Over-voltage Protection Against Invading Lightning Wave

A set of zinc-oxide surge arrester will be installed on the high-voltage side of step-up and startup-standby transformer

One zinc-oxide lightning arrester will be installed between step-up transformer and generator.

3.4.6.2 Protection Against lightning stroke

Lightning Rod will be installed on top of steam turbine hall A column and 500kV switchgear area to protect outdoor transformers and 500kV electrical equipment against direct lightning stroke.

Independent lightning rod will also be installed on H₂ generating station and oil tank area to protection against direct lightning stroke.

3.4.6.3 Grounding System

The earthing grid made of horizontal and vertical earthing device will be installed in the whole power plant. The earthing conductor will be copper based on the bidding document . The section area of the earthing conductor will be complied with the requirement of the technical specification of the power plant.

3.4.7 Lighting and Maintenance System

AC normal lighting, AC and DC emergency lighting system will be provided. AC normal lighting system in main block will be fed by LV lighting transformer and 380/220V lighting PC, while AC lighting in auxiliary workshop will be fed by the local 380/220V PC & MCC.

AC emergency lighting will be provided by 380/220V emergency lighting bus which will be fed by lighting PC in normal operation condition, when the normal lighting power source is in false, it will be switched to be fed by emergency MCC of unit.

DC emergency lighting system will be adopted in central control room and diesel generator room. Its power will be fed from 220V DC battery system.

In addition, at main entrance of building, exit lighting will be provided by lighting fixtures with self-contained battery and rechargeable control equipment.



3.4.8 Cable and Raceway System

6kV power cable will be copper conductor, cross-linked polyethylene insulated (XLPE) type.

1kV power cable will be copper conductor; polyvinyl chloride (PVC) insulated type.

Control cable will be copper conductor PVC insulated with type

Cable raceway in plant area and workshops will be mainly cable tray and cable trench. Cable will be layout through conduit from cable tray or trench to equipment.

3.4.9 A.C. Uninterrupted Power System (UPS)

A.C. uninterrupted power system will mainly supply power to I&C inspection and measurement of the unit, distributed control system (DCS), transducers, important electrical meters etc., so as to guarantee the normal operation of the unit and that even when the whole station power source is cut off, the inspection instruments, adjusting equipment and computers (DCS) will still operate regularly. Two set UPS will be provided for one unit.

UPS equipment will consist of rectifier, inverter, static change-over switch, by-pass switch, batteries, isolation transformer, voltage-adjusting transformer, transducer and electronic elements etc. The batteries of UPS shall be rated to supply the total load for a period of 30 minutes in the event of loss of normal supplies.

3.4.10 DC System

3.4.10.1 Batteries

Two banks of 220V battery will be designed to provide power source to DC oil pump control, protection, auto devices, CB closing devices, emergency illumination etc.

Furthermore, In order to ensure safety operation of HV electrical equipment in the switchyard, two banks of 220V battery also will be provided to power source for control and protection device.

All batteries will be of valve regulated lead-acid type and the capacity will be capable to supply power to DC load for 1 hour after loss of AC power.

3.4.10.2 Chargers

For Unit 220V DC system, one service charger will be provided for each bank of batteries. Totally two battery chargers will be supplied for one unit.

For switchyard 220V DC system, one service charger will be provided for each bank of batteries. Totally two battery chargers will be supplied for switchyard DC system, all



the battery chargers will be of high-frequency switch types. Standby charge module will be adopted in each battery charger.

3.4.10.3 Distribution Boards

The main distribution boards are consist of individual panels and will include: incoming feeder from battery charger, required number of outgoing feeders complete of miniature circuit breakers (MCBs), DC feeders from main distribution boards to each DC load.

The necessary protective and measuring devices will be provided for safe and reliable operation of the DC systems. The DC system will be an ungrounded system, equipped with earthing detection device.

3.4.11 Control and Protection system

3.4.11.1 Control system

The electrical control system will consist of unit electrical control system and network electrical control system (NCS).

1) The unit electrical control system will be monitored and controlled by DCS, the range including following electrical equipment:

Generator

Step-up transformer, HV unit transformer, HV start-up/standby transformer

Emergency DG

MV/LV switchgear

Generator and transformer protection (only monitor)

DC system (only monitor)

UPS system (only monitor)

DCS vendor will provide the control system and logic for electrical equipment, the signals of electrical equipment will be sent to DCS I/O interface by hardwire connection.

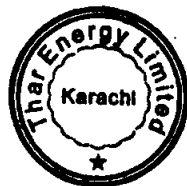
2) The HV equipment in switchgear will be monitored and controlled by electrical network control system (NCS). The control and monitor scope of NCS as follow:

HV incoming/outgoing lines

HV bus bars

HV circuit breakers

HV isolators





HV electrical protection (only monitor)

DC system (only monitor)

UPS system (if necessary, only monitor)

The NCS can provide data acquisition and disposal for digital, analog and pulse value, metering, display, alarm, print, recording the sequence of event, previous occurrence review and recording, control and operation on HV switchgear.

3) The ESP will be controlled by the microcomputer control system which will be supplied by ESP manufacturer.

4) The coal handling system will be controlled by the programmable logic controller (PLC) control system.

3.4.11.2 Automatic device

For the Power Plant economic operating and equipment's safety, the following automatic devices will be furnished:

1) The microprocessor based synchronization device will be furnished for the Generator's synchronization with the system.

2) Power changeover device will be used for the 6kV switchgear's power changeover safe, quickly and smoothly.

3) The fault recorder device will be supplied to record fault current, voltage and trip signal for Generator & transformer group and switchyard.

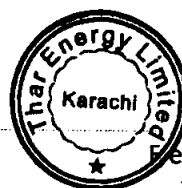
4) A set of supervisory control and data acquisition (SCADA) system will be provided in the 500kV switchyard, and it will be as a sub function integrated in NCS.

3.4.11.3 Protection system

Two (2) sets of independent micro-processor based protection systems will be provided for generator, step-up transformer, HV unit auxiliary transformer, HV standby transformer, HV switchgear etc. The protection systems will include the follows:

Protection for generator –step-up transformer group:

- Generator differential
- symmetric overload
- asymmetric overload
- Overcurrent with under voltage maintained
- Generator reverse power
- Generator overvoltage
- Stator turn-turn short circuit
- 100% stator earth fault





- Field failure protection
- Pole slipping protection
- Voltage unbalance
- Frequency abnormal
- Instantaneous overcurrent for excitation transformer
- Overcurrent for excitation transformer
- Excitation overload
- Step-up transformer differential
- Step-up transformer zero-sequence over current
- Step-up transformer over flux protection
- Buchholz
- Temperature protection
- Cooler fault

2) Protection for HV start-up/standby transformer

- Differential protection
- Over current protection
- Buchholz protection
- Temperature protection

3) Protection for HV switchgear

- line protection for each transmission line
- bus bar protection
- bus couple protection
- Circuit breaker protection
- Line breaker's auto-reclosing (if necessary)

The protection of MV switchgear is furnished in each circuit.

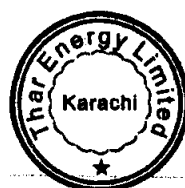
For air circuit breaker and feeder circuits of LV switchgear, the protection shall be provided by breaker itself. For motor feeder, the motor controller provides the motor protection, and the circuit breaker provides the short circuit protection.

3.4.12 Electrical Measuring and metering

The electrical measuring will be provided for Generator, step-up transformer, HV auxiliary transformer, HV standby transformer etc., the measuring parameter will be as follow:

Generator Current

Generator Voltage





Generator active power

Generator reactive power

Generator frequency

Generator power factor

Step-up transformer output current

Step-up transformer output active power

Step-up transformer output reactive power

HV auxiliary transformer current

HV auxiliary transformer active power

HV auxiliary transformer reactive power

And the some energy meters also will be adopted for energy metering, the accuracy will be active 0.5 and reactive 2.0 at least, the metering parameter includes as follow

Generator import / export active energy (MWh)

Generator import / export reactive energy (MVARh)

Step-up transformer import / export active energy (MWh)

Step-up transformer import / export reactive energy (MVARh)

HV Auxiliary transformer import active energy (MWh)

HV Auxiliary transformer import reactive energy (MVARh)

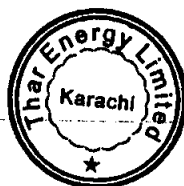
HV standby transformer import active energy (MWh)

HV standby transformer import reactive energy (MVARh)

Furthermore, the tariff metering will be provided for each 500kV transmission line and 500kV side of HV transformer. The accuracy of tariff metering will be active 0.2s and reactive 2.0.

3.4.13 Fire Alarm and Control System

A set of fire detection and alarm system will be equipped for the power plant. The system will be composed of alarm control panel, temperature/smoke detector, manual alarm pushbutton and so on.





3.4.14 Excitation System

The excitation will be provided by a static shunt excitation system consisting of excitation transformer, thyristor rectifier device, automatic voltage regulator device (AVR), field breaker device, over-voltage protection device, excitation-starting device etc. The AVR will be digital type and have dual automatic channels with a follow-up control to ensure a smooth change-over from one to another. AUTO/MANUAL control mode will be provided. The supplementary functions including over-excitation limit, under-excitation limit, PSS etc. will be provided in AVR as well.

3.5 Control and Instrumentation

3.5.1 Scope:

This document specifies the Instrumentation and Control (I&C) requirements for the Project. The I&C system shall comprise of the Distributed Control System (DCS), Sectional Controls for BOP, Coal Handling system, Field Instrumentation, etc and all Integrations at the Control System levels.

3.5.2 General Requirements

All materials, equipment and services so as to make a totally integrated Instrumentation and Control System together with all accessories shall be provided inclusive of auxiliaries and associated equipment ensuring operability, maintainability and reliability. The Instrumentation and Control System shall be consistent with modern power plant practices and shall be in compliance with all applicable codes, standards, guides, statutory regulations and safety requirements as required.

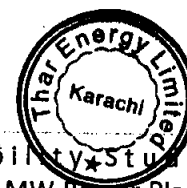
For the selected C&I equipment, system, instruments shall have completed five years of trouble free and satisfactory operation on a coal fired power station having unit size of 300MW or more.

Overall configuration of the control system is provided in ANNEX-10 (AF2016022-K01 CONTROL SYSTEM CONFIGURATION OF POWER PLANT)

3.5.2.1 Instrument Engineering Standards

The Following Engineering shall be applicable to this Project.

- American National Standards Institute (ANSI)
- American Petroleum Institute (API)
- American Society for Testing and Materials (ASTM)
- British Standards
- International Electro technical Commission (IEC)
- Institute of Electrical and Electronic Engineers (IEEE)





- Instrumentation Systems and Automation Society (ISA)
- International Organization for Standardization (ISO)
- National Association of Corrosion Engineers (NACE)
- National Electrical Manufacturers Association (NEMA)
- National Electric Code (NEC)
- National Fire Protection Association (NFPA)

3.5.2.2 General Design Considerations

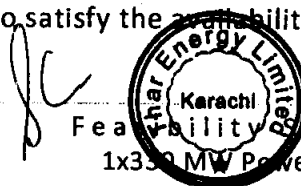
Instrument Protection: The dust-in-air concentration for the local environment is usually 1 mg/m³ normal. During sandstorms, concentrations in the order of 100 to 500 mg/m³ or higher may be encountered. Particle size distribution is 95% below 20 micrometer (0.8 mils) and 50% below 1.5 micrometer (0.06 mils). This dust contains sand and compounds (salts of aluminium, calcium, magnesium, and sodium which in the presence of water can conduct electricity and corrode metals. This dust is found everywhere; therefore, all instruments shall therefore be adequately protected.

Instrument Signal Transmission Standards: Instruments signal transmission shall be electronic type for all indicating, recording and controlling instruments mounted in the control room. Transmission and control signal range shall be as follows:

- 4-20 mA output current loop signal powered by 24 VDC
- 0.2 - 1.0 kg/cm²G for Pneumatic Instruments
- 24 VDC for motor start/stop control outputs.
- 110 VDC for solenoid valves
- mV for thermocouple signals, with in-situ mv to 4-20 mA convertors,
- HART protocol superimposed on all Transmitters.
- Serial Communications shall be MODBUS.

3.5.3 Reliability and Availability

- Each component and system selected shall be of established reliability. The minimum target reliability of each piece of equipment like each electronic module/card, power supply, peripheral etc. shall be established considering its failure rate/mean time between failures (MTBF), meantime to repair (MTTR), such that the availability of the complete C&I system is assured for 99.7%.
- Reliability calculations shall be available for each system/equipment which (with the help of a schematic of various sub-system connected in series or in parallel as the case may be and MTBF & MTTR values for the various equipments) shall show that availability calculation is as per IEEE Standard-P1046 or equivalent.
- To ensure availability, adequate redundancy in system design shall be provided at hardware, software and sensor level to satisfy the availability criteria.





3.5.3.1 Standardization and Uniformity of Hardware

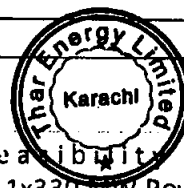
- In line with Company's Engineering Standardization Objective specified in Section on Codes and Standards to ensure smooth and optimal maintenance, easy interchangeability and efficient spare parts management of various C&I instruments/equipment.

3.5.3.2 Operability & Maintainability

- Design of the I&C systems and related equipments shall 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 shall not cause a hazardous condition. However, it shall also be ensured that occurrence of false trips are avoided / minimized.
- The choice of hardware shall also take into account sound maintainability principles and techniques.
- The assurance against obsolescence shall be provided for sub-equipment level e.g. DCS Cards, UPS Cards, etc

3.5.3.3 Terminology and Abbreviations

C&I	Control and Instrumentation
DCS	Distributed Control System
CCR	Central Control Room
LCR	Local Control Room
BOP	Balance of Plant
OIS	Operator Interface Station
EWS	Engineering Workstation
CER	Control Equipment Room
UCD	Unit Control Desk
CCD	Critical Control Desk
TG	Turbine Generator
LAN	Local Area Network
LVS	Large Video Screens
SOE	Sequence of Events Recording System
HMI	Human-Machine interface
MCS	Master Clock System
I/O	Input Output
MCC	Motor Control Center
MMIPIS	Man-Machine Interface and Plant Information System
TSC	Turbine Supervisory Control System
PB	Push-Button Stations
PIS	Plant Information System
MTTR	Mean Time To Repair
MTBF	Mean Time Between Failures





3.5.3.4 C & I Systems Philosophies

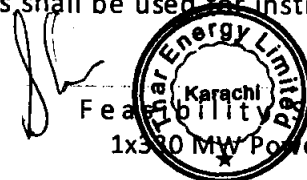
C & I Philosophies as mentioned herein shall be developed. Few important are mentioned briefly while the remaining shall be developed during Engineering Phase

3.5.3.4.1 Control & Monitoring Philosophy:

- **General:** The control & monitoring philosophy for the plant envisages control from two locations: a) From Central Control Room (CCR) and b) Through Local Control Rooms for BOP, Auxiliary Plants, Coal Handling Systems etc.
- **Control & Monitoring from Control Room:** The main plant equipment (namely steam generator & auxiliaries, TG & auxiliaries, regenerative cycle equipment, equipment cooling water system etc.) for this project is envisaged to be controlled from the OIS, mounted on the UCD, in the CCR, under all regimes of operation i.e. start-up, shutdown, load throw off and emergency handling. In addition, adequate large video-screens of minimum size of 200-210 cm (80"-84") per unit shall be provided.
- Operation of generator, generator auxiliary systems and breakers for unit and station switchgears associated with the main plant shall also be performed through OIS.
- The control, monitoring & operation of the auxiliary plants (i.e. ESP system, centralized oil purification system for TG, condensate polishing system etc.) shall be carried out from local control panel/operator workstation of the respective plants.
- The control, monitoring and operation of the off-site plants (i.e. coal handling plant, ash handling plant, fuel oil plant, D.M. plant etc.) will be carried out from the local control panel/operator work station.
- All hardware and software for establishing a link for collection of data in the DCS in CCR, shift charge engineer etc. shall be provided through a Plantwide LAN.

3.5.3.4.2 Instrument Power System Philosophy

- **Electric Power Supply:** Components of power supply system shall be of highest available quality for reliability and long service life.
- Power supplies for all transmitters, controllers, signal converters, electric system and components in shutdown system shall be supplied from uninterruptible power supplies.
- Power distribution to each consumer shall be through proper, independent switch and fuse. Protective fuses shall be of indicating cartridge type mounted in fuse holders.
- In general, the following Power Supplies shall be used for instrumentation and Control:





- For Process Platforms: 220V AC + 10%, 50HZ + 2% (UPS) for all instruments control will be considered. However, all components / instruments / system shall be suitable for 220 V + 10% AC, 50 Hz + 3%. Tolerances will however be finalized in design phase to create synergy in Thar Block-II
- Pneumatic Supply: For pneumatic instruments, dry instrument gas / air supply shall be as follows: 5.5 Kg/cm² (min.), 7.5 Kg/cm² (nor.), 10.5 Kg/cm² (max.)

3.5.3.4.3 Instrument Earthing System Philosophy

- Three separate earthing systems shall be provided:
- Electrical Safety Earth – Bonded to the site structure and utilized for electrical safety of metal enclosures and chassis on all instruments and electrical components.
- Instrument Clean Earth – Insulated from the site structure and other metal work, utilized for instrument cable screens and bonded to the main electrical earthing system at a single point.
- Intrinsically Safe Earth – Insulated from the site structure and other metal work, utilized for termination of IS zener barrier earth connections, and bonded to the main electrical earthing system at a single point.

3.5.3.4.4 C&I Equipment Protection Philosophy

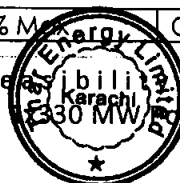
Environmental Protection

- All instruments / equipment and installation material shall be suitable for the overall climatic conditions, the position within the installation and the local environment, with particular attention to site ambient conditions. The conditions will include exposure to Sunlight, monsoon rainfall, tropical temperature, humidity, wind, fungal growth, vibration and shock, EMI and RFI.
- All field instruments shall be provided with necessary weathering and anticorrosion protection.

Instruments and Enclosures Environmental Protection

Instruments, devices and equipment for location in outdoors/indoor/air- conditioned areas shall be designed to suit the environmental conditions indicated below

Ambient Temperature*1	Pressure	RH %*2	Atmosphere	IP Class *3
Outdoor Locations				
55 Deg C max	Atmosphere	100 % Max	Air (dirty)	IP 55 *4*7*8
4 Deg C min	Atmosphere	5 % Min	Air (dirty)	IP 55 *4*7*8
Indoor Location				
55 Deg C max	Atmosphere	100 % Max	Air (dirty)	IP 55*5*7*8
4 Deg C min	Atmosphere	5 % Min	Air (dirty)	IP 55*5*7*8
Air Conditioned Areas				
24 +/- 5 Deg C normal	1.5 In WG	95 % Max	Clean Air	IP 22



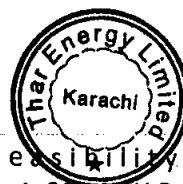


50 deg C max. *6	Atmosphere	5 % Min	Clean Air	IP 22
Notes:				
*1 As per Standard Definition of Ambient Temperature				
*2 Relative Humidity in percent				
*3 Required Ingress Protection Class of Instruments/JBs/Panels/Cabinets/Controls Desks.				
*4 With a canopy to provide sun shade and prevent ingress of dripping water				
*4 Fungus Protection shall be applied				
*4 Corrosion Protection for Environment is required as per specified Corrosion Classification.				
*5 Corrosion Protection for Environment is required as per specified Corrosion Classification, in addition to fungus Protection				
* 6 To cater for HVAC Failure Scenario				
*7 The required IP Classes are minimum.				
*8 The Explosion Protection shall be treated independently than IP Protection, and is included in the relevant section				

- **Tropicalization:** All electrical components shall be tropicalized to protect against humidity, moisture and fungal growth by means of hermetically sealed units, protective coating on circuit boards, gold plated edge connectors, etc.
- **Hermetic Sealing:** All relays and switches shall be hermetically sealed, and those utilized in 24 V DC control logic circuits shall have gold plated contacts rated 0.5 Amp at 24 V DC. Those interfacing with field equipment shall be rated 2 Amp 24 V DC.
- **Hazardous Area Instrumentation:** Hazardous areas shall be classified in accordance with API 500 and specify various equipments. All instruments which are mounted outside of normally pressurized control / equipment rooms shall be certified by bodies such as FM / UL / BASEEFA / CSA / DGMS / CMRS for use in Class I, Division I, Group D, T3 hazardous area.
- **R F Interference:** All equipment shall remain unaffected by radio transmissions (Levels of permissible RFI shall be as per IEC 801). Band-pass and / or band stop filters shall be fitted, as necessary.
- **Sealing**
 - Seal systems shall be used to isolate instrument from the process fluid encountered wherever Condensing wet services, Vaporizing Process Fluids, viscous fluids etc
 - Sealing may be accomplished with diaphragm seals.

3.5.3.4.5 Instrument Material Selection Philosophy

- All materials and equipment furnished shall be new and unused, of current manufacture and the highest grade and quality available for the required service, and free of defects. Materials shall be selected with regard to the following criteria:





- Suitability for the specified process conditions, with SS 316 as the minimum for use outside pressurized rooms, except for salt-water service, in which case, it shall be Monel.
- Suitability for the corrosive effects of the atmosphere.
- Galvanic compatibility between dissimilar materials, with isolating bushes, plates, used where necessary to prevent corrosion due to galvanic action.
- Material for all junction boxes, and instrument electronics and termination housings shall be SS 316.
- Stand pipes, supports for instruments and any other item directly welded to the structure shall be CS galvanized.

3.5.3.4.6 Instrument Installation Philosophy

- All work shall be of the highest quality craftsmanship and shall conform to the best applicable engineering practices, and, relevant codes referred in the bid document.
- All instruments shall be installed in a neat workmanlike manner ensuring ease of operation and maintenance.
- Hook-up and installation detail drawings regarding each type of instrument shall be prepared, and the installation shall be carried out in accordance with these approved drawings.

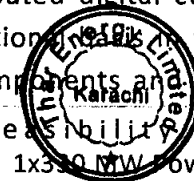
3.5.3.4.7 Instrument Inspection & Testing Philosophy

- The Quality Plan shall include a comprehensive fully documented inspection and testing plan specific to the project shall be prepared.
- All testing, calibration and pre-commissioning shall be done as well as done.
- Suitable workshop facilities shall be available during construction, complete with necessary test and calibration instruments and equipment.
- In general, the pipes and tubes shall be cleaned before testing. They shall then be subject to hydrotest (or other applicable tests) and then blow dried.
- Upstream of all filter/regulators before testing, the piping and tubing shall be hydrotested

3.5.4 Distributed Digital Control (DCS)

A Microprocessor based Distributed Control, monitoring & information system (DCS) shall be provided for the safe and efficient operation of Boiler, Turbine, Balance of Plant, Generator /Transformer and auxiliary power supply.

General Requirements: The requirements for distributed digital control monitoring and information system (DCS) are indicated on function blocks in this specification. The engineering, selection and connection of all components and sub-systems shall





form a complete system whose performance is in accordance with functional, hardware, parametric and other requirements of this specifications. It is not the intent or purpose of this specification to specify all individual system components since the EPC Contractor shall have responsibility for engineering and furnishing of a complete system.

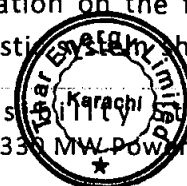
DCS shall basically consist of :

- Control system of boiler, turbine & balance of plant (namely SG - C&I, TG - C&I & BOP - C&I including their respective measurement system);
- Man-Machine interface and plant Information system (MMIPIS);
- System programming & documentation facility;
- Data communication system (DCS);
- Sequence of events (SOE) recording system;
- Annunciation system;
- Master & slave clock system.
- System Expandability

Modular system design shall be adopted to facilitate easy system expansion. The system shall have the capability and facility for expansion through the addition of controller modules, process I/O cards, drive control modules, hand/auto stations, push button stations, peripherals like LVS/Keyboards, printers etc. while the existing system is fully operational. The system shall have the capability to add any new control loops groups/subgroups, in control system while the existing system is fully operational.

On Line Maintenance: It shall be possible to remove/replace online various modules (like I/O module) from its slot for maintenance purpose without switching off power supply to the corresponding rack. System design shall ensure that while doing so, undefined signaling and releases do not occur and controller operation in any way is not affected (including controller trip to manual, etc) except that information related to removed module is not available to controller. Further, it shall also be possible to remove/replace any of the redundant controller module without switching off the power to the corresponding rack and this will not result in system disturbance or loss of any controller functions for main controller. The on-line removal/insertion of controller, I/O modules etc. shall in no way jeopardize safety of plant and personnel.

Fault Diagnostics: The DCS shall include on-line self-surveillance, monitoring and diagnostic facility so that a failure/malfunction can be diagnosed automatically down to the level of individual module giving the details of the fault on the programmer station LVS displays and printers. The faults to be reported shall include fault in main and standby power supplies, sensor fault, any channel fault in 2V3 channels etc. These faults shall be indicated on LVSs as well as local indication on the faulty channel/module and on corresponding rack/ cubicle. The diagnostic system shall ensure that





the faults are detected before any significant change in any controller output has taken place. Failure of any I/O modules, controller etc. shall be suitably grouped and annunciated to annunciation facia and to OIS.

Fault Tolerance: The DCS shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is jeopardized. Control system shall be designed to prevent abnormal swings due to loss of control system power supply, failure of any control system component, open circuits/short circuits, instrument air supply failure etc. On any of these failures, the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering.

Signal Exchange: All the signal exchange between various functional groups of each control group (i.e. within SG - C&I, TG - C&I and BOP - C&I) shall be implemented through redundant main system bus (the main bus connecting various sub- systems) and local system bus within a sub-system as per the standard practice. It shall be ensured that any single failure in electronics involved for such communication, e.g., communication controllers, bus interface modules, physical communication media, etc. does not result in loss of such signal exchange and there in no deterioration in specified system response and system parametric requirements..

No single failure either of equipment or power source shall be capable of rendering any part/system/sub-system of DCS in-operative to any degree.

3.5.4.1.1 System Spare Capacity:

Over and above the equipment and accessories required to meet the fully implemented system as per specification requirements, DCS shall have spare capacity and necessary hardware/ equipment/ accessories to meet following requirement for future expansion at site: 10% spare channels in each of the functional groups, fully wired upto marshalling cabinets.

Wired-in "usable" space for 20% modules in each of the system cabinets for mounting electronic modules wired up to corresponding spare terminals in marshaling cabinets such that implementation of any additional control loop/logic can be achieved only by insertion of necessary electronic modules(s) in system cabinets, configuration of corresponding controller and connection of inputs/ outputs at 'field end' of marshaling cabinet / logic cabinet as applicable.

MMIPIS shall be provided with capacity to handle 25% or at least 1 no. of each type of peripherals additionally, like LVSSs, keyboards, printers, PCs etc., over and above already specified, without any additional hardware or software.





Each controller shall have 30% spare functional capacity to implement additional function blocks, over and above implemented logics/ loops. Further, each controller shall have spare capacity to handle minimum 20% additional inputs/ outputs of each type (including (a) & (b) above), over and above implemented capacity. Each of the corresponding communication controller shall also have same spare capacity as that of controller.

The data communication system (including main system bus and other bus system) shall have the capacity to handle the additions mentioned in clauses above. This will be in addition to 50% spare capacity specified under this clause.

Twenty (20) percent spare relays of each type and rating, mounted and wired in relays cabinets. All contacts of relays shall be terminated in terminal blocks of relay cabinets. In each of the relay cabinets 20% spare terminal blocks shall be provided so that additional relays can be mounted and wired.

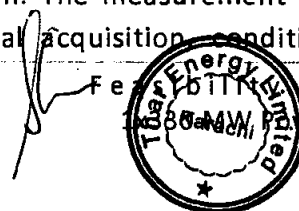
The spare capacity as specified above shall be uniformly distributed throughout all cubicles. The system design shall ensure that above mentioned additions shall not require any additional controller/ processor/ peripheral drivers in the system delivered at site. Further, these additions shall not deteriorate the system response time/ duty cycle, etc. from those stipulated under this specification.

3.5.4.1.2 Remote Input Modules and Cubicles

- It is envisaged to use remote input modules and racks / cubicles at the following locations in the plant to the extended I/O bus, to minimize cabling. The exact areas where remote I/O modules to be provided shall be decided during detailed engineering. However some of the areas where such remote I/O can be provided are listed below:
- Boiler area (for metal temperature etc.)
- Generator area (for generator body temperature).
- Etc.

System Description: The DCS shall work in full integration and conjunction with field equipment/drives like pumps, motors, valves, actuators, dampers, hydraulic control systems (e.g. for HP&LP bypass etc.) and field instruments to be provided. The DCS hardware (controllers, modules/cards etc.) shall be housed in cabinets located in control equipment room (CER) except for operation interfaces located in unit control desk (UCD) and unit control panel (UCP), if applicable, in unit control room (CCR).

Control System: The control system along with its measurement system shall perform functions of closed loop control, sequence control, interlock & protection of SG, TG and auxiliaries under all regimes of unit operation. The measurement system of control system shall perform the functions of signal acquisition, conditioning and signal





distribution of various types of inputs/outputs like analog, (4-20 mA DC, thermocouple, RTD), binary, pulse, etc. The inputs which are required for only information and monitoring purposes shall be distributed suitably in various groups of the measurement system.

3.5.5 Man-Machine Interface and Plant Information System (MMIPIS)

The MMIPIS shall perform control, monitoring and operation of SG, TG and auxiliaries under all regimes of unit operation, interacting with the control system. For this, MMIPIS shall primarily perform following functions:

- Operator interface for control system
- Plant supervisory functions like displays, alarm monitoring & reporting, (reports & logs, calculations, trend recording, historical and long term data storage & retrieval, etc.)
- System Programming & Documentation Facility
- The programmer stations shall be provided for
- on-line configuration & tuning of control system
- on-line program development/modifications in MMIPIS
- In addition, latest state of the art work-station based system documentation facility shall be provided to retrieve, generate & document all system documentation, logics, control loops, cable interconnection, etc. to achieve paperless documentation for the complete plant.
- Data Communication System (DCS): The data communication system shall be provided for communication between control system and MMIPIS communication and signal exchange between various functional groups as well as communication between various units & off site / off line systems.

3.5.5.1 Sequence of Events Recording System (SOE)

The DCS shall be capable of carrying out sequence of event recording function to scan and record events in the sequence of occurrence within a resolution of 1 milli sec.

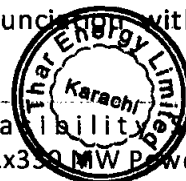
3.5.5.2 Master and Slave Clock System

Master and Slave Clock System shall be provided to ensure uniform time indication throughout the various plant facilities and time synchronization between control system, MMIPIS, switchyard disturbance recorder, other PLC's etc.

3.5.5.3 Annunciation System

Annunciation system based on ISA 18.1 and 18.2 shall be LVS based in the CCR and LCRs. The annunciation logic will be implemented as a part of DCS.

Top portion of all the LVS shall be reserved for annunciation with 3/4 bands for different priority.





3.5.5.4 Measurement Functions of Control System

All the signals coming into/going out of the control system shall be connected either directly or routed through marshalling cabinets as per the interconnection philosophy of DCS. The input / output modules employed in the control system shall be separate from controller hardware. .

3.5.5.5 Analog signal conditioning & processing

The conditioning and processing functions shall be performed as a minimum for the analog inputs coming for control and information purposes. are :

3.5.5.6 Binary signal conditioning & processing

The changeover type contacts (i.e. 'NC' + 'NO' together) shall be wired to the control system for all the binary inputs required for control purposes, except for inputs from MCC/switchgear, actuators and inputs related to hardwired signal exchange among various functional group for which non-changeover type contacts ('NC' or 'NO') shall be wired to the control system. The binary inputs required for information purposes only shall be wired to control system in the form of non-changeover type contacts.

3.5.5.7 Control System Requirements

The control system shall be broadly divided into SG - C&I, TG - C&I and BOP - C&I.

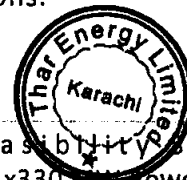
The SG- C&I part of DCS system shall perform the following function as minimum but not limited to:

- Burner management system (BMS) including control & protection of coal mills, fuel oil system etc.
- Analog control functions pertaining to secondary air damper control etc.
- Soot blower control.

The TG- C&I part of DCS system shall perform the following functions:

- Turbine protection system function (TPS)
- Turbine governing system for main turbine
- Turbine stress control system (TSCS)
- Automatic turbine testing (ATT)
- Automatic turbine run up system. (ATRS)
- HP&LP bypass control system
- Turbine generator control system
- EHG, interlock & protection for turbine driven BFP

The BOP- C&I system shall perform the following functions:





- Analog control functions, other than those covered in SG-C&I and TG-C&I, like co-ordinated master control, furnace draft control, SH/RH steam temperature control, FW flow control, heaters/deaerator/condenser level control, Auxiliary PRDS pressure & temperature control etc.
- Binary control functions pertaining to main plant auxiliaries like FD/ID/PA fans, APH, BFP etc., Generator auxiliary systems and electrical breakers etc.
- Functional grouping of various controllers shall be decided during detailed engineering.

Process redundancies shall be maintained. For example, in case the mechanical equipment has been provided with redundancy, the drive shall not be controlled by a common controller i.e. for redundant set of process equipments(eg.2x60%ID fans,3x60% CEP etc.),it shall be ensured that there is no sharing of controller components between independent groups.

Facility shall also be provided for manual switchover from main to 100% hot back-up controller and vice versa from the programmer's console.

The control system hardware design shall be such that it is able to withstand power line disturbances as per relevant standard.

3.5.5.8 Burner Management System (BMS)

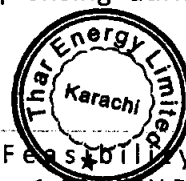
Fully proven microprocessor based system, based on hardware and software proven for burner management application shall be provided to achieve the boiler protection e.g. master fuel trip (MFT), control of mills & fuel oil systems etc.

The BMS shall be provided with automatic self monitoring facility. All modules to be used in this system shall be of fail safe design. Any single fault in any primary sensor, I/O modules, multifunction controllers, etc. should not result in loss of safety function. All faults should be annunciated to the operator, right at the time of its occurrence and also for alarm annunciation facia.

The BMS shall meet all applicable relevant safety requirements including those stipulated in latest editions of NFPA 8502/ 8503.

The BMS shall be designed to :

- Prevent any fuel firing unless a satisfactory purge sequence has first been completed.
- Prevent start-up of individual fuel firing equipment unless permissive interlocks have first been satisfied.
- Monitor and control proper equipment sequencing during its start-up and shutdown.





- Provide equipment status feedback and annunciator indication to the unit operator.
- Provide flame monitoring when fuel-firing equipment is in service and effect a burner trip or master fuel trip upon warranted firing conditions.
- Continually monitor boiler conditions and actuate a master fuel trip (MFT) during adverse operating conditions which could be hazardous to equipment and personnel.
- Reliably operate and minimize the number of false trips.

3.5.5.9 Turbine Protection System (TPS) Functions

Turbine Protection System shall be with high reliability, redundancy and availability. Fully proven microprocessor based system, based on hardware and software proven for turbine protection application for the same turbine shall be utilized for this project, shall be provided to achieve the turbine protection action.

Most signals of Turbine Protection System shall use 2 out of 3 voting logic. Design of Turbine Protection System shall follow OEM standards and shall be decided at later design stage.

3.5.5.10 Binary Controls/Open Loop Control System (OLCS) Function

The OLCS shall include sequence control, interlock & protection for various plant auxiliaries, valves, dampers, drives etc. The sequence control shall provide safe and automatic startup and shutdown of plant and of plant items associated with a plant group. The interlock and protection system shall ensure safe operation of plant/plant items at all times and shall automatically shut down plant/plant items when unsafe conditions arise.

3.5.5.11 Analog Controls/Closed Loop Control System (CLCS) Functions

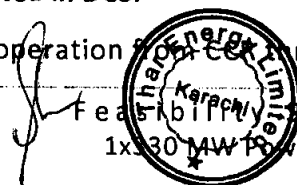
The CLCS shall continuously act on valves, dampers or other mechanical devices such as hydraulic couplings etc., which alter the plant operation conditions. The system shall be designed to give stable control action in steady state condition and for load changes in step/ramp over the load range of 60% to 100% MCR with variation or parameters within permissible limits to be finalized during detailed engineering state. The system shall have the following minimum features:

3.5.5.12 Turbine Control System (TCS)

The Turbine control system shall consist of turbine governing system, turbine stress control system and BFP turbine Electro-hydraulic governing system HP&LP bypass system & automatic turbine testing (ATT) system.

3.5.5.13 Electrical Functionalities to be incorporated in DCS:

It should be possible to carry out all switching operation from C&T through DCS





Data should be available to DCS from all the protection relays and circuit breaker status in order to generate SOE

The SOE resolution and sampling shall adequately permit fault diagnosis of the Electrical Fault occurrences, without any a) Data loss, b) Overlapping of events. C) Missing events, etc.

3.5.5.14 Plant LAN

The servers/ethernet LAN of the each unit shall be connected to a station wide ethernet Wide Area Network (LAN). Connections for PCs at various plant locations and PLC/PC based systems shall be connected to this station wide ethernet LAN through TCP/IP protocol. The station head/O&M head & shift in-charge stations shall be located in this LAN to monitor data of all units as well as of the common plant location and off-site plants.

A server shall be provided for this station wide LAN. All networking functions of LAN, calculation including merit order calculation shall be performed in this server.

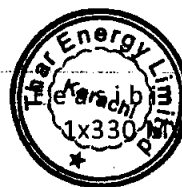
3.5.5.15 SOE Function

The system shall monitor SOE inputs with a resolution of 0.25 millisecond at all times for all SOE inputs including spare inputs. That is, all SOE points entering status change shall be reported and time tagged within 0.25 millisecond of their occurrence. Input card shall be equipped with digital filters with filter delay of minimum 4ms (identical for all points) to eliminate contact bounce such that field contact which is changing state must remain in the new state for successive 4 ms to be reported as one event. The start of data collection for SOE report shall be reported to OIS within 0.25 of SOE data collection initiation. The system shall also have provision of rejection of chattering inputs.

3.5.5.16 Annunciation system Function

The annunciation system shall be implemented as an inbuilt function of the DCS. The field contacts shall be acquired through DCS only. The annunciation sequence logic shall be implemented as a part of the DCS controllers. The annunciation window lamps mounted on unit control panel shall be driven through contact output modules of the control system of DCS. In case, the annunciation sequence logic is not performed within the controllers for MFT (BMS), TPS etc., then these signals can be transmitted through some other controller through bus and processed therein.

However, the annunciation system shall have the facility of driving independent lamp box in the event of failure of MMIPIS or system bus in case the annunciation system is affected due to the same.





3.5.5.17 Master & Slave Clock System

A Master and Slave clock system shall be provided with adequate number of output signals to provide uniform timing throughout the various plant facilities. The system shall be complete with receiving antennae (for receiving time from satellite & radio signal), receiver and associated electronics, redundant master clocks, slave clocks, interconnecting cables, cubicles, power supplies & any other accessories. However, a provision shall be kept for synchronisation of the master clock with other source as decided during detailed engineering.

3.5.5.18 Power Supply & Grounding

All panels, desks, cabinets shall be provided with a continuous bare copper ground bus. The ground bus shall be bolted/ welded to the panel structure and shall efficiently ground the entire structure. All individual cabinet grounds shall be connected to separate earthing riser to be provided for C&I system signal grounding. The grounding requirements of various parts of the C&I system shall be properly coordinated with design of plant earthing system.

3.5.5.19 System Software Requirements

- All software required by the system for meeting the intent and functional/ parametric requirements of the specification shall be provided.
- The system shall have user oriented programming language & graphic user interface.
- System related software including real time operating system, file management software, screen editor, database management software, on line diagnostics/debug software, peripheral drivers software and high level language compilers shall be furnished.
- All application software for control system functioning like input scanning, acquisition, conditioning processing & control along with communication among various control system functional blocks, system bus, software for operator interface of monitors, displays, trends, curves, bar charts etc., performance calculations (with steam properties routines utilities) historical storage and retrieval utility, sequence of events recording system functions shall be provided.

3.5.5.20 System Documentation

Detailed System and Equipment documentation. Acquired from the vendors through EPC shall include detailed system and components description covering the installation, operation, care and maintenance of all system components. All final system documentation for DCS hardware and related software shall be furnished. The same shall be complete, accurate and fully representative of the supplied system and its elements. All documentation/catalogues etc. shall be furnished in English language.



In addition to the hard copies, DVD ROM based documentation system shall also be provided. The same should be compatible to the on-line document generation facility indicated elsewhere in the specification.

All Data shall be in the form of a Database.

The Company intends to use Intergraph Smart Plant Instrumentation (SPI) for C&I Documentation. All C&I design and relevant documentation shall be modeled on Intergraph SPI

Documentation Format for Instrumentation Specifications: All Instrumentation Specification and data sheets only ISA S 20 shall be used.

3.5.5.21 Hardware documentation

Detailed technical literature, reference manuals, user's guide/manuals for the complete hardware like control system hardware, I/O hardware, bulk memory units, peripherals and their controllers, communication hardware including controllers, man-machine interfaces programmers unit, power supply modules etc., shall be furnished.

3.5.5.22 Training

Operation and Maintenance Engineers, Operators and Technicians shall be trained at the Vendor facilities as well as at the Plant to safely operate the DCS and maintain it effectively.

3.5.5.23 Large Video Screen (LVS)

Large video screens, complete with projectors, screens, control units (graphical generators) & associated accessories shall be supplied as per the following specifications.

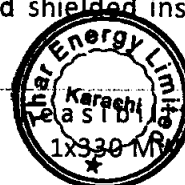
3.5.5.24 Mill and Air Heater Fire Detection System

Adequate number of thermocouples type fire detection system for each mill and air heater shall be provided as a composite and complete units with all required signals and accessories with adequate redundancy.

The controls & protection required for the mill fire detection system shall be implemented in the SG-C&I and air heater fire detection system shall be implemented in the BOP -C&I, Part of DCS using rate-of-rise algorithm taking care of manufacturer's recommendation.

3.5.6 Turbine Supervisory System (TSS)

The turbine supervisory equipment shall be complete including sensors, transmitters, converters, limit value monitors, measuring and amplifier modules, power supplies etc. with the required accessories including twisted and shielded instrumentation cables, compensating cables, junction boxes etc.





3.5.6.1 Boiler Feed Water Pump Turbine Supervisory Instruments

- In addition to the instruments specified previously, the following instruments shall be provided for supervisory purpose. The supervisory equipment shall include detection, indication and recording of the following as a minimum.
- Shaft eccentricity
- Axial shift, (with three pickups)
- Differential expansion.
- Overall expansion.
- Speed (triple pickups)
- Turbine casing and bearing metal temperature for all bearings.
- Stop valve metal temperature
- Bearing pedestal vibration (both in horizontal and vertical direction)

3.5.6.2 Plant Performance Analysis, Diagnosis & Optimization System (PADOS)

A PC based on- line plant performance analysis, diagnosis & optimization (PADOS) system shall be provided. The system shall incorporate the complete thermal design model of each unit. The model of each unit shall work together from the same PC for the complete plant. The system shall use the measured data from the C&I system through appropriate interfaces.

3.5.6.3 Coal Handling Management System

- A comprehensive Management System for Coal Handling shall be provided to fulfill the following functionalities:
- Coal Receipts from SECMC
- Coal Pile Management
- Coal Receipts Measurement and Accounting
- Trucks and Weighbridges Management
- Safety Management
- Inventory Management
- Coal Analysis

3.5.6.4 Measuring Instruments (Primary and Secondary)

- Measuring instruments/equipment and subsystems shall be from reputed experienced manufacturers of specified type and range of equipment, whose guaranteed and trouble free operation has been proven. Further, all instruments shall be of proven reliability, accuracy, repeatability requiring a minimum of maintenance. They shall comply with the acceptable international standards and shall be subject to Owner's approval. All instrumentation equipment and accessories under this specification shall be furnished as per technical





specifications, ranges, make/ numbers as approved by the Owner during detailed engineering.

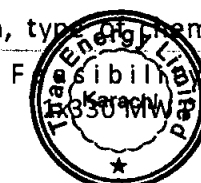
- **Temperature Elements:** Thermocouples: Chromel-Alumel (Type K) or Pt-Rhodium Pt (Type R); Integral Transmitter with inbuilt CJC; MgO Insulation, Standard : IEC shall be utilized. Temperature Elements (RTDs) shall be 3 wire/4 wire - Pt RTD 100 ohm conforming to DIN-43760) class-A. Thermocouples shall have CJC Boxes (if Required)
- **Flow Elements:** Orifice Plate, Flow Nozzles, Venturi Tubes, Positive Displacement meters, Ultrasonic Flowmeters and Rotameters shall be used.
- **Local Gauges:** Sensing Element and material: Bourdon for high pressure, diaphragm/ bellow for low pr. of 316 Stainless steel
- **Electric to Pneumatic (E/P) Converters:** E/P converters and associated accessories shall be furnished in accordance with the specifications: Input signal : 4-20mA DC (as required by the design of control system), Output : 0.2 to 1.0 kg/cm sq., Mounting : close to actuator (but not on the actuator),
- **Displacer Type Level Transmitters:** Displacer type level transmitters shall be provided for level measurements of the vessel under vacuum or low pressure applications.

3.5.6.5 Vibration Monitoring System

- Microprocessor based vibration monitoring system shall be provided for ID fans, FD fans, PA fans, CEPs , BFPs ,and all other pumps/ fans operating on 3.3kv/11kv. The number of bearing locations to be monitored on each fan/ pump shall be as per requirements finalized during detailed engineering but not less than 2 bearing locations for each fan/pump (except for vertical pumps for which one bearing location may be sufficient).
- The vibration monitoring system shall be furnished on a system basis including vibration transducers with low noise flexible cables in flexible conduit, terminated in local terminal boxes, necessary pre-amplifier/electronics mounted in local weather proof boxes, vibration monitors, mounting racks and cabinets. The vibration monitoring system shall include all power supplies, interconnecting cabling, calibration equipment, indicators, integrating units, signal conditioning devices and all other accessories required for monitoring of vibration at each point.

3.5.6.6 Steam and Water Analysis System (SWAS)

- The purity of the condensate, BFW, Steam etc. shall be continuously monitored through on-line analysis for pH, conductivity, hydrazine, sodium ion, silica, dissolved oxygen, etc.
- It shall be carried out in the plant cycle at strategic points. The exact analyzers, the respective sample points, their location, type of chemical analysis to be





carried out for each sample, measurement ranges etc., shall be developed during detailed Engineering.

- The system shall be generally designed in accordance to the recommendation of ASME PTC 19.11 Part-II, water & steam in power cycle.

3.5.6.7 Online Analyzers

All Analyzers, cells, monitors as offered shall be from field proven of international reputed make.

Field proven Chemical Analysis monitors/analyzers based on microprocessors with LCD display and with necessary fault diagnostic features shall be employed.

All analysers, cells, monitors as offered shall be from field proven of international reputed make.

The main Analyzers are as under

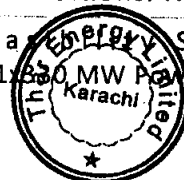
- Conductivity Analyzer
- pH Analyser
- Dissolved Oxygen Analyzer
- Silica Analyser (SIOX)
- Hydrazine Analyzer
- Sodium Ion Analyser.
- Chloride Analyser
- Hydrogen Purity System
- Hydrogen Moisture Analyzer
- Flue Gas Analysers

3.5.6.8 Unit Control Desk, Unit Control Panel, System Cabinets, Local Panels & Racks, etc.

All unit control desks, panels, system cabinets, local panels and local instrument enclosures, racks shall be furnished fully wired with necessary provision for convenience outlets, internal lighting, grounding, ventilation, space heating, anti-vibration pads, internal piping and accessories as per IS:5039-1969 as required for completeness of the system.

All panels, desks, cabinets shall be free standing type and have bottom entry for cables unless otherwise specified. The bottom of desks, panels, cabinets, enclosures shall be sealed with bottom plate, compression cable glands and fire proof sealing material to prevent ingress of dust and propagation of fire.

All electronic system cabinets shall be designed for 50 deg C operating under maximum ambient temperature without air conditioning system in service. Further cabinets, panels shall be so designed that temperature rise due to heat load does not exceed 10 deg. C above ambient temperature under all operating conditions. Necessary louvers,





fans, limited packing density, adequate spacing between instruments, devices etc. shall be provided to maintain temperature rise within permissible limits.

3.5.6.9 Uninterruptible Power Supply (UPS) System

The UPS system shall have 2x100% parallel redundant chargers and inverters, 1x100% battery bank, bypass line transformers and voltage stabiliser, static switch, manual bypass switch, AC/DC distribution boards, other necessary protective devices and accessories and shall meet the following requirements as a minimum.

The kVA rating of UPS shall be as required by expected loads and include 10% spare capacity guaranteed at 50 deg. C ambient. However, for bidding purpose, a minimum capacity of 90 KVA shall be considered. If UPS KVA rating is applicable at a lower ambient temperature than specified 50 deg. C.

3.5.6.10 Instrumentation Cables

3.5.6.10.1 General Requirements

- All the instrumentation cables i.e. twisted and shielded multipair cables, compensating cables, pre fabricated cables etc. shall be flame retardant low smoke (FRLS) type. The Cables shall be provided in non returnable drums. The drum length shall be 1000m (+/-5%) up to & including 8 pairs and 500 m (+/- 5%) above 8 pairs.
- Voltage grade of the instrumentation cables shall be 225V (peak value).
- The conductor shall be of minimum 0.5 sq.mm size, high conductivity, multi-stranded copper for all types of instrumentation cables .

3.5.6.11 Instrumentation Cable Interconnection and Termination Philosophy

- The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group JB's at strategic locations (where large concentration of signals are available, e.g. switchgear) is done and consequently cable with higher number of pairs are extensively used. JB's to be furnished under this specification shall be of 6/12/24/36/48/64/72/96/128/256 way. The material dimension and interior/ exterior colour of JB's shall be subject to Owner's approval. The details of termination to be followed is mentioned in the following table

3.5.6.12 Maintenance and Calibration Equipment

- Maintenance and calibration equipment of proven type, as specified under this sub-section, shall be provided



- Electrical power supply requirement of the instruments offered under this sub-section shall be 240 V AC, 50 Hertz nominal, single phase, unless specified otherwise.
- Microprocessor based instruments shall be offered wherever specified. The make, model, range and other technical features of the maintenance and calibration equipment shall be as finalized during detailed engineering. The laboratory shall be modular in design, enabling easy change of arrangement wherever applicable.
- All the microprocessor based maintenance and calibration units should also have the provision for data logging facility for keeping calibration/ maintenance records with proper communication facility for download these data on the laboratory PC.
- All required accessories for the maintenance and calibration equipment shall be included whether specifically indicated herein or not.

3.5.6.13 Programmable Logic Based Control System

PLC Processor: The processor unit shall be capable of executing the following functions:-

- Receiving binary and analog signals from the field and operator initiated commands from OIS/ control panel.
- Implementing all logic functions for control, protection and annunciation of the equipment and systems.
- Implementing modulating control function for certain application as specified elsewhere in the specification.
- Issuing control commands.
- Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
- Performing self-monitoring and diagnostic functions.

PC based OIS shall perform control, monitoring and operation of all auxiliaries/ drives interacting with PLC based control system. It shall be possible to use the same as programming station of the PLC. It shall basically perform the following functions.

Operator interface for PLC based control system. Operator functions shall as minimum include local/ remote selection, A/M selection, open/ close operation, sequence auto, start/ stop selection, ON/OFF, bypassing criteria etc.

Supervisory functions like:-

Mimic displays, which shall depict the process in graphical form and shall cover all the process areas being monitored.





Alarm monitoring/reporting, generation of logs, calculations, printing of logs & reports etc.

Suitable Interface with stations wide LAN for two-way transfer of data.

Programming station shall have access to the processor of the control system for programming. Programming shall not require special computer skills. On the programming console, it shall be possible to do the programming, self-diagnostics, testing of sequence, simulation and any sequence modification.

3.5.6.13.1 Control & Power Supply Scheme

For PLC system, redundant 220VAC power supply shall be provided, and one from UPS and the other one from emergency power supply.

3.5.6.14 *Control Cabinets / Panels / Desks*

All Control Cabinets/ Consoles/ Desks/ Panels etc. shall have the same color.

Ventilation fans shall be furnished as required by the equipment design and shall be sound proof to the maximum feasible extent.

Suitable louvers with wire mesh shall be provided on the cabinet.

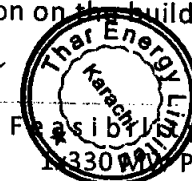
The cabinets shall be designed for front access to system modules and rear access to wiring and shall be designed for bottom entry of the cables.

The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications, preferred height of the cabinet is 2200 mm. The cabinets shall be equipped with full height front and rear doors.

Cabinet doors shall be hinged and shall have turned back edges and additional bracing where required ensuring rigidity. Hinges shall be of concealed type. Door latches shall be of three-point type to assure tight closing. Detachable lifting eyes or angles shall be furnished at the top of each separately shipped section and all necessary provisions shall be made to facilitate handling without damage. Front and rear doors shall be provided with locking arrangements with a master key for all cabinets. If width of a cabinet is more than 800 mm, double doors shall be provided.

Two spray coats of inhibitive epoxy primer-surface shall be applied to all exterior and interior surfaces. A minimum of 2 spray coats of final finish colour shall be applied to all surfaces. The final finished thickness of paint film on steel shall not be less than 65-75 micron for sheet thickness of 2-mm and 50 microns for sheet thickness of 1.6 mm.

Cabinets shall be designed for a grounded installation on the building structure.





3.5.6.15 Annunciation System

Annunciation System shall be provided in the following cases. However, the alarm parameters, duplication of DCS/HMI vs Annunciator Indications shall be developed during detail Engineering:

- As integral part of PLCs.
- With DCS on Operator Consoles and Control Panels.
- With Vendor supplied packages.
- TG Controls
- With Common Monitoring and Control of Power Island.

Field contacts shall be acquired through PLC only. Approximately 20% Spare windows shall be available

3.5.6.16 Software Documentation and Software Listings

All technical manuals, reference manuals, user's guide etc., in English required for modification/editing/addition/deletion of features in the software of the PLC System shall be furnished.

All The software listings including Source code for application software, All special-to-project data files etc. shall be available.

3.5.6.17 Installation Materials

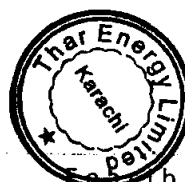
- For all the materials to be used for Instrumentation construction shall be approved prior to Installation
- Material List during Engineering phase shall be developed with detailed specifications prior to Construction Phase.

3.5.6.18 Instrumentation Standard Installation Drawings.

- Prior to Construction a set of Standards Installation Drawings shall be available.
- Typical Standard shall be augmented by application specific and loop specific drawings during detail engineering.
- Installation Drawings shall comply with API 552

3.5.6.19 Weather Station.

- A weather station shall be provided that shall give weather data e.g Wind Speed, Wind Direction, Dry and Wet Bulb Temperatures,
- Maximum/minimum records and trends shall be available.
- It shall be interfaced with the DCS.





3.5.6.20 Plant Information System (PIS)

- A PIS shall be provided that shall import data from DCS and make it available on the Plant LAN.
- The PIS shall give functionality of remote Production Reporting, Plant Monitoring, Production Planning, Plant Optimization, etc.
- The Number of PIS Tags shall be minimum 5000.
- PIS shall be installed on 50 PCS of which 25 shall be concurrent.
- The PIS shall be one way only, with data transfer only from DCS to PIS, no reverse data transfer shall be permitted.

3.6 CIVIL

3.6.1 Architecture

The design includes Main Block, all producing auxiliary and ancillary building in the plant. The character of modern industrial architecture shall be materialize in the design style.

3.6.1.1 Main Block

1) Architectural Arrangement

The Main Block is steel structure. The longitudinal length of the Main Block is 93m. The main column spacing is 10.8m, 10m, 9m, 8.1m.

Three rows arrangement in turbine hall, deaerator & coal bunker bay shall be adopted. The span of turbine hall is 27m. The span of deaerator & coal bunker bay is 10m.

There are three floors in turbine hall: 0.00m (ground floor), 6.30m (middle floor), 12.60m (operating floor), five floors in deaerator & coal bunker bay: 0.00m, 6.30m, 12.60m, 20.00m and 43.00m. The generator is arranged between A axis and B axis in 12.60m of Main Block. The roofing is steel roof truss and cladding metal plate. The bridge crane is arranged under the roof truss. The top elevation of the track is 25.50m.

2) Architectural treatment

The local perforated clay bricks or the local fireproofing wall are adopted in filler walls. The light fireproofing masonry are used in some partition wall. The pressed steel plate shall be adopted as the exterior wall of Main Block.

It shall be compact and clear, fluent in line, plain and brief in the treatment of elevation in Main Block. Each producing auxiliary and ancillary building shall be harmonized with each other in elevation and color.





3) The architectural finishing

The doors include electro motion (hand-operated) steel roll-up door, aluminum door, steel plate door, fire proof door. The windows include aluminum alloy windows.

The white plaster paint is used for interior wall with clay brick and light masonry. The ceramic tile is used for toilet. The plaster acid resist paint is used for chemical room. The 0.00m, 6.30m floor in turbine house is the fine concrete floor. The 12.60m floor is the polished quartz tile floor covering. The polished quartz tile floor covering is used in control room and electronics room etc. electrical and chemical water room is using the quartz tile floor covering (acid resist). The suspended gypsum board ceiling is adopted in control room and offices. The white plaster paint ceiling is adopted in other rooms. The aluminum alloy windows and louver windows are adopted.

3.6.1.2 The other main producing building

The other main producing buildings include auxiliary boiler house, oil pump house, Industrial waste water treatment station and others. The other ancillary buildings include administration building, guard room.

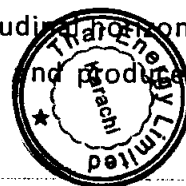
Those buildings finishing: For steel structure buildings, the local perforated clay bricks or the local fireproofing wall are adopted for inner partition wall. The pressed steel plate shall be adopted as the exterior wall and roof. For reinforced concrete structure, the local perforated clay bricks or the local fireproofing wall are adopted for wall. The environment protecting exterior paint is adopted in exterior wall. The white plaster paint is used for interior wall. The preservative treatment is used for all rooms which have this preservative requirement. The floor is fine concrete floor with preservative treatment are used. The steel doors and fireproof doors and windows are used for the places which have the requirements.

3.6.2 Structure

3.6.2.1 Main Block Structure Design

1) Transversal, Longitudinal Bearing Structure System and Type of the Main Block

Columns on row A together with the space steel trusses of the turbine hall and the frame of deaerator & coalbunker bay form the transversal bearing structure system. The longitudinal steel beams, columns and steel braces between columns make up the longitudinal bearing system provided to resist the longitudinal and horizontal actions. The structure of the boiler house, which is to be designed and produced by the boiler manufacturer, is isolated from the main block structure.





2) Scheme of the Roof Structure and Floor of Main Block

The structure of turbine hall roof will be composed of space steel truss, covered with colored pressed steel plate. While the roof of deaerator & coalbunker bay will be reinforced concrete slab & steel beam with pressed steel plate as the permanent formwork. The boiler manufacturer will design the roof of boiler.

The floors of turbine platform and deaerator & coalbunker bay will be combined structure of RC slab & steel beam with pressed steel plate as permanent formwork.

3) Crane Girder

The Crane Girder is of steel structure.

4) Fire Proofing

The surface of steel members near the main oil tank in turbine hall will be coated with a layer of fire-resistant materials if necessary.

5) Turbine Generator Pedestal and Foundation

The turbine generator pedestals and foundation will be of cast-in-site reinforced concrete framing structure.

6) Gable Structures

The gable of the turbine hall is consisted of steel columns and wind-resisting steel truss. The top of the gable columns is connected with the chord of horizontal truss of the roof. The wind load will be transferred to the longitudinal frame of the main block mainly through the truss.

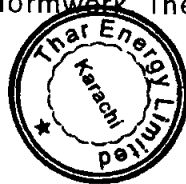
7) Coal scuttle

The coal scuttle will be of steel structure with stainless steel lining.

8) Platform in front of Boiler

The platform in front of boiler will be combined structure of RC slab & steel beam with pressed steel plate as permanent formwork. The roof in front of boiler will be pressed steel plate.

9) Boiler Frames





The platform and the path of each store are of steel structure. The rigid of each boiler does not transfer lateral force to the frame of deaerator & coalbunker bay.

10) Elevator Derrick

The elevator derrick will be steel structure, it connect with boiler structure.

11) Center Control Building

The control building will be steel structure. The floors and roof will be combined structure of RC slab & steel beam with pressed steel plate as permanent formwork.

3.6.2.2 Ground and Foundation

According to the 'Geotechnical investigation report for proposed construction of power plant at THAR, block-II', the soil condition of the project site is as follow:

The subsurface deposits up to the explored depth consist of silty fine sand with mica and silty clayey shale.

Silty fine grained sand was encountered in all the boreholes from existing ground surface up to the explored depth of around 60m while these deposits were encountered up to a depth of 16 meters in the borehole. The in-situ state of compactness of these deposits is in the medium to very dense state. The silty sand is poorly graded silty fine grained sand and the interlocking between the particles is low.

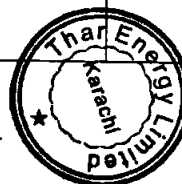
Silty clayey shale was encountered in borehole No 01 only at the depth range of 31.5m to 34m. The in-situ state of compactness of these deposits is hard.

All piling works as well as other methods for the purpose of improvement of the existing soil conditions, such as sand fill or concreting or filling or soil replacement including design shall be performed to satisfy the requirements.

Allowable bearing capacities for isolated and raft footing is as follows:

Depth below existing ground level (meters)	Isolated foundation(kPa)	Raft foundation(kPa)
2.0	125	175
2.5	140	200

Allowable axial pile capacities is as follows:





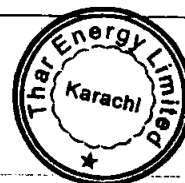
Pile Diameters(mm)	Depth below existing ground level (meters)	Tension(kN)	Compression(kN)
760	12	215	1530
	15	360	2085
	18	535	2680
900	12	260	2100
	15	425	2850
	18	635	4030

The foundation with piles of diameters 760~900mm will be adopted for the main buildings which resist big-heavy-load such as the turbine building foundations, turbine foundation, boiler foundations, stack, ash silo, etc. The isolated foundation deeper than 2.0m will be adopted for the common building which resist comparatively-lesser-load such as water treatment building and the other auxiliary buildings etc. Final design for the foundations shall be in accordance with the detailed geotechnical report and soil investigation.

Ground water was not encountered in any of the boreholes up to explored depth of 60m. The content of chloride and sulphate in soil is negligible.

3.6.2.3 Description of main buildings in power plant

No.	Item	Structure Description
Mechanical Structures		
	Turbine Hall	The steel framing structure with braces will be adopted, covered with pressed steel plate. Turbine platform will be combined structure of RC slab & Steel beam with pressed steel plate as permanent formwork. Welding H-steel girders will be provided for the crane.

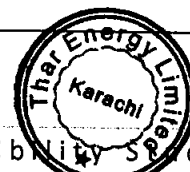




No.	Item	Structure Description
1	Deaerator & Coal Bunker Bay	The steel framing structure with braces will be adopted, covered with pressed steel plate. Roof and floor will be combined structure of RC slab & Steel beam with pressed steel plate as permanent formwork. The coal scuttle shall be steel structure with stainless steel lining.
	Boiler House	Boiler frame will be of steel structure, which is to be designed and produced by the boiler manufacturer . Steel elevator derrick will be laterally supported by the boiler structure. The structure between the boiler and the deaerator & Coal Bunker Bay will be of combined structure of RC slab & Steel beam with pressed steel plate as permanent formwork. The roof in front of boiler will be pressed steel plate.
2	Central control building	The control building will be steel structure. The floors and roof will be combined structure of RC slab & steel beam with pressed steel plate as permanent formwork.
3	The foundation of electrostatic precipitator	Reinforced concrete foundation with piles if necessary. The support frame will be of steel structure, which is to be designed and produced by the manufacturer.
4	Induced draft fan supporting frame and flue supporting frame	It will be steel structure and reinforced concrete foundation with piles if necessary.
5	Forced fan supporting frame	It will be steel structure and reinforced concrete foundation with piles if necessary.



No.	Item	Structure Description
6	Stack	It will be cast-in-site reinforced concrete structure with inner acid-resistance brick lining. The foundation will be raft foundation with piles if necessary.
7	Auxiliary boiler house	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
8	Oil pump house	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
9	Maintenance workshop & stores building	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
Main Electrical System Buildings & Structures		
1	Transformer foundation	The transformer foundation will be reinforced concrete foundation with piles if necessary.
2	500kV GIS building	It will be steel structure with outer cladding. The foundation will be reinforced concrete foundation with piles if necessary.
3	DC and relay room	It will be steel structure with outer cladding. The foundation will be reinforced concrete foundation with piles if necessary.
4	In/outgoing line framework	It will be galvanized anticorrosion steel pipe A-sharp column structure and the triangle trellis type steel girder. The foundation will be reinforced concrete foundation with piles if necessary.
5	Fire-resisting wall	It will be reinforced concrete structure and the foundation will be reinforced concrete foundation.
Main Chemical Water Treatment System Buildings & Structures		

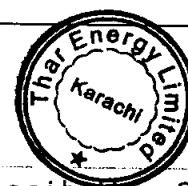




No.	Item	Structure Description
1	Boiler make-up water treatment plant	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
2	Industrial waste water treatment plant	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
3	Circulating water dosing room	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
4	Hydrogen generating station	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
5	Condensate make-up water tank foundation	The foundation will be raft foundation.
6	Unit drain sump	It will be cast-in-site reinforced concrete structure .
7	Mine dewatering water treatment plant	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
8	Waste water pool of condensate polish station	It will be cast-in-site reinforced concrete structure .
Main Fuel and Limestone Building		
1	Coal/Limestone conveyor gantry	The gantry will be of steel truss with outer cladding, and floors of conveyer gantry will be combined structure of RC slab & steel beam with pressed steel deck. Steel structure will be adopted for the gantry supporting. The foundation will be reinforced concrete foundation with piles if necessary.



No.	Item	Structure Description
2	Coal/Limestone Conveying Tunnel	It will be cast-in-site reinforced concrete box-type structure
3	Coal transfer tower	It will compose of superstructure and underground structure .The superstructure will be steel structure with outer cladding. The underground structure will be cast-in-site reinforced concrete structure.
4	Coal handling building & bulldozer garage	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
5	Coal crusher house	It will be steel structure with outer cladding. The foundation will be reinforced concrete foundation with piles if necessary.
6	Coal unloading station	It will compose of superstructure and underground structure .The superstructure will be steel structure with outer cladding. The underground structure will be cast-in-site reinforced concrete structure.
7	Lighting house	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
8	Coal sampling building	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
9	Bucket wheel machine foundation	It will be Cast-in-site reinforced concrete structure.
10	Truck scale equipment foundation	It will be Cast-in-site reinforced concrete structure.

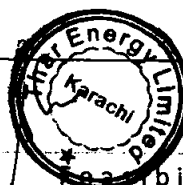




No.	Item	Structure Description
11	Truck scale control room	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
12	Sampling equipment foundation	It will be Cast-in-site reinforced concrete structure.
13	Coal storage yard	It will be outdoor arrangement
14	Dry limestone shed	It will be steel structure with roof cladding. The foundation will be reinforced concrete foundation with piles if necessary.
15	Limestone milling house	It will be steel structure with outer cladding. The foundation will be reinforced concrete foundation with piles if necessary.
16	Limestone underground hopper	It will be underground reinforced concrete structure.
Main Ash Removing Building		
1	Air Compressor room	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
2	Ash Silo	It will be cylindrical reinforced concrete structure. The foundation will be raft foundation with piles if necessary.
3	Bed Ash Silo	It will be cylindrical reinforced concrete structure. The foundation will be raft foundation with piles if necessary.
4	Limestone powder silo foundation	It will be cast-in-site reinforced concrete structure.



No.	Item	Structure Description
5	Bed material silo foundation	It will be cast-in-site reinforced concrete structure.
6	Combination pipe frame	It will be steel structure with isolated foundation.
Hydraulic Buildings		
1	C.W pump house	It will compose of superstructure and underground structure .The superstructure will be steel structure with outer cladding. The underground structure will be cast-in-site reinforced concrete structure.
2	Comprehensive water pump house	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
3	Mechanical Draught Cooling tower	It will be reinforced concrete structure.
4	Service/ fire-fighting/Potable water tank foundation	It will be raft reinforced concrete foundation.
5	Sanitary sewage water pond and Equipment foundation	It will be reinforced concrete structure.
6	Emergency oil pond	It will be underground reinforced concrete structure.
7	Reuse water pond	It will be underground reinforced concrete structure.





No.	Item	Structure Description
8	Coal yard rain water sedimentation pond	It will be underground reinforced concrete structure.
9	C.W drainage trench	It will be underground reinforced concrete structure.
10	Foam room	It will be steel structure with outer cladding. The foundation will be isolated reinforced concrete foundation.
Main ancillary Buildings		
1	Administration Building	It will be cast-in-site reinforced concrete framing structure with isolated foundation
2	Guard room	Cast-in-site reinforced concrete framing structure.
3	Hostel	It will be cast-in-site reinforced concrete framing structure with isolated foundation

3.6.3 Site Preparation and Drainage

3.6.3.1 Grade Elevation and Plant Drainage

Plant finished grade elevation will be approximately +84 meters Above Mean Sea Level (AMSL). This height is based on minimum leveling/land-filling criteria (about and will be adjusted to suit specific site conditions and drainage patterns. Land-filling will be done with granular soil excavated from the high elevation areas. The finished grade surface will be sloped away from the buildings to provide surface drainage.

The site will be graded to drain rainwater using storm sewers, catch basins, manholes, etc. Storm water run-off will be discharged to a storm water detention pond. Areas not drained via a storm water sewer will be drained via an open ditch system consisting of trapezoidal ditches, or swales and culverts at road crossings.

The design of storm water drainage system will be based on rainfall data.

The rainwater runoff from the coal pile area will be collected in a lined retention pond for settlement of coal particles and discharged to storm drainage system.



The storm water runoff from the ash disposal area will also be collected in a lined detention basin. All chemical waste from the air heater wash, chemical unloading areas etc. will be collected in a specially lined retention pond to prevent any leaching to the ground water.

3.6.3.2 Drainage of Other Wastes

All oily waste from floor wash, transformer areas, the diesel generator area, equipment drain areas, and other areas will be collected in oil separators provided at strategic locations.

A sanitary sewer system shall be provided to collect sanitary waste from sources of sanitary waste, shall be treated before disposal.

3.6.3.3 Water Intake and Discharge System

3.6.3.3.1 Function

The water intake and discharge system provides a continuous supply of water to the plant and discharges the effluent from the power plant towards the Salt Lake (Runn of Kutch). The major use of water is the cooling water for the condenser. Other uses include other cooling requirements and as the water supply to the demineralization system (and desalination system in case groundwater is used), ash handling system, coal dust suppression, ash dust suppression and potable purposes.

3.6.3.4 Design Basis

3.6.3.4.1 Water Intake

The design of the water intake system will be based on the water source.

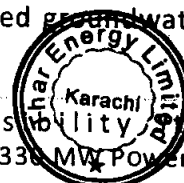
3.6.3.4.2 Canal Water

The water will be pumped from Nabisar area, Sindh Province, towards Thar Block II in underground pipeline. The water will enter the Block from the North-Western boundary. The power plant will receive the water in the water treatment facility.

3.6.3.4.3 Water Discharge

The discharge from the power plant will include saline cooling tower blow-downs, brine from RO treatment of groundwater (if required) and may also include treated oil water and sewage.

The effluent will be discharged in a pipe towards the Salt Lake (Runn of Kutch). This pipeline will also carry effluent from the mine and unused groundwater pumped out during mining activities.





3.6.3.5 Operation

The Canal/LBOD water will be pumped continuously from the water reservoir in Nabisar towards Thar Block II. A storage capacity of about 15 Million m³ is planned at Nabisar to serve as water source in case of closure of canal or LBOD water supply.

The effluent will be continuously pumped out to the interim storage pond, having a capacity of -, from where it will be disposed off to the Salt Lake.

3.7 WATER SUPPLY

3.7.1 General

3.7.1.1 Design Principle

The circulating water system will be designed as open secondary circulating water supply system.

The raw water supply will be supplied from LBOD. Additionally, there will be an alternate source of raw water which is mine dewatering water. The mine dewatering water will be treated in the mine dewatering water treatment plant which located in the power plant.

Required amount of raw water will be supplied at 2 m outside the battery limit of power plant site.

The rainwater will be designed as a gravity system, and then to outside of the plant. The interface will be at the 2 m outside of the fence.

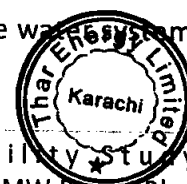
The sewage water will be a separate system apart from the rainwater system. The sewage water will be collected and sent to the sewage water treatment system. The clear water will be discharged to evaporation pond.

The power plant residue (ash, slag) will be transported to the mine overburden area by trucks.

3.7.1.2 Scope of Design

This part will include the following systems.

- 1) The circulating water system
- 2) The industrial water system, sanitary water system, sewage water system, rainwater system of the plant.





3) The mine dewatering water treatment system.

3.7.2 Water Quantity

3.7.2.1 Circulating Water Quantity

Circulating water quantity is as following:

Unit (MW)	Steam flow (m ³ /h)	Condenser (m ³ /h)	Auxiliary facilities cooling water (m ³ /h)	Total (m ³ /h)
1x330	659.4	42202	1100	43302

3.7.2.2 Service Water Quantity

The service water quantity for the 1x330MW power plant is about 740t/h at design temperature condition.

3.7.2.3 Raw Water Quantity

Under normal operation condition, the raw water will be LBOD water. And the quantity of LBOD water for the 1x330MW power plants is about 746t/h at design temperature condition.

When there is an accident of LBOD water supply, the mine dewatering water will be adopted as an alternate source of raw water, and it will be treated in the mine dewatering water treatment plant. The alternate raw water quantity of mine dewatering water for the 1x330MW power plants is about 1050t/h at design temperature condition.

3.7.3 Circulating Water System and Arrangement

3.7.3.1 Circulating Water System

The C.W. system will be a secondary circulating water supply system. The circulating water system will be designed as:

The outlet of the cooling tower basin → C.W. pump → C.W. pressure steel pipe → Condenser → C.W. drainage pipe → Cooling tower

Refer to ANNEX-12 (AF2016022-S01 WATER SUPPLY SYSTEM) for details.

3.7.3.2 The arrangement of the C.W. system

The C.W. pump house will be designed for 1x330MW unit. There are 2x50% C.W. pumps in the C.W. pump house.

1) Circulating water pumps

The Circulating water pumps will be vertical wet type. The flow of each C.W. pump will be about 6.03 m³/s, the head will be about 21m.



2) The hydraulic butterfly valve

There is a hydraulic butterfly valve at the outlet of each C.W. pump.

3) Circulating water pressure pipe

There is one(1) DN2400 C.W. pressure steel pipe for one unit.

4) Circulating water drainage pipe

There is one(1) DN2400 C.W. drainage steel pipe for one unit.

5) Mechanical Draft Cooling Tower

Parameters of Mechanical Draft Cooling Tower for Circulating Water System as follows:

Number of cells : 10 (eight work and two standby)

Single cooling water : $Q=5500\text{m}^3/\text{h}$

Fan power : $N=200\text{kW}$

Fan diameter : $D=9.75\text{m}$

Designed air flow: $300\times 10^4\text{ m}^3/\text{h}$

Inlet water temperature : 41.5°C

Outlet water temperature: 33°C

Single size : $19.6\text{m (L)} \times 19.6\text{m (W)} \times 12.5\text{m (H)}$

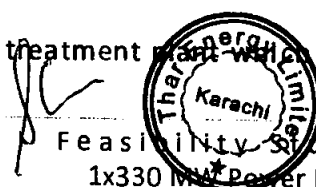
There are three cooling tower ponds, in which two sets of cooling tower basin size are $58.8\text{m (L)} \times 22.9\text{m (W)} \times (-2.0\text{m})\text{ (H)}$ and one set of cooling tower basin size is $78.4\text{m (L)} \times 22.9\text{m (W)} \times (-2.0\text{m})\text{ (H)}$.

Mechanical Draught Cooling tower will be installed outdoor with cooling water basin. Cooling tower consists of housing, packing, water distribution system, water inlet, water outlet, overflow and drain pipe.

Tower packing will be made of PVC corrugated plates. The plates will provide better water distribution efficiency, have good thermal stability and be the fire resistant. The space between the packing is so enough that there is no need washing down system. Water distribution pipe will be made of PVC which will make water distributed evenly, with low head loss. Cooling tower water basin will be made of reinforced concrete structure, the depth of basin is 2.0m.

3.7.4 Make-up Water System

The raw water will be treated in the raw water treatment plant located in the power plant.





Required amount of raw water will be supplied at 2 m outside the battery limit of power plant site.

3.7.5 Service Water System

The service water system will supply the fresh make-up water to the users in plant. It will consist of one (1) complex pump house, two (2) service & fire fighting water tanks and 2x100% service water pumps. The volume of each tank is 1500 m³.

3.7.6 Potable Water System

The potable water will be supplied from the raw water treatment plant. One (1)100m³ potable water tank will be provided. The water consumption quantity is about 3m³/h (averaged over hours). Potable water will be supplied for the users by potable water pumps. The pumps will be installed in the complex pump-house.

3.7.7 Reused water system

All the treated sewage water, chemical waste water etc will be collected to the reused water basin and reused to wash main block, humidify ash and etc. The volume of reused water basin is 500 m³. Reused water will be supplied for the users by reused water pumps. The pumps will be installed in the complex pump-house.

3.7.8 Sewage Water System

The sewage water will be collected by pipe at various points and then flow to the sewage water treatment system. It will be pumped into the sewage treatment facility. After treatment, the water will be discharged to evaporation pond.

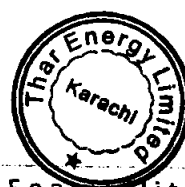
3.7.9 Rainwater System

All surface rainwater will be collected gravity by the rain water pipe and drained to outside of the plant fence 2 m.

3.7.10 Ash Storage Yard

The terrain of the plant site is plain. These fields can be used as ash storage yard for the power plant. The ash storage yard will run after adopting environmental protection measures mentioned in ESIA. The ash will be transported to the ash storage yard by truck.

The current project use dry disposal method, ash yard max stacking height is about 12m. Ash storage yard area is about 19.4ha. The gross capacity for the ash storage yard is about 185.32x10⁴m³, which can meet current unit ash and slag disposal for 3 years for 1x330MW units under design coal type.





3.8 CHEMICAL WATER TREATMENT

The main water source is the LBOD water and back-up water source is mine dewatering water in this project.

- Mine dewatering water treatment system
- Boiler Make-up Water Treatment System
- Condensate Polishing System
- Industrial Waste Water Treatment System
- Chemical Dosing System
- Water & Steam Sampling System
- Hydrogen gas Generating System
- Circulation Cooling water treatment system
- Dosing and sampling for auxiliary boiler
- Laboratory

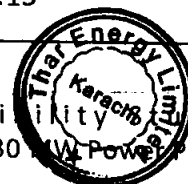
3.8.1 Quality Criterion of Water and Steam

3.8.1.1 Boiler Feed Water Quality Standard

Item	Unit	Standard Value
Cation Conductivity (25 °C)	μs/cm	≤0.15
Dissolved Oxygen	μg/L	≤7
Fe	μg/L	≤15
Cu	μg/L	≤3
SiO ₂	μg/L	≤20
pH(25°C)(the system without copper alloys)		9.2~9.6
Hydrazine	μg/L	≤30
Total Organic Carbon(TOC)	μg/L	≤200

3.8.1.2 Steam Quality Standard

NO.	Item	Unit	Standard Value
1	Na	μg/kg	≤5
2	Cation Conductivity (25 °C)	μs/cm	<0.15





NO	Item	Unit	Standard Value
3	SiO ₂	μg/kg	≤20
4	Fe	μg/kg	≤10
5	Cu	μg/kg	≤3

3.8.1.3 Condensate Quality Standard After Polishing

NO	Item	Unit	Standard Value
1	Cation Conductivity (25 °C)	μs/cm	≤0.15
2	Na	μg/L	≤5
3	Cu	μg/L	≤3
4	Fe	μg/L	≤5
5	SiO ₂	μg/L	≤15

3.8.1.4 4 Boiler Make-Up Water Standard

Item	Silicon dioxide μg/L	Inlet water conductivity of desalted water tank (25 °C) μs/cm	Outlet water conductivity of desalted water tank (25 °C) μs/cm	TOC μg/L
Standard values	≤20	≤0.20	≤0.40	≤400

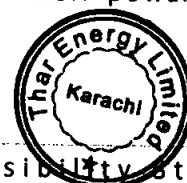
3.8.2 Mine dewatering water treatment system

3.8.2.1 Process of the mine dewatering water treatment system

The production of mine dewatering water treatment will be carried to full fill the need of the industrial water for whole power plant purposes, such as for boiler make up water, service water, firefighting etc.

The System Process is as follows (designed as the assumed condition):

Mine dewatering water → Clarifier → Filter → Self-cleaning filter → Ultrafiltration device (UF) → safety filter → high pressure pump → RO device → desalinated water tank → desalinated water pump → industrial water for whole power plant (service water, firefighting etc).





The effluent generated from mine dewatering water treatment plant will be discharged to the Re-injection well / evaporation pond.

Effluent water will be reinjected into the third aquifer at a location that is around 15 Km away from the power plant. Material of the piping (effluent water pipe) is steel wire mesh and plastic (PE) composite pipe. There will be 1xDN300 buried pipeline for 1x330MW unit.

Concentrated brine will be drained into the evaporation ponds temporary located in coal mine area when the reinjection wells or water pipelines are in maintenance. Because the site detailed meteorological data, such as the average monthly rainfall and the average monthly evaporation are absent, evaporation pond is assumed as follows:

The evaporation ponds will locate in coal mine area where plant is 4km away. The total design volume of evaporation pond of is 50000 m³, divided into two 25,000 m³ pond, the size of each pond will be LxBxH=90m×90m×3.5m, open type and linear arrangement. There will be a brine drainage pumping stations for the evaporation ponds.

3.8.2.2 The capacity of the mine dewatering water treatment system

According to the consumption of boiler make up water treatment system and the service water system for whole plant. The capacity of RO device will be 3x404t/h. The two units are running simultaneity and one unit is standby.

3.8.3 Boiler Make-up Water Treatment System

3.8.3.1 The Process and Capacity of the Boiler Water Treatment System

Distillate water from the industrial water system → secondary RO unit → Cation exchanger → Anion exchanger → Mixed bed → Demineralized water tank → Demineralized water pump → Plant user.

Refer to ANNEX-9 (AF2016022-H01 THE MAIN SYSTEM FOR BOILER MAKE-UP WATER TREATMENT) for details.

3.8.3.2 The Capacity of the System

Water and steam loss table(Reference):

Item	Data	Normal (t/h)
Water & steam circle loss	1.5% boiler max. continuous evaporation output	16.5
Boiler Blowdown loss		11
Others(laboratory, hydrogen generating plant etc.)		10
Total		40



According to the total loss of the plant, the capacity of the water treatment system is 40t/h. Water quality at the outlet of the mixed beds will be as followed:

Item	Silicon dioxide $\mu\text{g/L}$	Inlet water conductivity of desalted water tank (25°C) $\mu\text{S/cm}$	Conductivity at outlet of desalted water tank (25°C) $\mu\text{S/cm}$	TOC $\mu\text{g/L}$
Standard values	≤ 20	≤ 0.20	≤ 0.4	≤ 400

3.8.4 Condensate Polishing System

3.8.4.1 System Description

The system adopts external regenerative type high speed mixed bed polisher. Medium pressure condensate polishing system will be designed for this project. 3×50% condensate polishing mixed beds will be provided for one unit and one(1) package of external regeneration equipment will be provided.

3.8.4.2 Connection Mode of Condensate Polishing System and Thermal System

Connection mode of condensate polishing system and thermal system is as follow:

Condensate

pumps → High flow rate mixed beds Gland steam seal cooler

Bypass →

3.8.5 Industrial wastewater treatment System

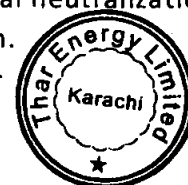
3.8.5.1 System Description

This system can meet the requirement to treat the regeneration waste of the water treatment plant, condensate polishing waste water, acid washing, the cleaning water of air preheater etc., it can make them all reaching the drain standards.

The capacity of the system is about 50t/h. The capacity of storage basins for infrequent waste water is 2x1500m³.

3.8.5.2 The Main Process of the Waste Water Treatment System

The main process : waste storage pit → waste water pump → pH regulation tank → coagulating tank → reaction tank → clarifier → the final neutralization basin → clarified water pit → clarified water pump → water reuse basin.





The process of the sludge discharge : sludge from the clarifier→ sludge pump for clarifier→ concentration pool→ sludge pump for concentration pool→ dehydrator → output by car.

3.8.6 Chemical Dosing System

The chemical dosing system supply water conditioning chemicals to the feed water and boiler systems to minimize corrosion and prevent scale formation.

Chemical dosing systems include the sub-system:

- Oxygen scavenger dosing systems
- pH adjustment (ammonia) dosing systems
- Phosphate/ boiler water dosing systems

3.8.7 Water & Steam Sampling System

In order to monitor quality of water and steam cycle and ensure safety operation of unit, one unit will set one (1) water & steam sampling and analysing device. Water & steam sampling and analysing system include high-temperature cooling rack and low-temperature instrument panel.

3.8.8 Circulation cooling water treatment system

Circulating water treatment system includes the following system:

- Inhibitor dosing system
- Sodium Hypochlorite dosing system

In order to decrease the water quantity for circulating cooling water and water drain, the design needs to adopt stabilizer and scale-retardant for circulating water. Inhibitor dosing device will be set to prevent scale formation in the cooling water pipe system.

Sodium hypochlorite dosing system will be provided for preventing the microorganism growth in the circulating water.

3.8.9 Hydrogen gas generation system

The cooling mode of electric generator is water-hydrogen-hydrogen. One set of 10Nm³/h, p=3.2Mpa hydrogen generation device and corresponding accessory equipment will be provided for the one unit.

3.8.10 Dosing and sampling for auxiliary boiler

To prevent the corrosion cause by feed water system of auxiliary boiler and carbon dioxide, to ensure the chemical stability of boiler water and prevent scale deposit, the phosphate dosing treatment is required to arrange.



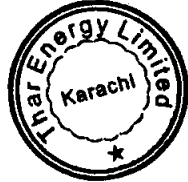
The manual sampling system is arranged for the supervision on water and steam of auxiliary boiler.

3.8.11 Laboratory

One set of instrument and equipment for chemical laboratory will be provided for the water, coal and oil analyzing.

A chemical laboratory will be provided for the plant including all the necessary furniture, instruments, apparatus particulars, glassware, as same as existing water treatment plant laboratory.

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3.9.1 Fire Protection

3.9.1.1 Function

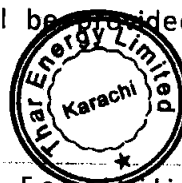
As a coal fired Power Plant has an immense fire risk and can pose a potential process safety hazard of fire and coal dust explosion, the fire detection and mitigation systems design and functioning is of critical importance. An effective fire protection system shall be installed to detect and suppress fires, to minimize hazards to station personnel, and reduce loss prevention.

The principal Standard shall be NFPA 850, Recommended Practice for Fire Protection for Electric Generating Plants. All firefighting equipment shall also comply with relevant NFPA standards.

3.9.1.2 F&G Systems

The fire detection and mitigation systems shall include, but not limited to, the following

- A fire and gas safety philosophy shall be formulated.
- A Fire
- A centralized F&G (Fire and Gas) System shall be designed and implemented.
- A Fire Station Building to House the Fire Tender, F&G Monitoring Panels and Offices and Stores for the Fire Safety Staff
- All coal conveyors shall have fire/smoke detection systems for early detection..
- Coal storage area shall be provided with fire/smoldering detection and mitigation systems.
- All switchgear rooms, generator rooms, transformers, cable trenches, cable rooms and tariff metering rooms shall be equipped with adequate fire detection and clean agent automatic suppression systems complying with NFPA 2000.
- Risk of Fire initiated from Electrical and Instrumentation equipment shall be analyzed through Hazard Area Classification as per IP 15, NFPA 497 and NEC 500. and all relevant design and equipment supply shall conform to this classification
- Hydrogen generation unit room and its related supply unit (transformer) shall be provided with gas leakage detection system
- Boiler burner area shall have smoke/optical beam detectors
- All liquid fuel and lubricating oil tanks shall have adequate fire detection and suppression system
- A comprehensive water based firefighting system shall be designed comprising to, fire water tanks, pumps, fire water network and hydrants.
- Adequate portable fire extinguishers shall be provided based on fire risk assessment.





3.9.1.3 Design Basis

The fire protection system will include water supply systems, clean agent extinguishing, sprinkler systems, stand pipes, hose stations and hand-held extinguishers.

Designed on NFPA 850, the system will include a ring header to supply water to fire hydrants spaced throughout the Project. Lines from this ring header will also supply water to sprinkler systems for some equipment and areas. This will include the power block area and major buildings. Two stand pipes will be provided on opposite sides of the boiler with hose stations at all major gallery levels.

The underground header will be constructed of cement-lined ductile iron or high-density polyethylene (HDPE) pipe. Adequate spacing between fire hydrants will be 80 meters in main buildings, shall be maintained as per NFPA.

Water will normally be supplied by the raw water storage tank. The water tank will be sized for the appropriate standards.

The system will include a fire pump house which will include the emergency diesel fire pump, the motor driven fire pump, and a pressure maintenance jockey pump. The emergency fire pump shall have a separate fuel oil tank sized for a minimum of 8 hours operation at full load.

In addition, a diesel fire pump will be installed as an emergency source of water to be used only when all other options have been exhausted or failed. Provisions will be included to allow regular flow tests of this pump without allowing raw water to enter the piping systems.

Any detection of a fire, or actuation of a fire suppression system, will be alarmed in the main control room in the F&G System panel and duplicated in the Administration Building.

3.9.1.4 Fire Extinguishing Pumps and Piping System

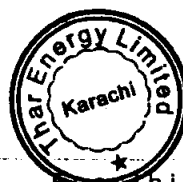
One (1) set of 100% electric motor driven fire extinguishing pump, two (2) jockey (one operation, one standby) pumps and one (1) set of 100% diesel driven fire extinguishing pump will be provided to feed enough water for fire-fighting system based on the flow and pressure requirements.

The electric motor driven pump will be automatically or manually started in case of fire. The diesel pump will be started in the case of failure of the electric motor driven pump.

Motor driven fire pumps: $Q = 120 \text{ l/s}$, $H = 100 \text{ m}$

Diesel driven fire pump: $Q = 120 \text{ l/s}$, $H = 100 \text{ m}$

Jockey pumps: $Q = 18 \text{ m}^3/\text{h}$, $H = 100 \text{ m}$

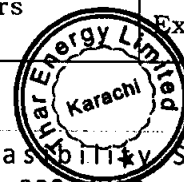




There are two service & firefighting water tanks. The capacity of each tank is about 1500 m³. The volume of firefighting water is about 800 m³. The capacity can meet the maximum demand of firefighting system in the continuous fire hazards lasting for different length of time in the power plant.

3.9.1.5 Major areas to be protected

Area	Detection or Actuation Type	Suppression Type
Turbine Room	Fire Call Points	Hose stations at grade, mezzanine, and main floor
Boiler Room	Fire Call Points	Hose stations at each side on all major floors
Coal Transfer towers, Crusher House, and Tripper Area above Silos	Spot type smoke detectors	Dry-pipe sprinkler fusible heads
Conveyors	Smoke/Linear heat detection	Automatic deluge
Coal Silos	CO and methane gas monitors	CO ₂ manual
Administration Building, Locker Rooms, Toilet Areas, Telephone and Communications Rooms, Storage Rooms	Spot type smoke detectors	Automatic wet pipe sprinkler system & Hand hoses
Water Treatment Building	Spot type smoke detectors	Automatic wet pipe sprinkler system, Hose stations, portable extinguishers
Maintenance Shops, Warehouse	Manual pull stations at each exit door	Hand hoses, automatic wet pipe sprinkler system, portable handheld
Fuel Oil Storage Tanks 2,000 m ³	None	Foam injection plus foam Monitors
Fuel Oil Truck Unloading Area	None	Foam Monitors
Steam Turbine and Generator Bearings	Spot type smoke detectors	Automatic pre-action sprinkler system, double interlock
Turbine Oil Tanks, Piping, Conditioner Skid, Hydrogen Seal Oil, EHC System	Linear Detectors	Deluge sprinklers
Turbine Electrical Enclosures	Spot type smoke detectors	None
Battery Room	Smoke detectors at the ceiling	Pre-action sprinkler system -electric release
Control Room	Smoke detectors at the ceiling level and beneath all raised floors	Clean Agent Fire Extinguishing System
Electrical Equipment Room, Electronics Room, Cable Spreading Room	Spot smoke detectors	Clean Agent Fire Extinguishing System





Main Power Transformers, Auxiliary or Reserve Transformers	Linear	Automatic deluge, dry pipe
GasInsulated substation	Beam smoke detection	Portable extinguishers
Intake Pumphouse	None	Hydrants, portable

3.9.1.6 Fire Protection Master Plan

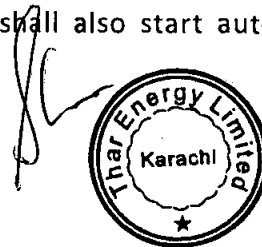
A Fire Protection Master Plan shall be developed, on the following lines:

- Building and Fire Codes and Life Safety Compliance Review Report
- Fire Risk Evaluation Report
- Hazardous Area Classification Evaluation

The above will result in a list of recommended fire prevention features to be provided based on acceptable means for separation or control of common and special hazards, the control or elimination of ignition sources, and the suppression of fires. Fire Protection measures shall be augmented on the recommendations

3.9.1.7 System Operation

A Jockey pump will normally be operating to keep all parts of the fire protection piping systems full of water and pressurized. If the pressure drops for any reason, the main motor-driven pump shall start automatically. If the pressure is not restored within a predetermined time, the diesel-driven pump shall also start automatically and will remain operating until manually stopped.





3.10 VENTILATION & AIR CONDITIONING

3.10.1 Design Scope and Contents of VAC

The design scope and content of VAC systems will include ventilation, air conditioning, dust collection and vacuum cleaning system for main block, coal handling buildings and auxiliary buildings in this phase of the project.

3.10.2 Ventilation System

3.10.2.1 *Ventilation for main block*

Natural air intake and mechanical exhaust systems will be provided for turbine hall separately. Outdoor air will enter into the room naturally through the aluminum-alloy weather-proof louvers. Hot air will be exhausted outside via the roof style axial fans on the turbine hall.

It will be provided with mechanical emergency exhaust systems respectively for MCC rooms and electric rooms in the main block, such as 380/220V distribution room, 6kV switchgear room, 380/220V PC room, excitation room and MCC room in main block. The rate of air exchange will not be less than 12 times per hour. Also mechanical emergency exhaust system will be provided for battery room and the rate of air exchange will not be less than 12 times per hour. Anti-corrosive & explosion-proof axial fans will be adopted as emergency exhausting equipment for battery room.

Axial fans will be provided for DC & UPS distribution rooms for emergency. The air changes will not be less than 12 times per hour.

3.10.2.2 *Ventilation for Compressed Air Room*

Air compressor room will be provided with a mechanical exhaust system by axial fans with an air change rate of 6 times per hour.

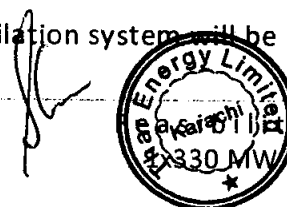
3.10.2.3 *Ventilation for Chemical Water Treatment Building*

Chemical dosing room, chemical storage room will be served with natural suction and mechanical exhaust ventilation by anti-corrosive & explosion-proof axial fans to discharge the poisonous gases to the outside. The air change rate per hour will not be less than 15 times per hour.

Testing rooms and analysis rooms will be provided with natural suction and mechanical exhaust ventilation systems by axial fans with an air change rate not less than 6 times per hour.

Analysis room will be provided with ventilation cabinet for experiments.

Natural intake and mechanical exhaust ventilation system will be provided for the unit drain sump.





Natural ventilation system will be provided for hydrogen generating station. The rate of air exchange will not be less than 3 times per hour. And it will be provided with mechanical emergency exhaust systems with 7 times air exchange per hour by explosive-proof fans. The fan shall be direct-connected with motor.

3.10.2.4 Ventilation for Other Rooms

Natural air intake and mechanical exhaust ventilation systems will be supplied for other distribution rooms and MCC rooms, and the air changes will not be less than 12 times per hour and axial fans will be used for emergency exhausting.

Underground tunnel and basement pump house will be served with mechanical ventilation by axial fans with an air change rate not less than 15 times per hour.

Auxiliary boiler house will be provided with natural intake and mechanical exhaust ventilation by roof axial fans.

Natural ventilation systems will be provided for bulldozer house, material storage & workshop and fire-fighting garage.

Natural air intake and mechanical exhaust system will be provided for sewage waste water station and industrial waste water treatment plant. The rate of air exchange will not be less than 6 times per hour.

2.8.3 Air Conditioning System

3.10.2.5 Central refrigerating system

Three sets of Air-cooled water chillers with 50% capacity will be installed on the roof of the control building. The chillers will produce chilled water with supply temperature of 7°C and return temperature 12°C. The chilled water will be pumped to the AHU and FCU in the main block.

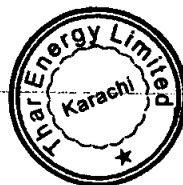
3.10.2.6 Air Conditioning System for Central Control Room and Electronics Room in Main Block

An air conditioning system will be provided for central control room to maintain the required indoor temperature and humidity. Also an air conditioning system will be for relay room and electronics room. In each air conditioning system, air handling units will be designed for 2x100% capacity. One is in operation, another standby.

The temperature and relative humidity for central control room, relay room, and electronics room will be designed as following:

Summer: $t = 25 \pm 1^\circ\text{C}$, $\text{RH} = 50 \pm 10\%$

Winter: $t = 20 \pm 1^\circ\text{C}$, $\text{RH} = 50 \pm 10\%$





A slight positive pressure shall be kept to avoid infiltration of dust for central control room and electronics room.

3.10.2.7 Air Conditioning System for Other Rooms in Main Block

In DC & UPS distribution room, Instrumental analysis room of steam & water sampling and condensate polishing treatment control room, fan coil units with electric heater will be provided to maintain indoor temperature at required range: 26 ~ 28°C in summer and 18°C in winter.

Fan coil units will be provided for cooling in summer for all electrical distribution rooms in the main block, which will maintain the temperature not exceeding 35°C.

Two sets of Air-cooled water chillers with 50% capacity will be provided. The chilled water will be pumped to the rooms mentioned above.

3.10.2.8 Air Conditioning System for Other Rooms

Air-cooled heat pump split air conditioners will be provided for following rooms to maintain indoor temperature at 26~28°C in summer and 18°C in winter:

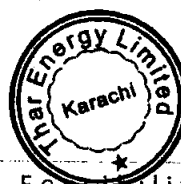
- 1) Water treatment plant control room and offices
- 2) Water treatment plant testing room and analysis room
- 3) Ash handling control room
- 4) Coal handling control room
- 5) Elevator machine room
- 6) Guard room
- 7) Control rooms of pump house
- 8) Offices

Explosion-proof air-cooled heat pump split packaged air conditioner will be provided for battery room.

3.10.3 Dust Collection System

3.10.3.1 Dust Collection for Coal bunker bay and Transfer Points

In order to guarantee a good sanitary condition for personnel working, dust collection systems will be provided by bag separators for all transfer points at transfer towers, crusher house and coal bunker bay. Water spray systems will be provided at the transfer points



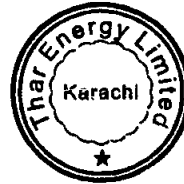


3.10.3.2 Dust Suppression for Coal Yard

The coal yard will be served with a water spray system to prevent the flying of dust. The water spray system is mainly consisted of a water tank, an automatic water supply installation, piping, spray guns and a water spray control panel. The water tank and water supply installation will be installed at ground floor in No1 transfer tower. The main pipe will be arranged along the wall around the coal stack. Spray guns with associated solenoids will be connected with main pipe. The diameter of the gun is 20mm, working pressure 0.5MPa, shot arrange 40m, water flow rate 35.9m³/h. The opposite two spray guns will put into operation one after one in turn during the water spray on coal stack in coal yard. The spray course will be controlled automatically through PLC and manually started on/off by the operator.

3.10.4 Vacuum Cleaning System

Boiler house, coal bunker bay and coal conveyor gantry will be provided with vacuum cleaning system for cleaning the dusts on the equipment, pipes and floors. The main equipment in the system will be a vacuum dust suction truck, which can be put into operation when connected with the stationary piping networks extended to each platform of the boiler and each floor of coal bunker bay.





3.11 COMMUNICATION IN THE POWER PLANT

3.11.1 General

A complete communication system is provided with high applicability, reliability, economical transmission and distribution. The communication equipment and material supplied are both high quality, with fast, reliable and clear transmission functions, easy for maintenance and redundant for main elements.

3.11.2 Internal Telephone System

3.11.2.1 *Private Automatic Branch Exchange*

The digital PABX is supplied for this system which can provide 256 lines (include of exchange lines and extension lines). It consists of attendant console, maintenance terminal. The PABX system will be provided with the following functions:

Extension to extension calls will be made by direct dialing. Extension to exchange lines and PLC lines for dialing a single access digit will make outgoing calls. Operator access from extension by dialing a single digit will be required. Trunk barring on outgoing calls will be provided as required on selected extensions. Provision for limited barring on outgoing calls from selected extensions will be provided.

Operator recall from an extension engaged with an incoming or outgoing call will be affected by operation of a recall button followed by dialing the operator access digit. Call transfer between extensions on incoming and outgoing public exchange calls will be provided.

Operator intrusion into an established call in order to offer an exchange call or urgent message will be provided. An intrusion tone will be introduced. Exchange alarms will be extended to the operator's console or switchboard.

3.11.2.2 *Telephone Facilities*

PABX telephones should be located as follows:

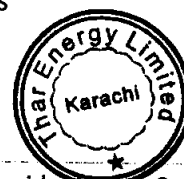
Central Control room

Steam turbine unit

Auxiliary control room

Office, Managers room, Workshop, etc

Administration building, guardhouses and other buildings





3.11.3 Paging System

3.11.3.1 General

The paging system equipment will be selected to meet the requirement of high automation, reliability, accomplish page/party and dispatching functions. It consists of main equipment such as center exchange, slave station, amplifier assemblies and loudspeakers, power supply and cable distribution network. The capacity of center exchange is 96 lines. 50 intercom stations (include of loudspeakers) can be used in indoor and outdoor places.

3.11.3.2 Function

1) Commanding Communication

Commanding and paging will be made from any handsets through the local speaker sets.

2) General Communication

When the other party answers the paging, general communication is established by releasing the page button. Simultaneous two way conversations will be possible on one same channel.

3.11.4 Power line carrier (PLC) communication

Considering the system communication network is not clear, so at present the PLC will be considered to communicate from the proposed switchyard to the remote substations.

Normally, PLC communication will be designed on the assumption that two PLC channels will be built on each power transmission lines from the switchyard to the remote substation. The PLC will be used to transmit dispatching speech, protection and tele control signals. The PLC terminals, line traps and coupling device in the switchyard will be supplied according to remote substation's requirement. The PLC equipment in remote substation are not in the scope of contractor.

3.11.5 Power Supply System

The communication equipment will be supplied by special communication power supply system. To improve the reliability and to lower the consumption of electricity, high frequency switch power will be adopted. Based on microprocessor, the supervision, control function and the friendly interface. It will include switch power module, system supervision and control unit, AC distribution unit, DC distribution unit.

The Internal communication power supply system for power plant will consist of two sets of high frequency switch power equipment and two banks of maintenance-free batteries.



Another set of communication power supply system will be provided for system communication of the switchyard, it will consist of two sets of high frequency switch power equipment and two banks of maintenance-free batteries

3.11.5.1 *The High Frequency Switch Power*

Specification:

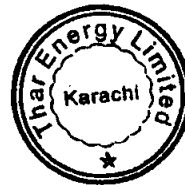
AC input	3 phase 4 wires 50/60Hz 380V $\pm$ 5%
Capacity of single module	30A/Module
Total capacity	4x30A+30A back up
Rated DC output Voltage	- 48 V

3.11.5.2 *Battery*

The 48V DC battery supplied will give long-time trouble-free service and provide adequate and uninterrupted power supply for communication system. It connects with DC-48V Switch Power equipment and operates with float charging mode.

Specification:

Quantity:	Two banks (24 cells for each bank)
Capacity:	300 Ah





3.11.6 Emission Controls

3.11.6.1 Low NO_x Emissions

When air is used as the source of oxygen for combustion, the heat of combustion causes significant conversion of nitrogen and oxygen to various oxides of nitrogen (NO_x). The Project will have CFB technology boiler that has low furnace temperatures of 800° to 900° C plus staging of air feed to the furnace produces very low NO_x emissions.

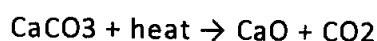
The Project will meet the National Environmental Quality Standards (NEQS) and recommendations of ESIA after air dispersion modelling to meet NO_x limits in stack.

3.11.6.2 Low SO_x Emissions

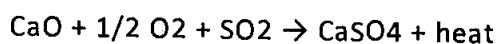
During coal combustion virtually all the sulfur is converted to sulfur dioxide (SO₂) gas. Since the Project will have a CFB boiler.

Sulfur is captured with limestone in the combustion chamber. The limestone reactions with the sulfur take place in two steps:

a. Calcination of limestone



b. Reaction with sulphur

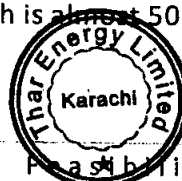


The product, CaSO₄, is an inert substance known as gypsum. The sulphur capture requires some excess amount of limestone present. The amount of excess limestone is dependent on a number of factors such as the amount of sulphur in the fuel, the temperature in the combustion system, and the physical and chemical characteristics of the limestone. The ideal reaction temperature range is 840-900 °C.

CFB boilers will be equipped with in-furnace sulphur removal systems consisting of pneumatic conveying lines with feeding points located in the lower furnace. Limestone is evenly distributed to the furnace front and rear walls.

3.11.6.3 Particulate Emissions Control

One of the by-products of burning coal is significant quantity of non-combustible material. Non-combustible material is known as ash. A portion of the ash forms large particles and falls to the bottom of the furnace. This is known as bottom ash/slag. In CFB boilers, the collection in the form of bottom ash is almost 50% that leads to reduce the load on the Electrostatic Precipitators.





Big slag particles removes from the bottom, however, lighter particles carried out of the furnace by the flue gas. This is called fly ash. The Project will be fitted with an Electrostatic Precipitator (ESP) to control particulate limit and remove nearly all the particulates form the flue gas.

The particulate collector is expected to operate at an emission rate of 30 – 60 mg/Nm³. The Project will meet the National Environmental Quality Standards (NEQS) and recommendations of ESIA to meet the PM limits in stack.

3.11.6.4 Thermal Discharge

Effluents from cooling system will result in the production of a thermal plume. The details of the thermal plume modeling and expected limits are specified in the ESIA report.

3.11.6.5 Noise

The plant is located in a very sparsely inhabited area; therefore, any impact to local residents is minimal. The plant will be designed to control the noise generated to meet international and Pakistan regulations within the plant and at the fence line. Details discussion on noise control measures are mentioned in ESIA report.

3.11.6.6 Ash

Ash will be stored in an ash yard which is close by to the plant site but not within the premises. The fly ash may be sold if a market exists, otherwise it will be dumped in the same ash yard.

Ash dumping in mine area from where the coal is being excavated is another option of dumping ash, and this option would be materialized after approximately 3 years of plant operation. Therefore, in any case, ash yard with the capacity of at least 3 years will be required for this project.

3.11.6.7 Airborne Dust from Coal Storage Yard

The potential dust from the coal piles will be controlled by a combination of water sprays, wind screens, and, if necessary, covers. The wind screens will be fabric fences to reduce the wind that would dry the surface of the pile and pick up the dust. Water sprays will reduce the amount of dust pickup by the wind. In addition, if necessary, fabric covers can be placed over the idle portions of the coal piles to prevent airborne dust.

3.11.6.8 Liquid Effluents

All effluent water of power plant processes and sewage will be treated before being disposed to meet the regulations specified in NEQS of Pakistan.

More details are provided in the waste water treatment section and ESIA report.



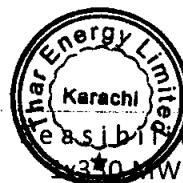
4 Labor Safety

4.1 Basis for preparation

All relevant OSHA standards and Best industrial practices.

Applicable China national standards, regulations and codes

- 1) *Code for Fire Protection Design of Buildings* (GB50016-2006);
- 2) *Code for Seismic Design of Buildings* (GB50011-2010);
- 3) *Code for the Design of Lightning Protection of Buildings* (GB50057- 2010);
- 4) *Code for the Design of Compressed Air Station* (GB50029-2014);
- 5) *Code for the Design of Electric Installations within Explosion and Fire Hazard Atmosphere* (GB50058-92);
- 6) *Code for the Design of Petroleum Depots* (GB50074-2002);
- 7) *Code for the Design of Automatic Sprinkler System* (GB50084-2005);
- 8) *Code for the Design of Automatic Fire Alarm System* (GB50116-2013);
- 9) *Code for the Design of Extinguisher Disposition in Buildings* (GB50140-2005);
- 10) *Code for the Design of Low Expansion Foam Extinguishing System* (GB50151-2000) (edition 2000);
- 11) *Code for the Design of Hydrogen Station* (GB50177-2005);
- 12) *Code for the Design of Carbon Dioxide Fire-extinguishing System* (GB50193-93 edition 1999);
- 13) *Code for the Design of Water Spray Fire Extinguishing System* (GB50219-95);
- 14) *Code for Fire Protection Design of Thermal Power Plant and Substation*(GB50229-2006);
- 15) *Code for the Design of Cables of Electric works*(GB50217-2007);
- 16) *Safety Color*(GB2893-2001);
- 17) *Safety Marking*(GB2894-96);
- 18) *Safety Requirements for Fixed Steel Ladder and Platform, Part 1: Steel Straight Ladder* (GB4053.1-2009);
- 19) *Safety Requirements for Fixed Steel Ladder and Platform, Part 2: Steel Inclined Ladder* (GB4053.2-2009);

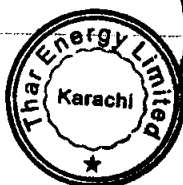




- 20) *Safety Requirements for Fixed Steel Ladder and Platform, Part 3: Industrial Guardrails and Steel Platform (GB4053.3-2009);*
- 21) *Fixed Industrial Steel Platform (GB4053.4-1993);*
- 22) *Safety Procedure for the in-plant transport of Industrial Enterprise(GB4387-2008);*
- 23) *General Rule for the Design of the Safety and Health of Productive Equipment (GB5083-1999)。*

Industrial procedures, codes and regulations

- 1) *Safety Supervision Procedure for the Boilers and Pressure Vessels of Electric Industry (DL612-1996);*
- 2) *Overvoltage Protection and Insulation Coordination of AC Electrical Installations (DL/T620-1997);*
- 3) *Grounding of AC Electrical Installations (DL/T621-1997);*
- 4) *Code for design of fossil fired power plant (GB 50660-2011)*
- 5) *Specification for the Design of the Civil Structure of Thermal Power Plant (DL5022-2012);*
- 6) *Typical Fire Protection Procedure of Electric Equipment (DL5027-93);*
- 7) *Procedure for the Design of the General Plan & Transport of Thermal Power Plant (DL/T5032-2005);*
- 8) *Procedure for the Design of Occupational Safety of Thermal Power Plant (DL5053-2012);*
- 9) *Procedure for the Design of Occupational health of Thermal Power Plant (DL5454-2012);*
- 10) *Specification for the Design of Steam/water Piping of Thermal Power Plant (DL/5054-1996)*
- 11) *Specification for the Chemistry Design of Thermal Power Plant (DL/T5068-2006);*
- 12) *Specification for the Architectural Design of Thermal Power Plant (DL5094-2012);*
- 13) *Specification for the Design of Coal Handling of Thermal Power Plant, Part 1: Coal-handling System (DL/T5187.1-2004);*
- 14) *Code for the Hydro technical Design of Thermal Power Plant (DL/T5339-2006);*
- 15) *Specification for the Lighting Design of Thermal Power Plant and Substation (DL/T5390-2014);*
- 16) *Specification for the Design of High-voltage Power Distribution Device (DL/T5352-2006).*





17) Notice on the Issuance of the *Regulation of the Detection, Supervision and Management of the Labor Environment of Electric Industry* dianzong [1998] No. 126 issued by Ministry of Electric Power

Processes and locations of the power plant where safety precautions shall be taken

- 1) Explosion protection of boiler and pressure vessels;
- 2) Fire protection of various types of building(structure)and oil system;
- 3) Safety-related accidents of electrical equipment;
- 4) Injury accidents of various types of rotating machinery;
- 5) Safety facilities of platform, staircase and handling hole/opening;
- 6) Emergency lighting measures

4.2 Fire protection and explosion protection

Fire-protection design principles and measures for buildings (structures)

- 1) Fire-protection design principles for buildings (structures)

The minimum distance among the main buildings (structures) of this project meets the minimum distance requirement of various types of building (structure) of power plant as specified in *Code for Fire Protection Design of Buildings* (GB50016-2006) and *Code for design of fossil fired power plant*(GB 50660-2011) and in API codes.

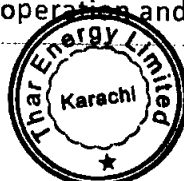
- 2) Fire hazard and minimum fire-resistant rating of various buildings(structures)in production

The fire-resistant rating of various buildings (structures) of this project will meet the regulation of *Code for Fire Protection Design of Buildings* (GB50016-2006), *Code for Fire Protection Design of Thermal Power Plant and Substation* (GB50229-2006) and *Code for design of fossil fired power plant*(GB 50660-2011) as per the fire hazard encountered in production.

- 3) Safety precautions for the fire protection and explosion protection of the main power house as well as the arrangement of escape passage and access

A row columns of the main power house is provided with steel staircases leading to various stories of steam turbine house, as well as the exits directly leading to outside so as to ensure the distance from the furthest workplace to safety emergency exit in the main power house does not exceed 50m. Class C fire-resisting doors are adopted in all power distribution unit rooms, cable interlayers and cable shafts.

The internal traffic of the main power house is designed to meet the requirements of existing fire-protection procedures and codes, and consideration is given to the safety and convenience of production, operation and maintenance.





Plant-wide fire-fighting and alarm facilities

On the base of the working guideline "prevention first and combating fire extinguishment with fire prevention", the fire-protection system of the power plant is designed according to the requirements of standard, regulation and code listed in clause 9.1.

Independent firewater supply pipe network is provided in the plant area and is arranged as annular pipe network.

In addition to indoor and outdoor hydrants systems in this project, foam fire-extinguishing system, automatic sprinkler system, water spray fire-extinguishing system, gas fire-extinguishing system, automatic fire alarm system, movable fire extinguishers and the like are provided as per different protection objects in accordance with the requirements of *Code for Fire Protection Design of Thermal Power Plant and Substation* (GB50229-2006). And also, two fire engines are provided (one of which is water fire engine, and the other one is foam fire engine).

Emergency oil tank is provided outside Arrow columns in the main power house so as to accept the oil drained from the oil tanks of transformer and steam turbine in the event of an accident.

1) Fire-protection measures for transformers

The distance between transformers shall meet the requirement of fire protection as per relevant procedures and regulations. The transformers are provided with oil sumps and oil drain facilities so that the oil inside oil sump can be drained into the emergency oil tank via oil drain pipeline at the bottom of the sump when oil is drained under an accident condition.

2) Fire protection of cables

The fire protection of cables shall be designed according to the regulations of *Code for the Design of Cables of Electric works* (GB 50217).

Necessary fire-resisting wall shall be provided in cable tunnels and cable trenches; the holes in cable shaft, the openings at the lower part of switchboard and penetration holes shall be plugged; fire-resisting partitions and automatic fire extinguishers shall be provided at the areas where cables are densely arranged.

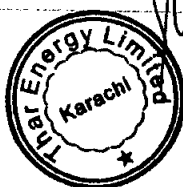
3) Explosion protection measures for electrical facility

The ventilators and their motors in storage battery room shall be of explosion-proof type.

Technical safety precautions for pressure vessels and explosive units

1) Explosion-protection measures for boilers

Boilers furnace be provided with furnace safety monitoring system. The furnace will be equipped with soot-blowing equipment. In order to prevent combustible material from





being remained in the furnace during boiler shutdown, the furnace will be soot-blown before main fuel is tripped and the fuel is ignited.

Safety valves shall be provided for superheaters and reheaters.

2) Explosion-protection measures for pressure vessels

Safety valves shall be provided for deaerator, blowdown flash tank, high-pressure heater and low-pressure heater so as to prevent explosion.

Fire protection and explosion protection for fuel oil tank & hydrogen generation station

Fuel oil tank farm is a highlighted fire-protection area, and shall be provided with tall enclosing wall around so as to individually form an area. Fire dike shall be provided around the fuel oil tank farm, in which the effective volume shall conform to the regulation, i.e., "the effective volume inside a fire dike shall not be smaller than the capacity of the largest oil tank of the oil tank bank". The distance between oil tanks and the distance between oil tank and fire dike shall conform to the regulation, i.e., "the distance from vertical oil tank to the slope feet line in a fire dike shall not be one half smaller than the height of tank wall". The distance among various buildings (structures) in the fuel oil tank farm shall meet the regulations of fire separation as specified in *Specification for the Design of the General Plan & Transport of Thermal Power Plant*. In addition, water and foam fire-extinguishing systems shall be provided in the fuel oil tank farm as per relevant fire-protection regulations.

Hydrogen generation station area is also a highlighted fire-protection area, and shall be provided with tall enclosing wall around so as to individually form an area. This area is consisted of hydrogen storage tank and hydrogen generation station. The distance between hydrogen storage tank and hydrogen generation station and the distance between hydrogen generation station and other buildings (structures) shall conform to the regulations as specified in *Specification for the Design of the General Plan & Transport of Thermal Power Plant*.

4.3 Protection against injuries.

Design principles for plant-wide lightning-protection grounding and its safety precautions

The lightning-protection grounding of this project shall be designed according to the relevant regulations of *Overvoltage Protection and Insulation Coordination of AC Electrical Installations* DL/T620. Lightning rods/conductors shall be provided for the incoming lines and outgoing lines of 500kV power distribution units; independent lightning rod shall be provided in fuel oil pump house; multiple lightning rods shall be provided on the top of stack; high and large buildings such as the crusher room of coal-



handling system shall be provided with lightning band, and measures shall be taken to protect against direct lightning strike.

Hydrogen generation station, fuel oil pump house and their pipelines shall be protected against static electricity and lightning induction.

Plant-wide grounding shall be accomplished according to the requirements of *Grounding of AC Electrical Installations* DL/T621, and grounding material shall be made of steel.

Technical measures for preventing electrical maloperation

- 1) Blocking devices shall be provided among disconnecting switches, applicable circuit breakers and grounding knife switches. The blocking devices shall be consisted of mechanical, electromagnetic and electrical circuits.
- 2) High-voltage switch cabinets shall be of the equipment available "five-prevention" functions.

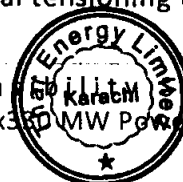
Isolation protection measures between live electrical equipment and operation personnel and the countermeasures for the impact of high voltage on personal safety

- 1) The clear safety distance of all items of live electrical equipment shall not be smaller than the minimum values specified in various relevant procedures.
- 2) The enclosures of live electrical equipment shall be grounded.
- 3) To prevent overvoltage from endangering personal safety, when determining the type and arrangement of grounding devices, care shall be taken to decrease contact potential and step potential as far as possible, and to allow contact potential and step potential not to exceed the values specified in relevant procedures.

Measures against mechanical injury

There are a great amount of mechanical equipment rotating during the operation of power plant; for this reason, getting done well with the protection of rotating machinery is quite necessary for protect the personal safety of operation personnel. It intends to take the following measures in the aspect of the prevention of mechanical injury:

- 1) Provide protective hoods for the exposed rotating part of rotary machinery;
- 2) Provide necessary interlock devices for rotary machinery;
- 3) As for the machinery with long transfer distance, provide spanning staircases with guardrails at spanning points;
- 4) Install protective hoods or baffles in the rotating parts of the equipment of coal-handling system ; Provide removable guardrails at two sides of belt conveyers; provide guard fence under the movement weight pulley of vertical tensioning device;





- 5) Provide removable guardrails that are not lower than the highest point of upper supporting roller, at the operation passage side of belt conveyor;
- 6) Provide railing within the throwing range of belt-type iron removal equipment;
- 7) Coal-handling belt conveyor is provided with startup predictor so as to prevent the unit from being started up by mistake; Pull switches are provided along the line so as for emergency brake.

Measures against fall injury

- 1) Guardrails or cover plates are provided surrounding the staircases, platforms, sumps, ponds and holes/openings of the power plant. The height of the guardrails surrounding indoor platforms and holes/openings shall not be less than 1.05m; the height of the guardrails surrounding outdoor platforms and holes/openings shall not be less than 1.10m; the height of the guardrails surrounding the platforms and holes/openings above 20m high shall not be less than 1.20m. Anti-slip measures shall be taken for staircases and platforms.
- 2) Parapet with headroom exceeding 1.20m shall be provided on the roof on which personnel may walk.
- 3) The access ladders on cooling tower and the like shall be provided with protective cages, and rest platforms shall be provided in the middle of access ladders.

4.4 Safety color and safety marking

Carrying out the design of color conditioning in workplaces is in favor of intensifying identification sense, centralizing attention and reducing asthenopia. Color conditioning can adjust the emotion of operation personnel and improve production efficiency during work, thus decreasing the occurrence rate of accident.

The setup locations and type of safety color and safety marking are shown in the following table.

Marking name	Safety color	Setup location	Marking content
Prohibition	Red	1.cable entry, access of oil system room	Smoke and fire prohibited
Warning	Yellow	1. Fence or railing of electrical equipment	Caution: electric shock





		2. Enclosures or frames of equipment on which temperature-rise exceeds 65K	Caution: high-temperature injury
		3. Fence or railing surrounding collection wells and the holes for hoisting objects 4. The upper end of steel straight ladder above 2.0m	Caution: fall
		5. Entrances of mechanical maintenance workshop and the workshops of repair factory	Caution: mechanical injury
		6. Steel inclined ladder above 55°	Caution: slipping and fall
		7. Main traffic crossings	Caution: vehicles
Instruction	Blue	1. Compressed air equipment room	Use ear protectors
Information	Green	1. Fire-fighting facility	Hydrant
			Fire extinguisher
			Fire hose
		2. Evacuation exit	escape passage, emergency exit

4.5 Other safety measures

The design of lighting system shall be in accordance with the requirements of the valid *Specification for the Lighting Design of Thermal Power Plant and Substation* (DL/T5390—2007). The lighting system of this project is consisted of three independent subsystems, i.e., normal AC lighting system, emergency AC lighting system and DC emergency lighting system.

The AC lighting system shall adopt 380/220V, 3 phases, 4-wire and neutral solidly grounded system. The voltage for lamp is 220V; the maintenance lighting voltage for boiler body is 12V; as for the lighting in cable tunnels, 220V power supply with leakage protection shall be used.





4.6 Labor safety organizations and facilities

Monitoring & supervision station of labor environment of power plant

It tentatively intends to build a monitoring & supervision station of labor environment of power plant in this project.

Safety education office

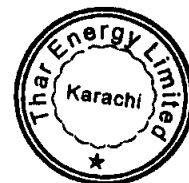
It tentatively intends to establish a safety education office in this project.

4.7 Security system

Based on the actual situation of the site of this project, see the relevant document that is entrusted separately for the details about security system.

4.8 Conclusions

- 1) Labor safety measures should meet the Mandatory codes, standards and regulations in Pakistan, OSHA Standards, API Codes as well as China national standards, regulations and codes. However they will be finalized during EPC contract negotiations
- 2) After the corresponding measures are implemented, the work safety condition of the workplace of the operation personnel of the power plant can meet the requirements of relevant standards.



5 Occupational Health

5.1 Basis for preparation

Mandatory codes, standards and regulations in Pakistan.

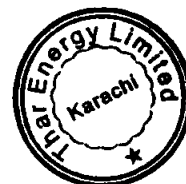
All relevant OSHA Codes.

Applicable China national standards, regulations and codes

- 1) *General Rule for the Design of the Safety and Health of Productive Equipment* (GB50187-1999);
- 2) *Hygienic Standard for the Design of industrial Enterprises* (GBZ1-2010);
- 3) *Occupational Exposure Limits of Harmful Factors in Workplaces, Part 1: Chemical Harmful Factor*(GBZ2.1-2007);
- 4) *Occupational Exposure Limits of Harmful Factors in Workplaces, Part 2: Physical Factors* (GBZ2.2-2007);
- 5) *Code for the Design of Noise Control in Industrial Enterprises* (GB/T50087-2013);
- 6) *Standard for the Daylighting of Buildings* (GB50033-2013);
- 7) *Code for the Design of Heating, Ventilation and Air Conditioning* (GB50019-2003);
- 8) *Code for the Design of General Plan for Industrial Enterprises* (GB50187-2012);
- 9) *Guideline for the Gas Management and Test in Sulfur Hexafluoride Electrical Equipment*(GB/T8905-2012);
- 10) *Code for the Design of Compressed Air Station* (GB50029-2014)

Industrial procedures, codes and regulations

- 1) *Code for design of fossil fired power plant*(GB 50660-2011);
- 2) *Procedure for the Design of Occupational Safety of Thermal Power Plant* (DL5053-2012);
- 3) *Procedure for the Design of Occupational Health of Thermal Power Plant* (DL5454-2012);
- 4) *Specification for the Design of General Arrangement and Transportation of Thermal Power Plant* DL/T5032-2005
- 5) *Specification for Architectural Design of Thermal Power Plant* (DL/T5094-2012);



- 6) *Specification for the Design of Heating, Ventilation and Air Conditioning of Thermal Power Plant (DL/T5035-2004);*
- 7) *Specification for the Design of Coal-handling of Thermal Power Plant, Part 1: Coal-handling System (DL/T5187.1-2004);*
- 8) *Specification for the Design of Coal Handling of Thermal Power Plant, Part 2: Coal Dust Prevention (DL/T5187.2-2004);*
- 9) *Specification for the Design of Coal Handling of Thermal Power Plant, Part 3: Coal-handling Automation (DL/T5187.3-2004);*
- 10) *Specification for the Chemistry Design of Thermal Power Plant (DL/T5068-2006);*
- 11) *Specification for the Lighting Design of Thermal Power Plant and Substation (DL/T5390-2014);*
- 12) *Specification for the Design of domestic, Firewater Supply & Drainage of Thermal Power Plant (DLGJ24-91);*
- 13) *Specification for the Monitoring of Labor Environment in Electric Power Industry (DL/T799.1~7-2012)*

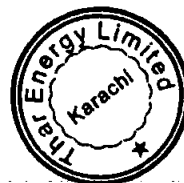
5.2 HSE Processes and locations of the power plant

- 1) Coal-handling system, such as the dust produced in coal-unloading device, crusher room, belt layer and various transfer stations;
- 2) Protective measures for the locations where harmful substance and corrosive fluid exist;
- 3) The main power house of the power plant belongs to high-temperature workshop, for this reason, insulation and cooling are to be provided at the higher level and the areas of the main power house where heat sources exist;
- 4) Prevention of noise originated from the rotary machinery such as turbogenerator unit, etc

5.3 Measures against dust, toxicity and chemical injury

Design principles and measures for dust protection

- 1) Design principles for dust control



As for the design principles of the coal dust treatment of coal-handling system, the coal-handling system of the power plant shall be given "prevention first, and combining prevention with treatment" comprehensive treatment in accordance with *Hygienic Standard for the Design of industrial Enterprises* (GBZ1-2010), *Code for design of fossil fired power plant*(GB 50660-2011), *Specification for the Design of Coal Handling of Thermal Power Plant, Part 2: Coal Dust Prevention* (DL/T5187.2-2004) and *Specification for the Design of Heating, Ventilation and Air Conditioning of Thermal Power Plant* (DL/T 5035-2004).

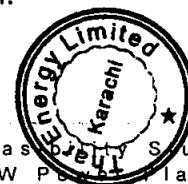
2) Comprehensive treatment measures for coal dust

The dust removal system shall be designed and arranged in such a manner that the area of dust-removing equipment room is minimized; care shall be taken to closely cooperate with the personnel of relevant process disciplines to share some passages and spaces as far as possible in combination with the integral arrangement of the entire coal-handling building so as to control the volume of the coal-handling building within a rational range, thus decreasing construction cost.

Measures against toxic and chemical injury

The corrosive fluid that are stored in the power plant and the harmful gases produced in relevant locations are mainly stored or produced in chemical system. In order to make the concentration of the harmful substance of workshops be lower than the maximum allowable concentration specified in *Occupational Exposure Limits of Harmful Factors in Workplaces* (GBZ2.2-2007) and to protect the health of operation personnel, it intends to take the following protection measures:

- 1) Protective cofferdams are provided surrounding acid & alkali storage equipment. Safety passages, showers, flushing and draining facilities are provided in acid & alkali storage rooms, metering room and acid & alkali pump house. Pumping mode will be used when concentrated acid and alkali liquor is loaded and unloaded.
- 2) The acid & alkali pipeline shall not be laid overhead in the indoor locations where people often pass by; Where overhead arrangement is necessary, protection measures shall be taken at flanges and connections.
- 3) The drummed ammonia liquor used for chemical dosing shall be placed in chemical dosing room. Breathers shall be provided in the agitating solution tank of ammonia liquor so as to prevent ammonia vapor from being diffusing into atmosphere.
- 4) Mechanical exhaust unit is provided in chemical dosing room.



5.4 Sunstroke prevention and cold prevention

Ventilation system

1) Ventilation in steam turbine house

The ventilation mode of natural air intake and mechanical exhaust will be adopted in the steam turbine house. The outdoor air naturally enters the steam turbine house through the electric rainproof shutter below the operating layer at Row A and the opened windows of the building at the operating layer in the steam turbine house; moist and hot air is exhausted with the ventilators on the roof of the steam turbine house.

2) Central control building

The diesel generator house of the central control building is provided with mechanical ventilation unit, and explosion-proof axial flow fan is used for exhaust; cable interlayer is provided with mechanical ventilation unit, and explosion-proof axial flow fan is used for exhaust; air conditioner room is provided with mechanical ventilation unit, and explosion-proof axial flow fan is used for exhaust. Other process rooms in the central control building will be provided with mechanical ventilation system respectively according to actual demand and the requirements of process equipment as well as specific arrangement situation, and applicable technical measures are taken as per explosion-proof and anticorrosion requirements.

With respect to the air intake mode of various rooms, the natural air intake of combined filter tuyere or shutter tuyere will be used as required.

3) Rechargeable battery room

Emergency ventilation unit is provided for maintenance-free lead-acid storage battery in the rechargeable battery room; the ventilation mode of natural air intake and the mechanical exhaust of axial flow fan will be adopted. All items of ventilation equipment shall be of anticorrosion and explosion protection.

4) All power distribution unit rooms and MCC rooms in the entire plant are provided with mechanical ventilation units which can be used for emergency ventilation as well as ventilation and air change under normal condition.

5) As for the remaining productive and auxiliary productive buildings, mechanical ventilation systems will be provided in the rooms where harmful gases are emitted and residual heat and moisture are generated, according to actual demand and the requirements of process equipment, and applicable technical measures will be taken as per explosion-proof and anticorrosion requirements.

Air conditioning system

A central control building will be set up for the two Units in this project. The air conditioning system in the central control building mainly serves the process equipment rooms such as unit control room, engineer room and electronic equipment room, etc.

Local split-type air conditioners will be used for local arrangement and control in the remaining control rooms and other rooms of the plant where specific process temperature and humidity requirements exist.

5.5 Noise control and vibration prevention

Analysis for the ambient sound sources of the power plant

The ambient sound sources of the power plant mainly includes the noise caused by the running, vibration, friction and impingement of various types of mechanical equipment; the noise caused by the movement, capacity expansion, exhaust and gas leakage of various types of fan, air duct, steam pipe and high-pressure gas flow; the noise caused during the combustion and gasification of gases inside boiler as well as the convection process of flue gas movement; the noise caused during the alternate motion of the magnetic field of power generator, exciter, transformer and other electrical equipment; and the noise caused by the drive of transport vehicles in the plant area and other vehicles.

Design standard for noise control

On the base of NEQS limits and *Code for the Design of Noise Control Standard in industrial Enterprises* (GB/T 50087-2013), the noise limits in various types of workplace will be ensured within limits

Noise control measures

Decreasing the ambient noise of workshop is one of important measures for ensuring safety operation, protecting the physical and mental health of staff and improving the working atmosphere of operation personnel. Decreasing noise shall be first started with the radical treatment of equipment, i.e., decreasing the noise level of noise source; and then, necessary measures shall be taken in the aspect of the arrangement of building and the construction treatment of buildings so as to allow the ambient noise value of workshop to meet the allowable national standards. The concrete measures to be taken in design are as follows:

- 1) Manufacturers are requested to supply the equipment that conforms to the noise standards of the State when the types of various main equipment and auxiliary equipment are chosen.

- 2) Control valves and relief valves shall be of low-noise valve.
- 3) As for the equipment that produces high noise such as coal crusher, high-pressure fan, temperature & pressure-reducing units, air compressor and the head of steam turbine, sound elimination and isolation measures shall be taken.
- 4) Silencers shall be installed on boiler ignition vent pipe that discharges to atmosphere, and on the vent pipe of the safety valve of boiler.
- 5) An acoustic doors and windows shall be used in the central control room where noise requirement is high. Double room shall be provided at the entrance of central control room. In order to decrease the reverberant sound inside the rooms, perforated acoustic mineral wool board shall be used on ceiling, and the perforated acoustic mineral wool board lined with mineral wool felt shall be used as suspended ceiling.
- 6) The enclosed doors and windows of communication room and sampling room of chemical water, in which air conditioning units are used, are available with sufficient sound insulation performance.

Health limits for vibration

On the base of *Hygienic Standard for the Design of industrial Enterprises*, the health limits of local vibration strength are shown in Table 10.5.4-1. The vertical or horizontal vibration strength of auxiliary rooms affected with vibration shall not exceed the limits specified in Table

Health limits for full-body vibration strength

Daily exposure time (t,h)	Health limit (m/s ²)
$4 < t \leq 8$	0.62
$2.5 < t \leq 4$	1.10
$1.0 < t \leq 2.5$	1.40
$0.5 < t \leq 1.0$	2.40
$t \leq 0.5$	3.60

Health limits for the vertical or horizontal vibration strength of auxiliary rooms

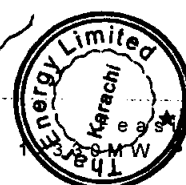
Exposure time (hour/d)	Health limit (m/s ²)	Work-efficiency limit (m/s ²)
$4 < t \leq 8$	0.31	0.098
$2.5 < t \leq 4$	0.53	0.17
$< 1.0 < t \leq 2.5$	0.71	0.23
$0.5 < t \leq 1.0$	1.12	0.37
$t \leq 0.5$	1.8	0.57

Vibration-proof measures

- 1) Manufacturers are requested to supply the equipment that conforms to the vibration standard of the State when the types of various main equipment and auxiliary equipment are chosen.
- 2) Vibration-damping measures shall be taken at the connections between air duct and enclosing structure and between floor slabs of central control room, main control room, unit control room and computer room; Vibration-damping measures shall also be taken for air conditioning system.
- 3) Vibration-damping measures shall be taken in the design of steam and water pipe on which vibration tends to occur.

5.6 Personal protection equipment for occupational disease

The power plant shall provide the working personnel with personal protection equipment that conforms to the requirements of applicable national standards, for example, provide anti-dust respirators for the workers working in dusty atmosphere; provide protective suits & caps, gloves and goggles for the personnel working in acid & alkali-contact posts; provide noise-proof ear protectors for the personnel working in noisy atmosphere; provide necessary gas masks for the personnel who manually fill ammonia, hydrazine or who manually prepare toxic substance such as hydrochloric acid, sulfuric acid and the like; provide shielding suits for the personnel working in microwave station and switchyard, etc. All selected personal protection equipment shall conform to the requirements of applicable national standards.



5.7 Warning identification of occupational disease hazard in workplaces

Warning identification of occupational disease hazard shall be provided in the eye-striking positions of the power plant where occupational disease hazard possibly occurs.

5.8 Occupational health management

Adhere to the working guideline of prevention and curing of occupational disease, i.e., prevention first, and combining prevention with curing, so as to create the working environment and condition conforming to occupational health standards and requirements for laborers. Strengthen employees' training in occupational health knowledge; fully understand the severity and preventability of occupational disease and intensify individual protection sense.

Establish strict management and utilization system of personal protection equipment. Check the allocation, distribution and utilization of occupational disease protection equipment and labor protection equipment so as to ensure that employees can strictly use valid personal protection equipment of occupational disease under normal production condition.

Establish the production management system of occupational health and safety, and ensure that enterprises can obey the national regulations, namely, when a project is constructed, the protection facility of occupational disease shall be designed, constructed and put into production and service at the same time when the main part of the project is designed, constructed and put into production and service. Care shall be taken to strengthen the maintenance management of productive equipment and protection facility during routine production so as to avoid the occurrence of "escape, overflow, dripping and leakage" phenomena and to ensure the normal operation of health protection facility. Occupational health protection measures shall be established and completed for emergency condition and maintenance.

Establish the watch and management system of occupational health, and carry out systematization management. Conduct occupational health watch for working personnel at regular intervals. If occupational contraindication or suspected occupational patient is found, applicable work regulation and variation shall be performed for this type of personnel, and when necessary, vacation even diagnosis and treatment shall be given so as to minimize the occurrence of occupational disease.

Establish the regular monitoring and evaluation system of the hazard factors of occupational disease of workplace; attach importance to, prevent and control the impact

of the hazard factors of occupational disease on the health of working personnel during equipment maintenance period.

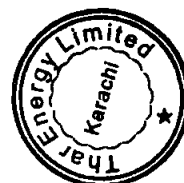
The emergency response preparedness plan for occupational disease hazard accident shall be established and completed after the project is put into production. Warning identification and description shall be provided according to the requirements of *Warning Identification of Occupational Disease Hazard in Workplaces* (GBZ158-2003) .

5.9 Occupational health organizations and facility

It tentatively intends to establish a monitoring and supervision station of occupational health in this project, and conventional monitoring apparatus and equipment will be equipped.

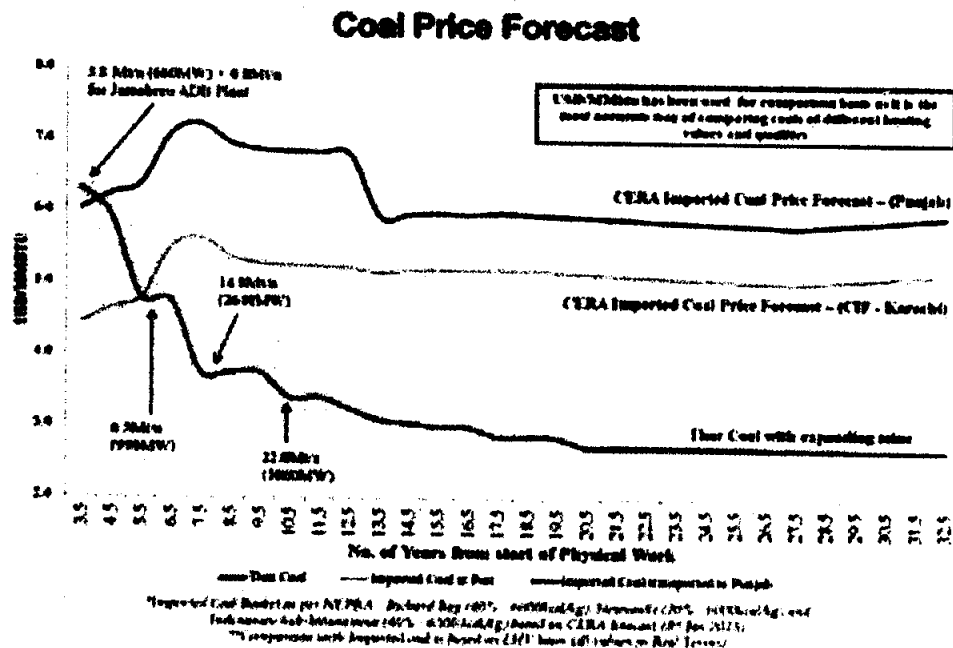
5.10 Conclusions

- 1) Occupational health measures should meet the Mandatory codes, standards and regulations in Pakistan, OSHA as well as China national standards, regulations and codes.
- 2) After the corresponding measures are implemented, the health condition of the workplaces of the operation personnel of the power plant can meet the requirements of relevant standards.
- 3) Standards and best practices will be finalized during EPC contract negotiations.



6 Fuel Supply

The supply of fuel for the Project is guaranteed from the adjacent SECMC mine which is expected to have sufficient volumes of coal to supply the fuel requirements over the operating life of the Project. Phase II of the Mine Project and Power Project are both expected to come online at the same time. As CFB technology is resilient to fuel quality fluctuations, additional fuel procurement strategy in case of mine delay/interruption will include importing Indonesian coal for the power plant operations. Cost of Thar / Imported coal is passed through in tariff. The following figure reflects that the cost of Thar coal is expected to be higher compared to imported coal in the initial years (Phase I) when mine is expected to be operated at a capacity of 3.8 Mtpa, however, with planned future expansions (Phase II, III & IV), the cost of Thar coal will go down. The following chart depicts the expansion plan of the Mine Project along with the improvement / reduction in the generation tariff as well.



Trucks will be used to transport coal from the mine crusher which will crush the coal. The crushed coal will be delivered to the SECMC coal storage yard. From SECMC's coal stockyard, coal with a guaranteed size of less than 300mm will be transported to Power Plant's unloading trench. The terminal point will be the weighing bridge near the coal unloading trench at the Power Project. After successful COD of the Power Project, approximately 6,040 tones/day coal will be transported from the mine stockyard to Power



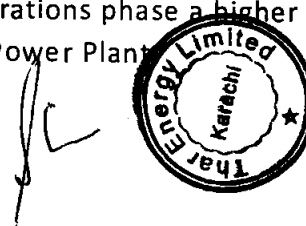
Project's unloading trench using trucks; the distance to be covered in this effort is around 5 Km and approximately 250 trips will be made each day by the trucks. TEL will have a total on-site coal storage capacity of 30 days' inventory as will SECMC.

Coal transportation charges from mine to the Project have been included in the coal tariff under a separate head. After COD, the coal will either be transported by any renowned third party or by SECMC. Amount available in the tariff for coal transportation will be paid to the transporting company. The Project also envisages a possibility of temporary operations on imported coal, in case mine operations are delayed / interrupted. The Sindh government has already undertaken a massive road reconstruction program along the entire route from Karachi to Islamkot to facilitate transfer of heavy machinery and coal (if needed) to the Project site; the road is now good enough to transport heavy power plant machinery and transportation of coal (if required).

6.1 Backup Coal Options

Preliminary studies have assessed imported coals from two different mines of PMC & BEP (Indonesia). Analysis from Bhakti Energi Persada (BEP) of 2,840 kcal/kg coal and from Putra Muba Coal (PMC) mine of 2,895 kcal/kg coal were analyzed for equivalence to Thar coal. The study concluded that imported coal from these mines can be used as a substitute for Thar Lignite; it was, hence, established that direct substitutes for Thar lignite are available from Indonesia. PMC Mine Company has a resource size of 1 Bn tonnes, whereas BEP Mine Company has a resource size of 7.9 Bn tonnes. In addition to the above, Thar boiler will also be able to use coal of a higher calorific value, which may be procured easily from Indonesia.

Accordingly, the backup coal strategy is as follows: The Project is being designed to operate on Thar Coal, as well as on Imported coal (incase Thar coal is not available). The imported coal strategy is characterized by two strategies depending upon mainly the circumstances of unavailability of coal from Thar mine. In case the Phase II Mine Project is delayed, the Power Project will import the aforementioned Thar coal substitute from Indonesia, thereby enabling power plant to conduct performance testing with similar coal, whereas in case the mine is interrupted during operations phase a higher calorific value, more readily available coal will be sourced for the Power Plant.



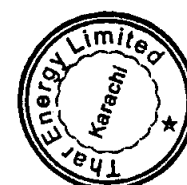
7 Implementation & Schedule

Project sponsors have already applied for the Letter of Intent (LOI) and received the Notice to Proceed (NTP) from PPIB on 13 May 2016. TEL plans to proceed with project development activities on a fast-track basis in order to achieve expeditious Financial Close for the project. Post FC the notice to proceed will be issued to an EPC Contractor on a lump-sum date-certain fixed-price basis.

Keeping in mind the acute power shortages in the country, the Government of Pakistan (GoP) and other government agencies will need support the project by giving timely approvals/NOCs. The envisaged project development schedule is as follows:

S. No.	Task	Target Completion
1.	Issuance of LOI by PPIB	Jul 2016
2.	Generation License from NEPRA	Aug 2016
3.	Application of Upfront Tariff Acceptance from NEPRA	Aug 2016
4.	Upfront Tariff Determination for Project by NEPRA	Aug 2016
5.	EPC Price lock-in from EPC contractor	Aug 2016
6.	LOS Issuance from PPIB (post submission of USD 5000/MW performance guarantee)	Sep 2016
7.	Execution of EPC Contract	Oct 2016
8.	Execution of Coal Supply Agreement	Oct 2016
9.	Execution of Land Lease Agreement	Nov 2016
10.	Execution of PPA and IA	Nov 2016
11.	Financial Close and Notice to Proceed to the EPC Contractor	Apr 2017

Note: Sanctity of our project's timelines especially for the Financial Close is heavily dependent upon timely performance of GOP/GOS entities as well as Regulatory Authorities

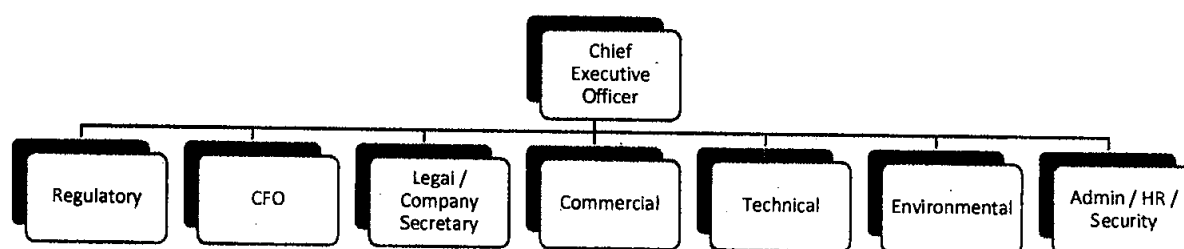


8 Project Company Management – Introduction & Organization

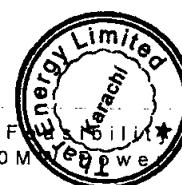
The main sponsor for the project will be HUBCO. However, there is a possibility of additional shareholders (equity partners) joining HUBCO. HUBCO has already incorporated a wholly owned subsidiary by the name of Thar Energy Limited (TEL or Project Company) for the development, implementation and execution of this project. Potential equity partners will become part of the Project Company by way of a Joint Venture Agreement (JVA) / Shareholders Agreement (SHA).

Qualified personnel will be placed in appropriate positions to carry out assigned duties, including those listed in sections below. The proposed project organization is based on proven concepts developed through years of experience. HUBCO has the experience of developing and operating a 1320 MW RFO Fired Power Plant at Hub which is the first ever Independent Power Producer (IPP) in Pakistan. HUBCO also owns and operates 225 MW Diesel engine based project at Narowal and has 75% stake in Laraib Energy Limited (84 MW Run of the River plant) which is the first hydel IPP in Pakistan.

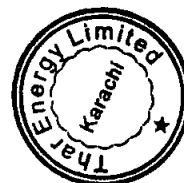
Guided by a Board of Directors, the Chief Executive Officer will provide primary oversight for the duration of the Project. A visual representation of the organization is given in the Figure below:



Each position beneath the Chief Executive Officer represents a distinct capability area that requires the attention of dedicated staff.

- The regulatory team is responsible for interface with all governmental / regulatory bodies as well as the execution and administration of Power Purchase Agreement and Implementation Agreement
- The finance organization under the CFO are primarily responsible for arranging project financing for the project. They are also responsible for reviewing the budgets established by the contractors and approving any expenditure outside the limits of the capital and operating budgets. They are also responsible for preparing all financial statements and maintaining the books of the Project Company. Finally, they are responsible for maintaining banking relations and all bank accounts and preparation/filing of all tax related documentation
- The legal department and Company Secretary ensures compliance with SECP guidelines and provides legal support for the many project agreements
- The Commercial organization manages all contracts required to conduct business, with the exception of those pertaining to fuel supply. They review contractor compliance and take whatever corrective action necessary to ensure meeting the terms of all agreements
- The technical department will be primarily responsible for project management team and has responsibility over both EPC and O&M efforts. The O&M organization is ultimately responsible for the operations of the facility, including colony administration. The EPC organization exists during the implementation phase of the Project. Once they have fulfilled their contractual obligations and the O&M team has assumed operations, the EPC is completed
- The Environmental group addresses environmental issues during the construction and operations phases. They help to ensure that the facility remains in compliance with applicable regulations.
- An Administrative organization manages the office, including reception, human and talent management as well as security for site



9 Project Agreements

9.1 Implementation Agreement

The Implementation Agreement (IA) is an agreement between the Project Company and the PPIB, on behalf of GoP, the "Parties". The IA will lay out the mechanisms, responsibilities, liabilities and actions of each party during the development, construction, commissioning, post commissioning and termination phases.

The IA will also cover the protections made available to the Project and its sponsors, lenders, etc., from political force majeure, change of law, nationalization, etc., in addition to the taxation and other policy related matters to allow them to develop, build and operate the complex in line with the other agreements, such as the PPA, the fuel supply agreement and others. In addition to the IA, there will also be a separate document, the Sovereign Guarantee, executed in favor of the Project Company, which will capture the essence of the understanding and agreement between the two parties. The IA, along with the Sovereign Guarantee, will form the core of concession extended to the Project Company to implement and operate the Project and will guarantee the GoP's performance pursuant to the failure to perform of the Power Purchaser and other entities, if any, whose performance is guaranteed by the GoP.

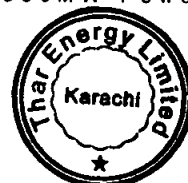
The GoP, through the IA, will commit to help the project to acquire all rights, consents and permits in line with the local laws including the acquisition of land or rights to the land usage. In this context, it will undertake to help the Project in dealing with all arms and tiers of governance structure in Pakistan to help the Project achieve its aims in timely and cost effective manner.

GoP through this document will also elaborate and crystallize the rights of the lenders to establish liens and/or encumbrances over the project moveable and immoveable assets to protect their interest and to have them recognized by the GoP.

The IA lists the consents or permits required to develop and operate the project and the GoP's commitment to help the Project acquire these permits and assist the latter in getting them.

9.2 Power Purchase Agreement

The Project Company and the Power Purchaser (CPPA-G) will enter into a Power Purchase Agreement (PPA). The PPA will include the tariff along with the related parameters approved and duly notified by the National Electric Power Regulatory Authority (NEPRA).



to establish guidelines for the delivery of and compensation for the Project's capital providers. The tariff structure outlined in the PPA will give the Power Purchaser the flexibility in the operation of the facility and its components, so as to meet the needs and specifications of the national grid, while providing the Project Company with the potential to generate revenues that adequately cover costs and provide an acceptable return. The PPA will also summarize the technical aspects, for example the interconnection, communications and all such foreseeable issues. The tariff part of the PPA will be defined over the term of the PPA and will have several components that can be broken into two categories: Capacity Charge and Energy Charge.

The PPA will also specify a series of conditions to deal with plant availability and outages which will be in line with the prudent utility practices and generally acceptable industry practices for this technology platform under the specific local conditions as recommended by the OEM.

Capacity Charges include fixed O&M costs, cost of working capital, insurance, debt service and return on equity (ROE).

Energy Charges include both fuel cost and variable O&M. Adjustments to these standard items will include the debt service component, principal repayment, interest cost, guarantee costs and interest during construction. The debt cost will cover for indexations applicable to the relevant foreign currency/currencies of the loans in question.

Pass through items generally include income tax on dividends, differences in withholding tax amounts for undeclared dividends and income taxes on ROE.

9.3 EPC Agreement

An Engineer, Procure and Construct contract will be entered between the Project Company and an EPC Contractor to govern the construction of the facility. The contract will be let on a fixed-price, lump-sum, date-certain, turnkey basis. It will include guarantees of completion, net plant generating capacity, fuel consumption efficiency and environmental parameters. Liquidated damages will be payable for certain defined events of default, including late completion. The Project Company intends that the facility will be constructed according to state-of-the-art current international standards and practices.

9.4 O&M Agreement

The scope of the O&M Agreement will include the following components:

- Hand-over from the EPC Contractor
- Operation
- Maintenance
- Repair

As per the EPC Agreement, the operator will agree to operate and maintain the facility in accordance with all applicable laws, standards and regulations. The O&M team will follow budgets prepared by the Project Company, which will be compatible with the tariff provisions of the PPA and administer the compliance to the PPA and fuel supply agreement terms. Also included in this agreement is a guarantee of the O&M organization's performance in respect of its responsibilities, by which a system of bonuses and penalties will be incorporated to correspond with the agreed performance levels.

9.5 Fuel Supply Agreement

The Project Company will procure fuel required for plant operation through Coal Supply Agreement with SECMC for 30 years uninterrupted supply of coal. The terms of the fuel supply agreements have not yet been determined.

9.6 Additional Agreements

In addition to the key contracts mentioned above, the Project Company would also enter into many other contracts, customary to projects of this nature and of varying tenors, to secure the project's interests and to ensure smooth and reliable operations, some of which are listed below:

- **Financing Agreements with Lenders:** Financing agreements with the lender's consortium will govern the relationship between the Project Company, the lenders and the GoP during the currency of project loans.
- **Infrastructure and Water Supply Agreement with GoS:** This agreement is necessary to ensure large scale development of the Thar Coalfield and minimize external risks to the Project.
- **Land Acquisition and Facilitation Agreement with the GoS:** In addition to the help extended by the GoS to acquire land for the project, this agreement would also provide the framework by which the roles of relevant GoS-controlled agencies would also be defined.



- Long-Term Spares Supply and Services Agreements: The Project Company could also decide to enter into such agreements of varying duration to procure such supplies and/or receive maintenance services.
- Transportation Agreement(s): The Project Company would enter into one or more long-term/short-term transportation agreements and/or understandings with local trucking companies, etc., to ship raw materials (e.g. limestone), waste (e.g. gypsum), spares, etc to and from the site.

9.7 Land Acquisition

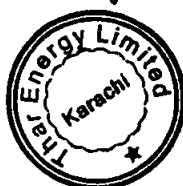
Land acquisition for 4,000 MW Energy Park and associated facilities has been done by SECMC. SECMC has the physical possession of land which will be subsequently sub-leased to power project developer. TEL will enter into a Land Lease Agreement with SECMC for land for power plant as well as associated facilities like ash yard, effluent disposal point etc.



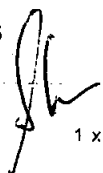
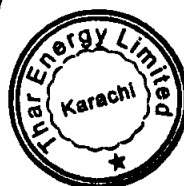
10 Consents & Permits

The following list has been developed to ascertain the number of consents and permits which will be required for the successful implementation of the project. The list is neither exhaustive nor conclusive at this point in time and is likely to undergo changes during the life of project development:

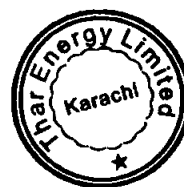
S.No.	Consent / Permit Required	Relevant Authority
1.	Approval of the term sheet for contracting loans to finance the debt component of the project cost	Private Power & Infrastructure Board (PPIB)
2.	Approval of the EPC Contractor	
3.	Approval of the O&M Agreement and the Contractor, if applicable	
4.	Land Acquisition and Facilitation Agreement with the GoS. The Project Company plans to enter into an agreement with the GoS with the aim of streamlining the interaction of the Project Company and all the arms of the GoS including the local authorities. This agreement will ensure among other things acquisition, transfer and possession of the land owned by the GoS and its agencies and other land to be acquired by the GoS under the Land Acquisition Act, 1894, for the purpose of this project, to the Project Company free of all liens, etc.	Government of Sindh & its Agencies
5.	A clarification and/or agreement with the Project Company that other than the taxes levied by all government entities and bodies under the control of the GoS (this list to be developed with the help of the GoS), there are no taxes applicable to the Project Company during the development and construction phase on import into and export out of Sindh and movement of the project equipment to and from the project site	
6.	A clarification and/or agreement with the Project Company that other than the taxes levied by all government entities and bodies under the control of the GoS (this list to be developed with the help of GoS), there are no taxes applicable on Project Company materials, such as coal, through import or local purchase or movement	
7.	Certificate of Stability under the Factory Act, 1934	
8.	Registration of the boilers under the Boilers Act, 1923	



9.	Exemption to the Project Company for the term of the IA from Sections 28,30 and 34 of the Electricity Act, 1910	
10.	Permission from Environment Protection Agency, Sindh	
11.	Permission for acquisition of arms licenses for the security of the Complex	
12.	Permission to the Project Company and its Contractors to open local currency and foreign currency accounts, wherever required as escrow accounts, inside and out of Pakistan, to deposit and take out moneys, retain profits, e.g., Debt Disbursement Accounts, Debt Payment Accounts, Debt Service Reserve Accounts, Maintenance Reserve Accounts, Insurance Proceeds Accounts and other such project accounts that may be mandated under various project documents including loan agreements during the construction as well as for post COD phases	State Bank of Pakistan (SBP)
13.	Registration of foreign currency loans as contracted under the financing documents and in terms of the approved term sheet by the PPIB	
14.	Permission to issue and export shares to non-residents on repatriable basis	
15.	Permission to foreign investors to transfer their shares against payment in foreign currency to other foreign investors and/or to local investors against payment in local currency on repatriable basis	
16.	Provision of foreign currency for debt servicing, principal, interest, other charges, like guarantee commission, etc. in foreign currency to non-residents without deduction and to remit dividends, etc.	
17.	Clarification from FBR on import and re-export of EPC equipment, if required	Federal Board of Revenue (FBR)
18.	Clarification from FBR on import and re-export of equipment for expats' personal use, if required	
19.	Clarification on taxes on expats, if required	
20.	Notification, clarification, and acknowledgement for exemption of income tax for the concession term as envisaged under the project agreements	

21.	Notification, clarification, and acknowledgement for exemption of minimum tax for the concession term as envisaged under the project agreements	
22.	Consent and clarification about repatriation of debt servicing, principal, interest, other charges, like guarantee commission, etc. in foreign currency to non-residents without deduction	
23.	Permission to issue shares against non-cash and at a discount or premium	Securities & Exchange
24.	Permission to issue convertible securities to residents and/or nonresidents in local and/or foreign currency	Commission of Pakistan (SECP)
25.	Permission, consent to remit, and deposit insurance premiums to nonresident insurer(s) abroad and to retain insurance claim proceeds abroad	Various
26.	Permission and consent to exempt the Project Company from other insurance-related matters mandated by the lenders	
27.	Registration of the Project Company, EPC and O&M contractor as industrial consumers for the purpose of import and export for the Project during the term of the concession	
28.	Permission and consent from Pakistan Environment Protection Agency	
29.	Permission to store petroleum products inside and outside of the Complex under the Petroleum Rules	



11 Financial & Economic Feasibility

A detailed financial model was developed for the Project that derives the electricity sales tariff based primarily upon the parameters in the Thar Coal Upfront Tariff, 2014 as well as detailed economic parameters, project financing structures, Pakistan tax laws, capital investment costs, operation and maintenance (O&M) costs, delivered fuel prices, and plant performance. Sponsors believes at this point in time that they will be able to manage project costs and other technical parameters within the range allowed in up-front tariff. These inputs are described in the following subsections:

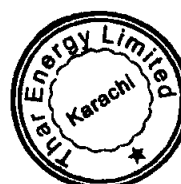
Project Assumptions	
Gross Capacity (MW)	330
Auxiliary Load (%)	9%
Net Capacity (MW)	300
Annual Net Generation at 100% (GWh)	2,631
Construction Period (months)	40
Concession Period (years)	30

Project Cost Assumptions	
CAPEX (USD Million)	408.2
Custom Duties & Cess (USD Million)	16.2
Financing Fees & Charges (USD Million)	11.1
Sinosure Fee (USD Million)	33.2
Interest During Construction (USD Million)	28.9
Total Project Cost (USD Million)	497.7

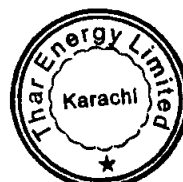
Project Financing Plan	
Capital Structure (Debt:Equity)	75:25
Debt (USD Million)	373.3
Equity (USD Million)	124.4

Technical Assumptions	
Plant Efficiency (%)	37%
Plant Availability (%)	85%
Coal Calorific Value (Kcal/Kg)	2,773

Project Debt Assumptions



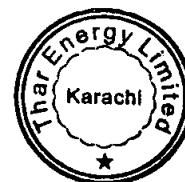
Debt Repayment Tenor (years)	10
Grace Period (months)	40
Reference LIBOR (%)	0.45%
Reference Spread (%)	4.50%
Project Returns	
Guaranteed Return on Equity (%)	30.65%
Annual Return on Equity (USD Million)	38
Equity IRR	20%

12 Projected Financials:

Thar Coal Power Projected Financials																						
Contract Year	Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Escalable Capacity Charge	USD M	8.32	8.32	8.34	8.32	8.32	8.32	8.34	8.32	8.32	8.32	8.34	8.32	8.32	8.32	8.34	8.32	8.32	8.32	8.34	8.32	8.32
Non-Escalable Capacity Charge	USD M	91.26	91.26	91.53	91.26	91.26	91.26	91.53	91.26	91.26	91.26	43.96	43.96	43.96	43.96	43.96	43.96	43.96	43.96	43.96	43.96	43.96
Energy Charge	USD M	116.35	116.35	116.71	116.35	116.35	116.35	116.71	116.35	116.35	116.35	91.23	90.98	90.98	90.98	91.23	90.98	90.98	90.98	91.23	90.98	90.98
Net Revenue	USD M	215.89	215.89	216.58	215.89	215.89	215.89	216.58	215.89	215.89	215.89	143.35	143.16	143.16	143.16	143.35	143.16	143.16	143.16	143.35	143.16	143.16
Fuel	USD M	(94.99)	(94.99)	(95.25)	(94.99)	(94.99)	(94.99)	(95.25)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)	(94.99)
Variable O&M	USD M	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)	(2.63)
Water Charges	USD M	(11.64)	(11.64)	(11.67)	(11.64)	(11.64)	(11.64)	(11.67)	(11.64)	(11.64)	(11.64)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)	(9.74)
Ash Disposal	USD M	(5.07)	(5.07)	(5.08)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.07)	(5.08)	(5.07)	(5.07)	(5.07)	(5.08)	(5.07)	(5.07)
Lime Stone	USD M	(2.07)	(2.07)	(2.08)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.08)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)	(2.07)
Total Variable Charges	USD M	(116.35)	(116.35)	(116.71)	(116.35)	(116.35)	(116.35)	(116.71)	(116.35)	(116.35)	(116.35)	(91.23)	(90.98)	(90.98)	(90.98)	(91.23)	(90.98)	(90.98)	(90.98)	(91.23)	(90.98)	(90.98)
Variable Margin	USD M	99.60	99.60	99.87	99.60	99.60	99.60	99.87	99.60	99.60	99.60	52.12	52.18	52.18	52.18	52.32	52.18	52.18	52.18	52.32	52.18	52.18
Fixed O&M	USD M	(8.32)	(8.32)	(8.34)	(8.32)	(8.32)	(8.32)	(8.34)	(8.32)	(8.32)	(8.32)	(8.34)	(8.32)	(8.32)	(8.32)	(8.34)	(8.32)	(8.32)	(8.32)	(8.34)	(8.32)	(8.32)
Insurance	USD M	(2.86)	(2.86)	(2.87)	(2.86)	(2.86)	(2.86)	(2.87)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)	(2.86)
Total Opex	USD M	(11.17)	(11.17)	(11.21)	(11.17)	(11.17)	(11.17)	(11.21)	(11.17)	(11.17)	(11.17)	(11.21)	(11.17)	(11.17)	(11.17)	(11.21)	(11.17)	(11.17)	(11.17)	(11.21)	(11.17)	(11.17)
EBITDA	USD M	88.42	88.42	88.67	88.42	88.42	88.42	88.67	88.42	88.42	88.42	41.11	41.00	41.00	41.00	41.11	41.00	41.00	41.00	41.11	41.00	41.00
Depreciation	USD M	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)	(16.19)
Amortization	USD M	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)	(1.07)
EBT	USD M	71.16	71.16	71.41	71.16	71.16	71.16	71.41	71.16	71.16	71.16	24.92	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.92	24.81	24.81
Interest Charge	USD M	(20.85)	(19.36)	(17.84)	(16.15)	(14.42)	(12.61)	(10.74)	(8.71)	(6.60)	(4.40)	(2.97)	(2.95)	(2.95)	(2.95)	(2.97)	(2.95)	(2.95)	(2.95)	(2.97)	(2.95)	(2.95)
EBT	USD M	50.31	51.80	53.56	55.01	56.74	58.55	60.67	62.46	64.56	66.77	21.95	21.85	21.85	21.85	21.95	21.85	21.85	21.85	21.95	21.85	21.85
Taxes	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EAT	USD M	50.31	51.80	53.56	55.01	56.74	58.55	60.67	62.46	64.56	66.77	21.95	21.85	21.85	21.85	21.95	21.85	21.85	21.85	21.95	21.85	21.85

Thar Coal Power Projected Financials																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
EBITDA	USD M	88.42	88.42	88.67	88.42	88.42	88.42	88.67	88.42	88.42	88.42	41.11	41.00	41.00	41.00	41.11	41.00	41.00	41.00	41.11	41.00	41.00
Interest Charge	USD M	(20.85)	(19.36)	(17.84)	(16.15)	(14.42)	(12.61)	(10.74)	(8.71)	(6.60)	(4.40)	(2.97)	(2.95)	(2.95)	(2.95)	(2.97)	(2.95)	(2.95)	(2.95)	(2.97)	(2.95)	(2.95)
Tax	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Working Capital Changes	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Short Term Running Finance	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operating Cash Flows	USD M	67.58	69.07	70.82	72.27	74.00	75.81	77.93	79.72	81.82	84.03	38.14	38.04	38.04	38.04	38.14	38.04	38.04	38.04	38.14	38.04	38.04
Investing Activities - CAPEX	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Loan drawdown	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Loan Repayment	USD M	(29.54)	(31.03)	(32.60)	(34.24)	(35.96)	(37.74)	(39.79)	(41.68)	(43.76)	(45.99)	-	-	-	-	-	-	-	-	-	-	-
Equity Drawdown	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Share Capital Repayment	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dividends Paid	USD M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Financing Cashflows	USD M	(29.54)	(31.03)	(32.60)	(34.24)	(35.96)	(37.74)	(39.79)	(41.68)	(43.76)	(45.99)	-	-	-	-	-	-	-	-	-	-	-
Net Cashflows Available for Dividends	USD M	38.04	38.04	38.14	38.04	38.04	38.14	38.04	38.04	38.04	38.14	38.04	38.04	38.04	38.14	38.04	38.04	38.04	38.04	38.14	38.04	38.04
Equity Cash Flows		38.04	38.04	38.14	38.04	38.04	38.14	38.04	38.04	38.04	38.14	38.04	38.04	38.04	38.14	38.04	38.04	38.04	38.04	38.14	38.04	38.04



13 Indicative Financing Plan

13.1 Capital Structure

The tentative capital structure for the project shall be 75:25 debt and equity respectively. However, the upfront tariff allows for a range of capital structure from 70:30 to 80:20. Indicative financing plan for both debt and equity is described in the following sections:

13.2 Debt Financing

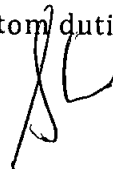
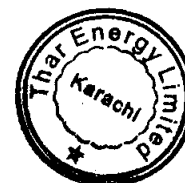
This project has the distinct advantage of being part of the China Pakistan Economic Corridor (CPEC). Being part of CPEC opens the door for the project to raise debt from China. The following Chinese banks are currently engaged with various power projects under CPEC and could potentially provide debt for this project as well:

- China Development Bank (CDB)
- China Exim Bank (CEXIM)
- Industrial & Commercial Bank of China (ICBC)

The major advantage of foreign financing is that it allows the project to bypass the local banking channels which have considerable limitations, both in terms of overall liquidity as well as per party and sectoral limits. However, it will not be possible for the project to secure debt financing for the entire project through Chinese banks due to the limitation arising out of Sinasure. Sinasure only guarantees up to 85% of EPC value (assuming Chinese EPC contractor and majority equipment coming from China) in addition to Sinasure's own premium amount. The balance amount would have to be financed through local banks. A snapshot of financing plan is as follows:

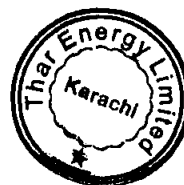
Description	Amount (USD M)
Total Project Cost	497.7
Total Debt (75% of Project Cost)	373.3
Debt from China (85% of EPC* + Sinasure Premium)	293.4
Debt from Pakistan (Balance)	79.8

*EPC assumed at 75% of Capital Cost including custom duties

13.3 Equity Financing

Total equity requirement for the project stands at USD 124 Million. HUBCO intends to inject its own equity into the project in addition to equity from other potential partners. Strategic partners may also be offered preference shares in the project company. Final equity structure of the project company will be finalized prior to applying for LOS with PPIB.

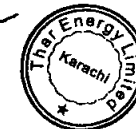
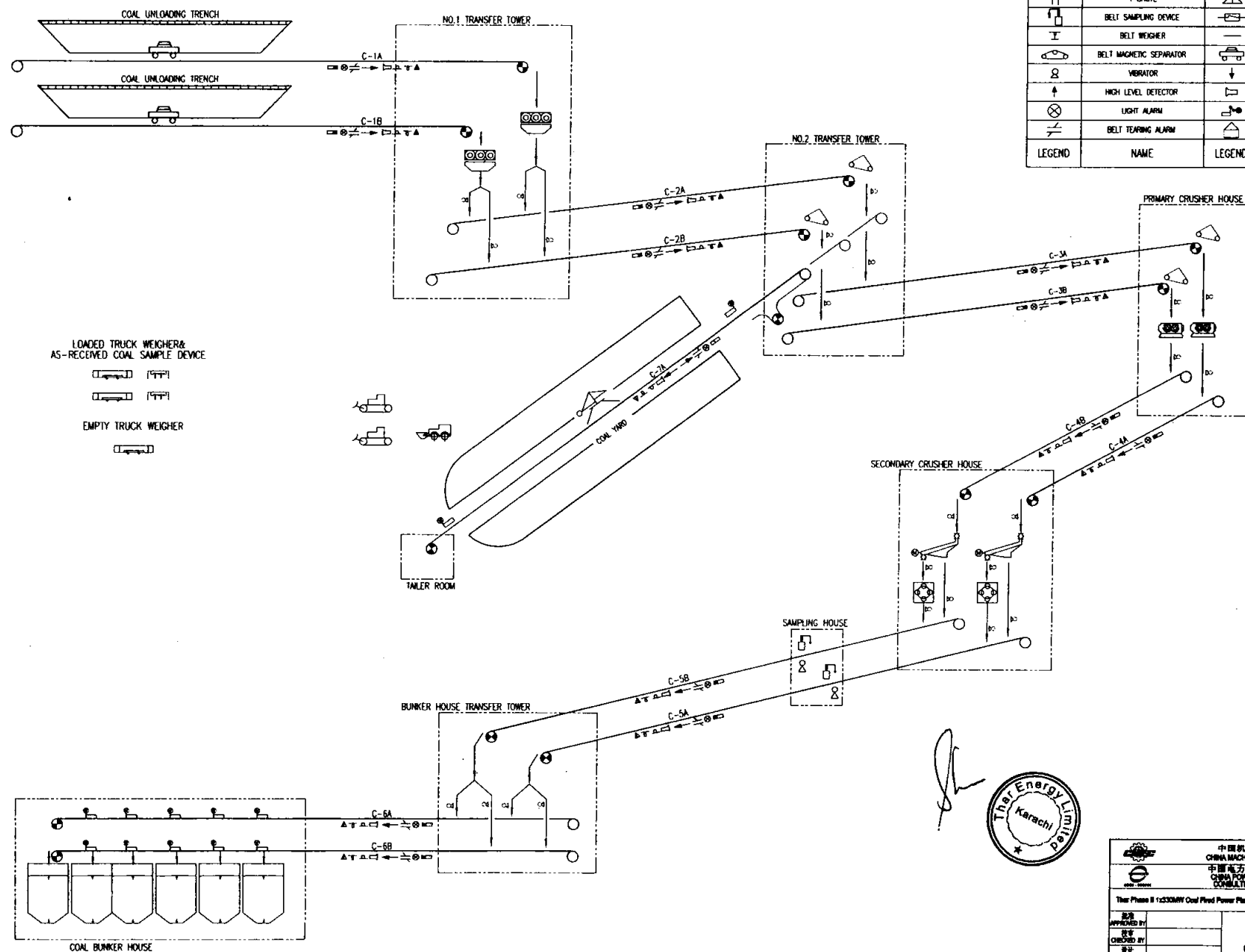


1 本图以 1x330MW 机组水量平衡图, 括号外为设计温度工况, 括号内为最大温度工况
设计气温 27 度, 相对湿度 50%, 冷却塔最高设计温度: 湿球温度 28 度

1. This is for 1.033MW water balance. Outside the brackets for the design temperature condition (Design temperature = 27 °C, Design Relative humidity = 50%) and in the brackets for the maximum temperature condition for cooling tower (Wet bulb temperature=26 °C).
2. The unit is m³/h.
3. The data with asterisk are based on conservative value considering water data.



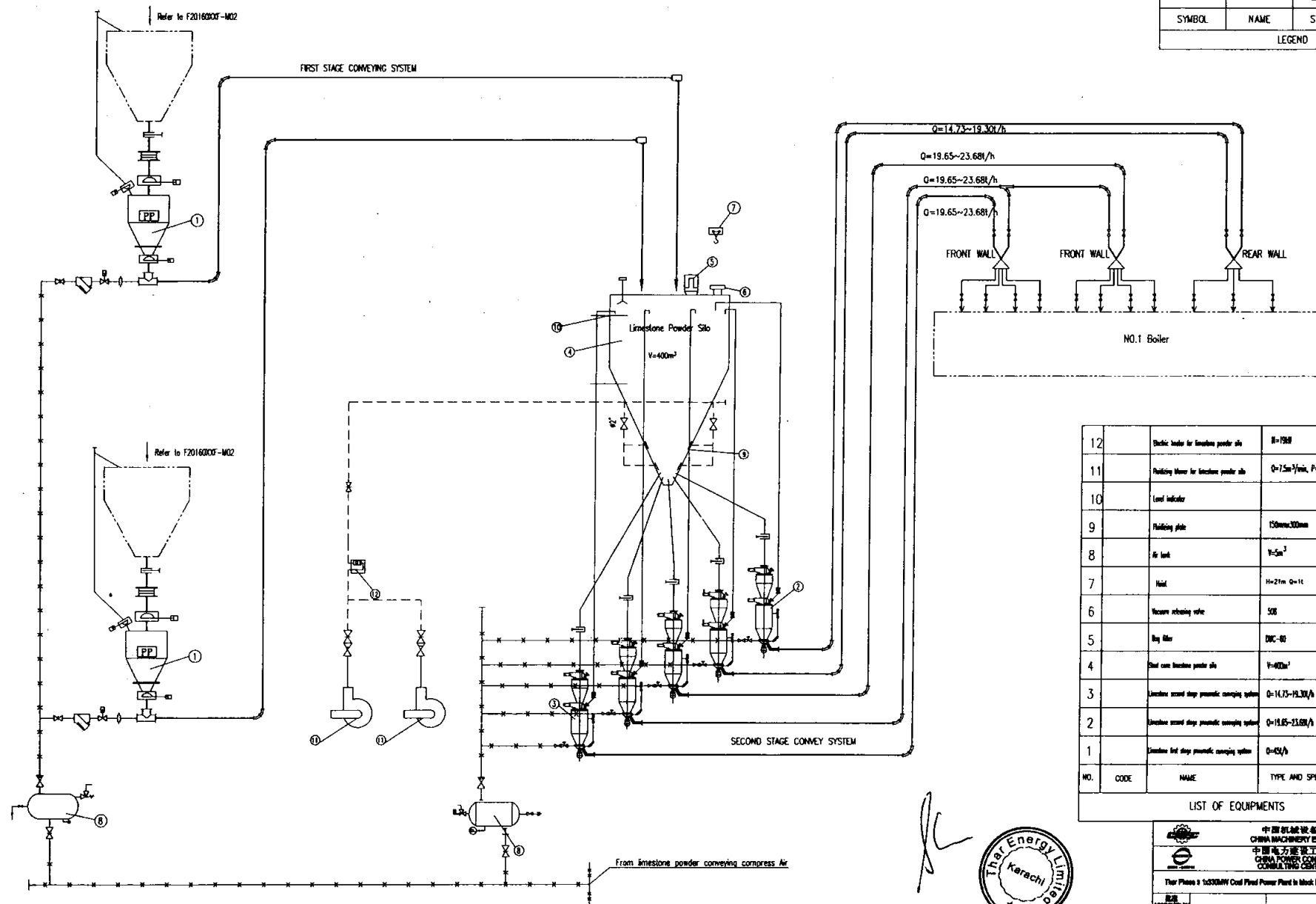
 CHINA MACHINERY ENGINEERING CORPORATION  CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CO., LTD.	中国机械装备工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中国电力建设集团中南有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CO., LTD.	项目 PROJECT
The Phase II 1250MW Coal Fired Power Plant in block II		项目 PROJECT
批准 APPROVED BY 设计 DESIGNED BY 校核 CHECKED BY 审核 AUDIT BY 日期 DATE	2016.07	WATER BALANCE
比例 SCALE	图号 DWG NO.	版本 REV
	AP2024002-002	版本 REV



中国机械装备工程有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中国北方重工集团有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CENTRAL SOUTHERN CO., LTD.	
This Phase II 1x130MW Coal Fired Power Plant to Unit 2 批准 设计 日期 DATE 比例 SCALE	PROPOSAL 设计 日期 DATE 比例 SCALE
FLOW DIAGRAM OF COAL HANDLING SYSTEM	

	PNEUMATIC GATE		PNEUMATIC VALVE
	AIR PIPE		HAND-OPERATED GATE
	CONVEYING PIPE		PNEUMATIC VALVE
	EXTENSION TUBE		GATE VALVE
	ELECTRIC VALVE		CHECK VALVE
	STOP VALVE		STOP VALVE
SYMBOL	NAME	SYMBOL	NAME

LEGEND

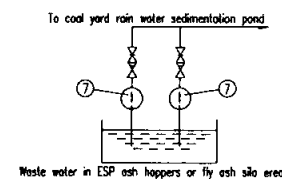
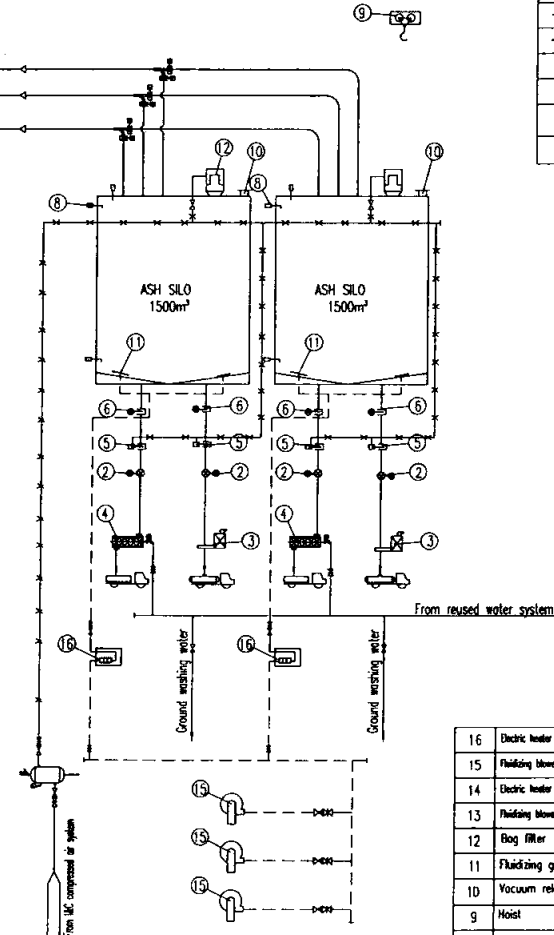
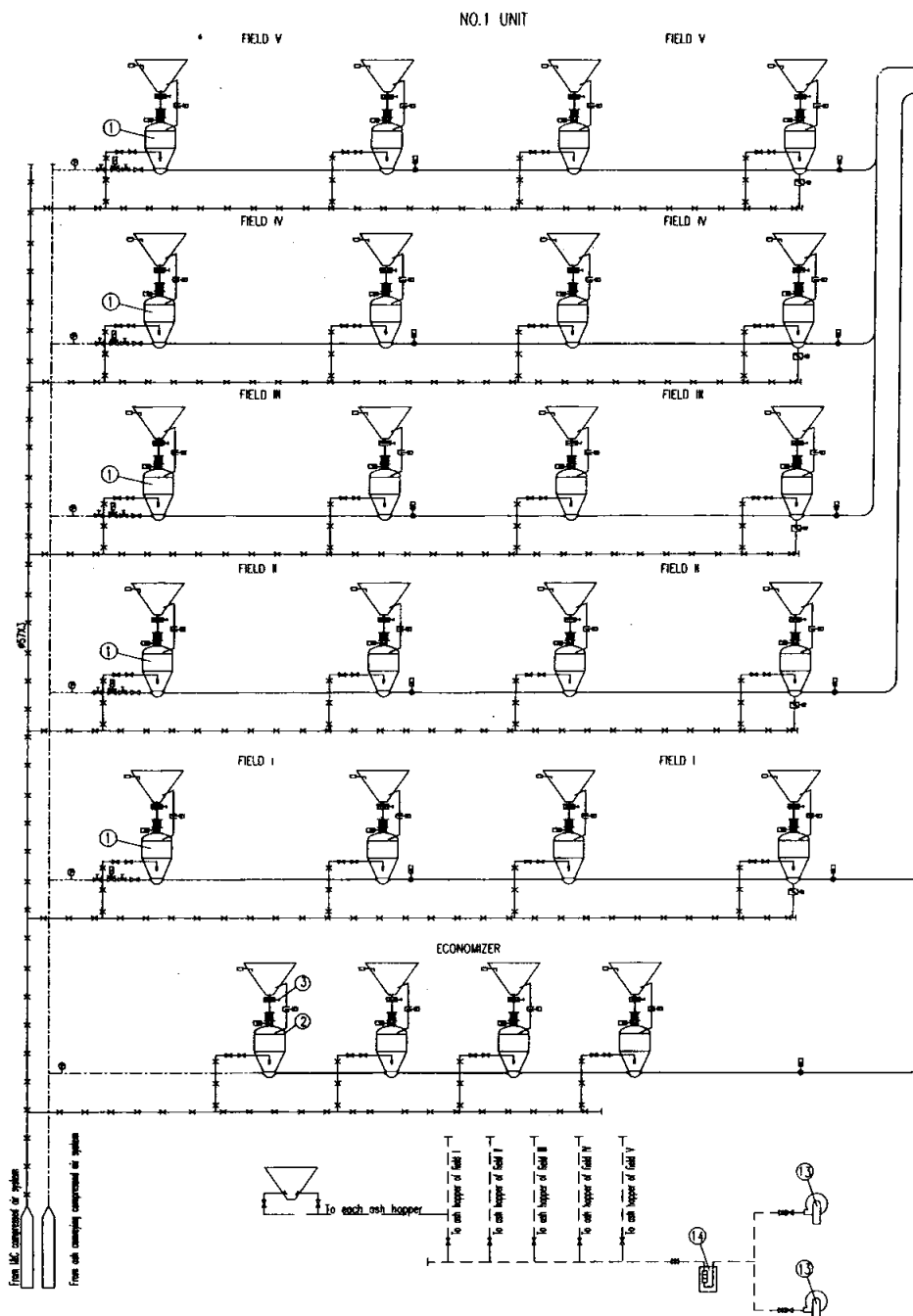


12	Electric motor for limestone powder silo	11-1900	1	
11	Building frame for limestone powder silo	Q=7.5m³/min, P=0.07MPa	2	
10	Level indicator		1	1套 (1 set)
9	Flushing plate	150mmx300mm	6	
8	Seal tank	V=5m³	2	
7	Valve	H=27m Q=1t	1	
6	Vacuum releasing valve	500	1	
5	Bag filter	DMC-60	1	
4	Steel case limestone powder silo	V=400m³	1	
3	Limestone second stage pneumatic conveying system	Q=14.75~19.30t/h	2	
2	Limestone second stage pneumatic conveying system	Q=19.65~23.68t/h	3	
1	Limestone first stage pneumatic conveying system	Q=0.5t/h	2	
NO.	CODE	NAME	TYPE AND SPEC.	QTY

LIST OF EQUIPMENTS

中国机械装备工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中国电力建设集团工程咨询有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CENTRAL SOUTHERN CO., LTD.	
Their Phase 1 1x330MW Coal Fired Power Plant in block II	
批准 APPROVED BY:	设计 DESIGNED BY:
审核 CHECKED BY:	计算 CALCULATED BY:
日期 DATE: 2016.07	比例 SCALE:
图号 DWG NO. #201602-001 版本 1/1	

FLOW DIAGRAM OF LIMESTONE CONVEYING SYSTEM



	FLUSHING AIR PIPE		PNEUMATIC GATE
	ASH CONVEYING COMPRESSED AIR PIPE		MANUAL GATE
	INSULATING COMPRESSED AIR PIPE		PNEUMATIC VALVE
	ASH PIPE		GATE VALVE
	EXTENSION TUBE		CHECK VALVE
	ELECTRIC VALVE		STOP VALVE
SYMBOL	NAME	SYMBOL	NAME
LEGEND			

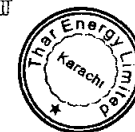
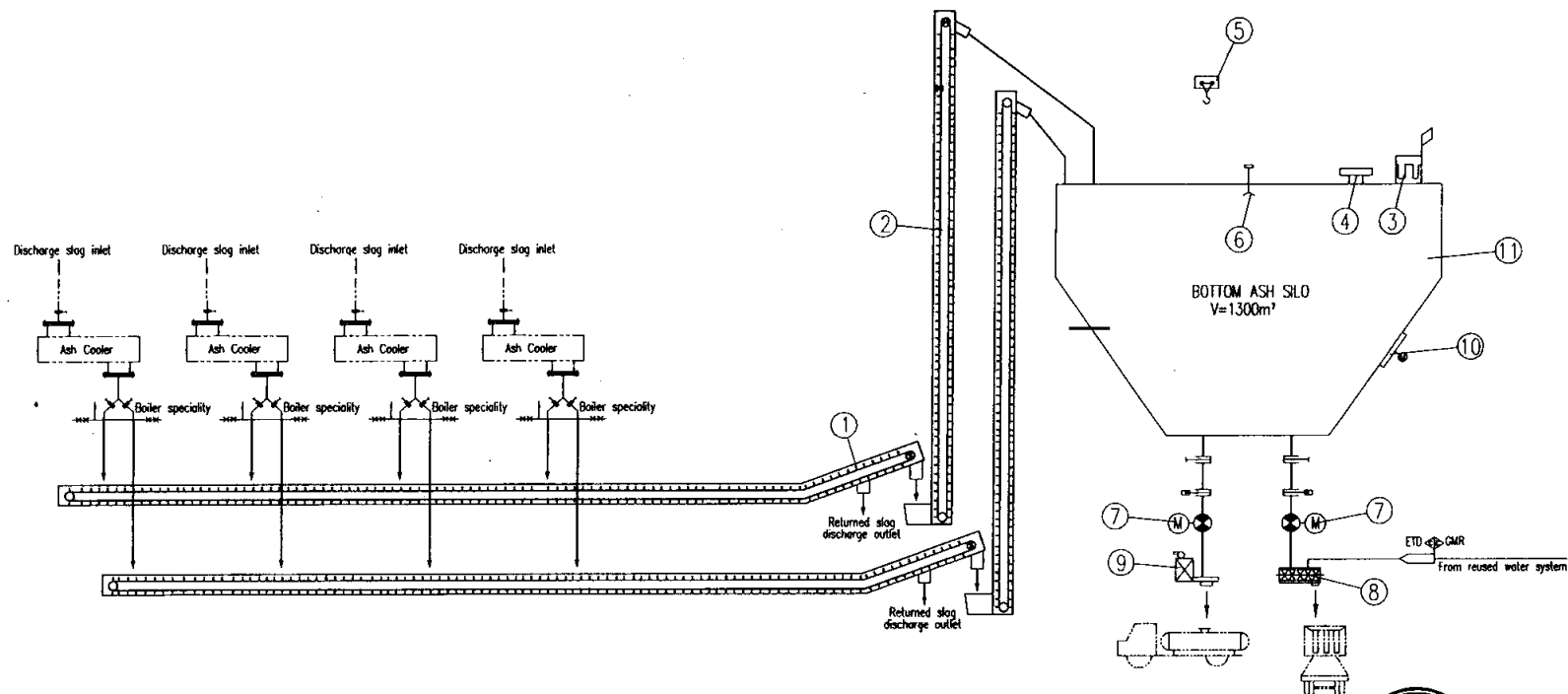
16	Electric heater for fly ash silo	N=30kW	2	
15	Fluidizing blower for fly ash silo	Q=13m ³ /min, P=0.0784MPa	3	
14	Electric heater for ESP hopper	N=30kW	1	
13	Fluidizing blower for ESP hopper	Q=8.5m ³ /min, P=0.0588MPa	2	
12	Bag filter	DAG-90	2	
11	Fluidizing groove for silo	B=150mm		230m
10	Vacuum relief valve	#508mm	2	
9	Moist	Q=1t, H=27m	1	
8	Level probe		2 set	High low continuous level probe
7	Sewage pump	Q=30m ³ /h, P=0.3MPa	4	
6	Electric operated gate		4	
5	Pneumatic gate		4	
4	Dual-axle mixer	Q=200t/h	2	
3	Dry ash unloader	Q=200t/h	2	
2	Electric rotary feeder	Q=200t/h	4	
1	Fly ash positive pressure conveying system	Q=55t/h	1 set	
NO.	Name	Type and spec	Quantity	Note

Main equipments schedule

 CHINA MACHINERY ENGINEERING CORPORATION 中国机械进出口总公司	中国机械进出口总公司 CHINA MACHINERY ENGINEERING CORPORATION 中国电力建设集团工程咨询有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING GROUP CO., LTD. (SOUTHERN CHINA)
	This Phase 3 1x538MW Coal Fired Power Plant in Block 3 PHILIPPINE 菲律宾
批准 APPROVED BY 设计 DESIGNED BY 竣工 COMPLETED BY 日期 DATE 比例 SCALE	2016.07 图号 (FIG NO) 设计阶段 (DESIGN STAGE) 设计人 (DESIGNER) 审核人 (CHECKER) 日期 (DATE)

—	FLUISING AIR PIPE	—	PNEUMATIC GATE
—	AIR PIPE	—	HAND-OPERATED GATE
—	ASH PIPE	—	PNEUMATIC VALVE
—	EXTENSION TUBE	—	GATE VALVE
—	ELECTRIC VALVE	—	CHECK VALVE
—	ROTARY FEEDER	—	STOP VALVE
SYMBOL	NAME	SYMBOL	NAME

LEGEND

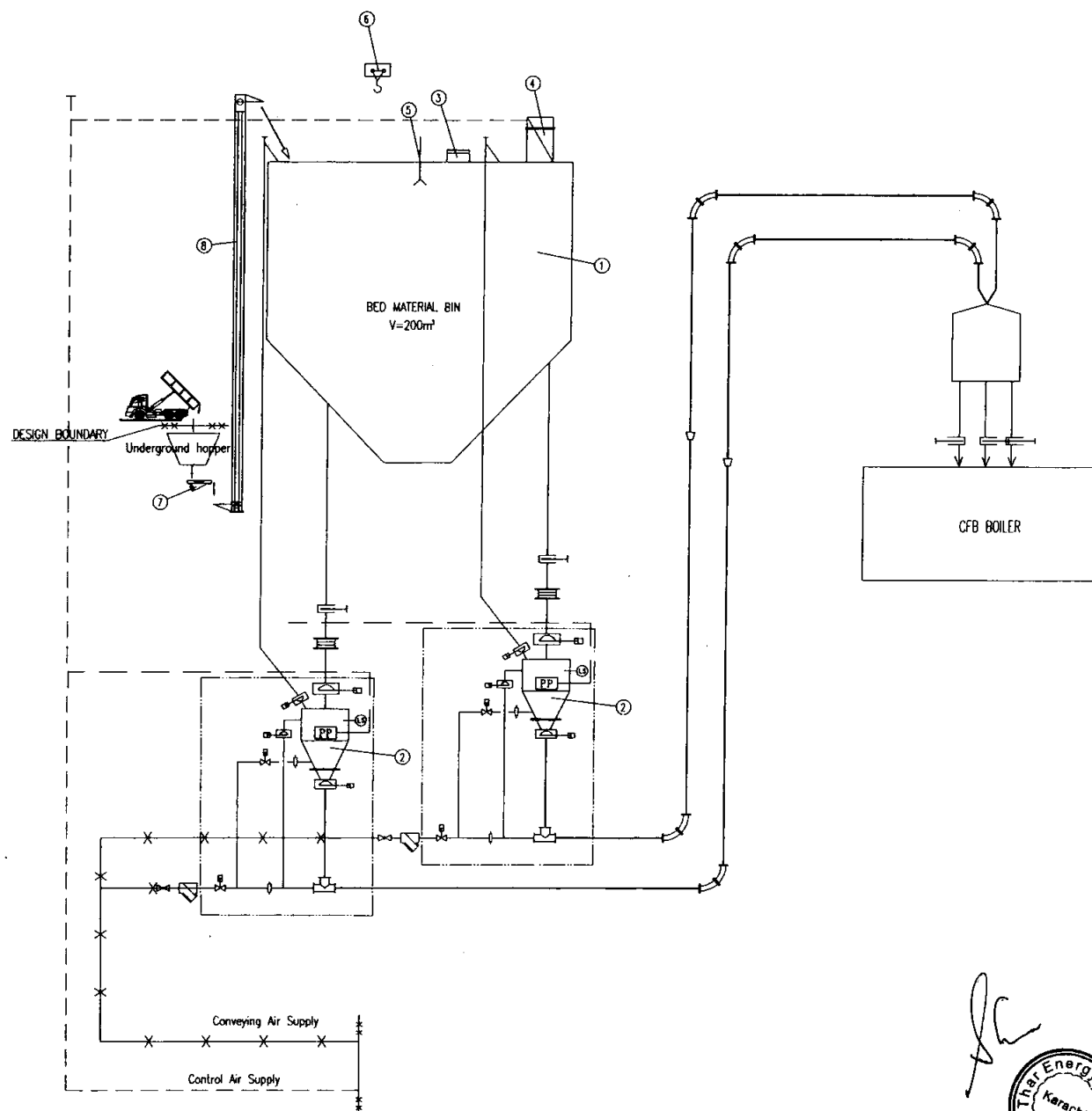


11	Steel bottom ash silo		1
10	Motor		4
9	Dry ash feeder	Q=200/h	1
8	Dust-seal mixer	Q=200/h	1
7	Rotary feeder	Q=200/h	2
6	Level indicator		1
5	Noise	N=31m Q=11	1
4	Vacuum releasing valve	SOS	1
3	Bag filter	DMC-60	1
2	Bucket elevator	Q=30/h	2
1	Chain bucket conveyor	Q=30/h	2

LIST OF EQUIPMENTS

中国机械装备工程有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中国电力建设集团中南有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CENTRAL SOUTHERN CO., LTD. The Phase II 1x330MW Coal Fired Power Plant in Madia PROPOSAL 阶段	
批准 APPROVED BY 设计 DESIGNED BY 日期 DATE 比例 SCALE	2016.07 图号 DRAWING NO. 审核 CHECKED BY 设计 DESIGNED BY
FLOW DIAGRAM OF BOTTOM ASH CONVEYING SYSTEM	
批准 APPROVED BY 设计 DESIGNED BY 日期 DATE 比例 SCALE	2016.07 图号 DRAWING NO. 审核 CHECKED BY 设计 DESIGNED BY

SYMBOL	NAME	SYMBOL	NAME
	REMOVABLE BEND		LEVEL PROBE
	PNEUMATIC PANEL		REDUCER
	FLUSHING AIR PIPE		PNEUMATIC GATE
	CONTROL AIR PIPE		HAND-OPERATED GATE
	CONNECTING AIR PIPE		PNEUMATIC VALVE
	WATER CONNECTING PIPE		GATE VALVE
	EXTENSION TUBE		CHECK VALVE
	ELECTRIC VALVE		GLOBE VALVE

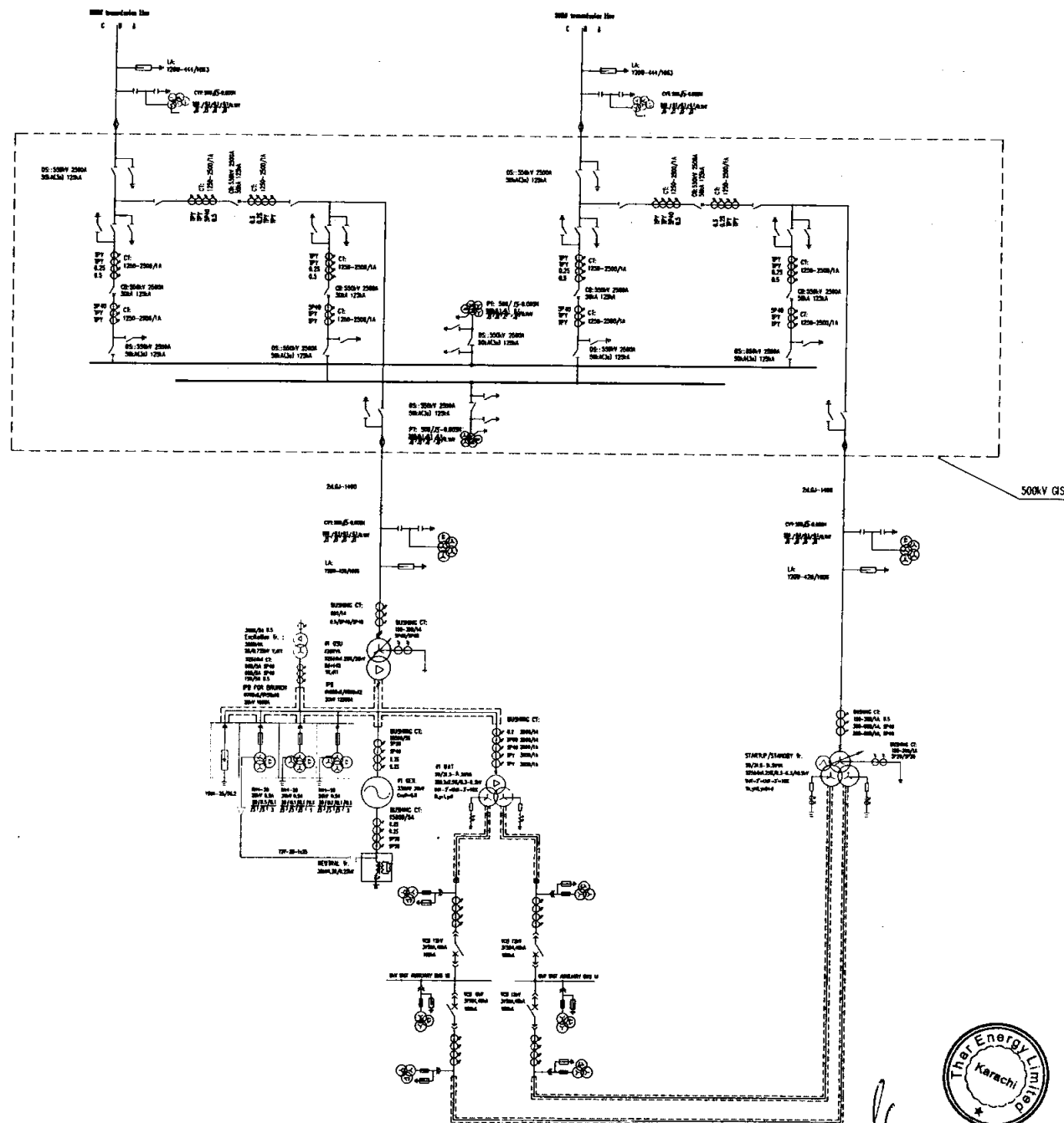


8	Signal detector	0-500/h	1		
7	Warning card feeder	0-500/h	1		
6	Roll	10-20cm Q=11	1		
5	Line indicator		1	High line confidence Real probe	
4	Bag filter	DAG-30	1		
3	Pressure reducing valve	SD8	1		
2	Real material pneumatic coupling system		1		
1	Real material fan	Y=300m³	1		
NO.	CODE	NAME	TYPE AND SPEC	Q'TY	NOTE

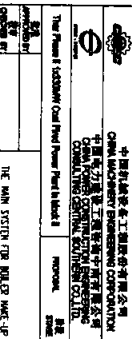
LIST OF EQUIPMENTS

	中国机械成套工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION		
	中国南方工业工程咨询中南有限公司 CHINA SOUTHERN INDUSTRIAL ENGINEERING CONSULTING GROUP SOUTHERN CO., LTD.		
	泰州 2016.07		
	设计人: 王强 审核人: 王强 日期: 2016.07		
泰州 2016			

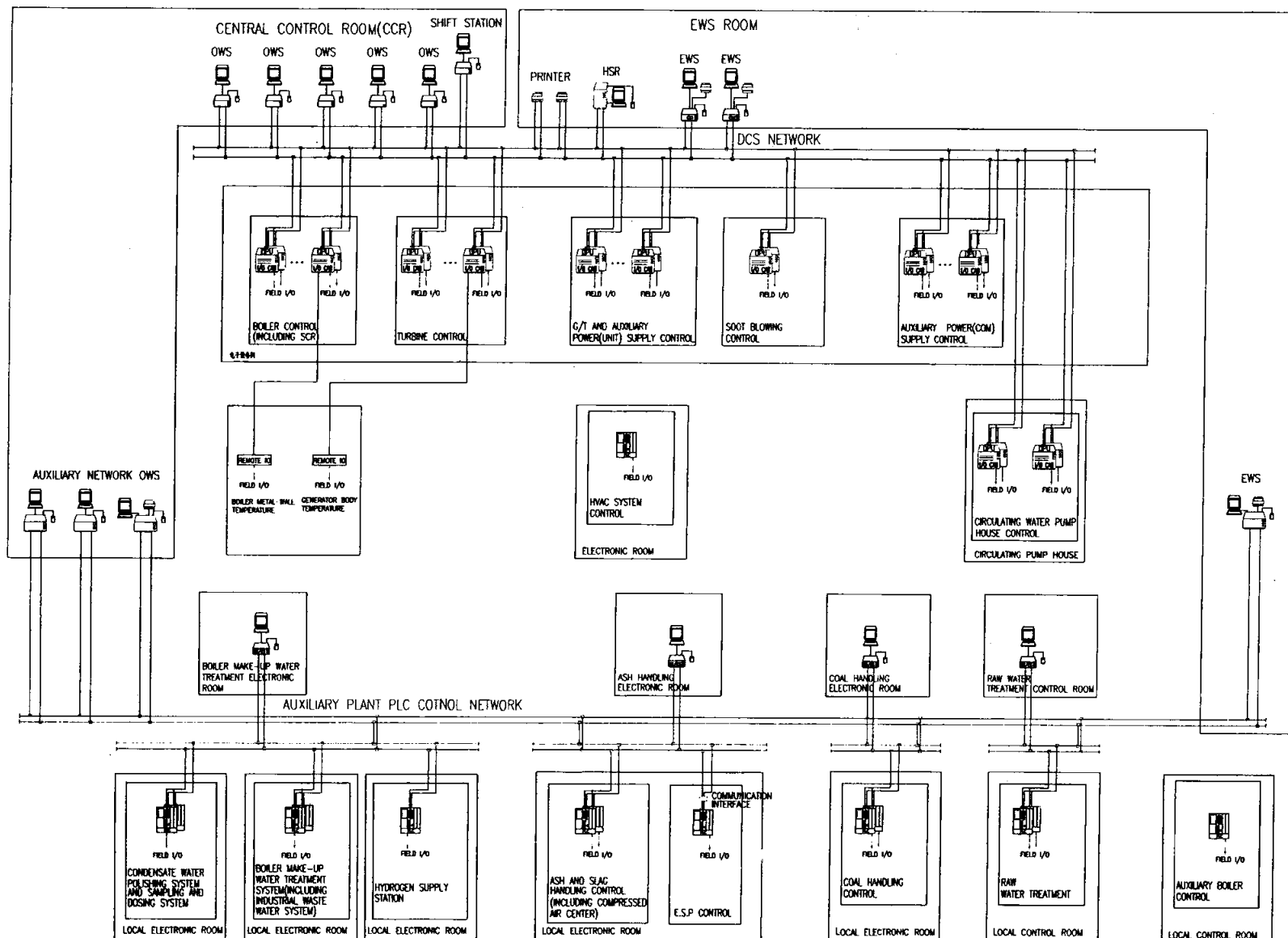
FLOW DIAGRAM OF
BED MATERIAL FEEDING SYSTEM



	中國機械設備工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION
	中國電力建設工程集團有限公司 CHINA POWER CONSTRUCTION GROUP CO., LTD.
CONJIA TONG CENTRAL ELECTRICITY CO., LTD.	
THE PLANTS IS 1x230MW Coal Fired Power Plant in block 6	
PROPOSAL	
STAGE	
批准 APPROVED BY	
校對 CHECKED BY	
設計 DESIGNED BY	ELECTRICAL SINGLE LINE DIAGRAM
日期 DATE	SCALE
比例 SCALE	
圖號 DWG NO.	A792822-001
版本 REV	



U.S. GOVERNMENT PRINTING OFFICE: 1970

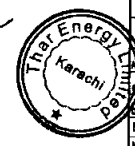
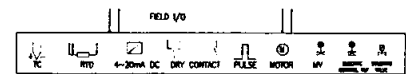


说明: 1. 本厂采用集散式一个控制室, 共设置两个值班室, 并由DCS系统
 和PLC系统组成, 各控制室均采用PLC控制, 通过数据网与中央控制室连接。

NOTE:

1. FOR THE WHOLE POWER PLANT, THERE ARE ONLY ONE MONITORING AND CONTROL SITE AT THE CENTRAL CONTROL ROOM. TWO NETWORK ARE SUPPLIED, SEPERATLY FOR UNIT DCS CONTROL AND AUXILIARY PLANT. FOR EACH AUXILIARY PLANT, PLC IS ADOPTED AND CENTRAL MONITORING AND CONTROL ACCORDING TO THE AUXILIARY NETWORK OWS IS SUPPLIED.

EWS



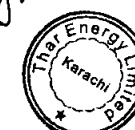
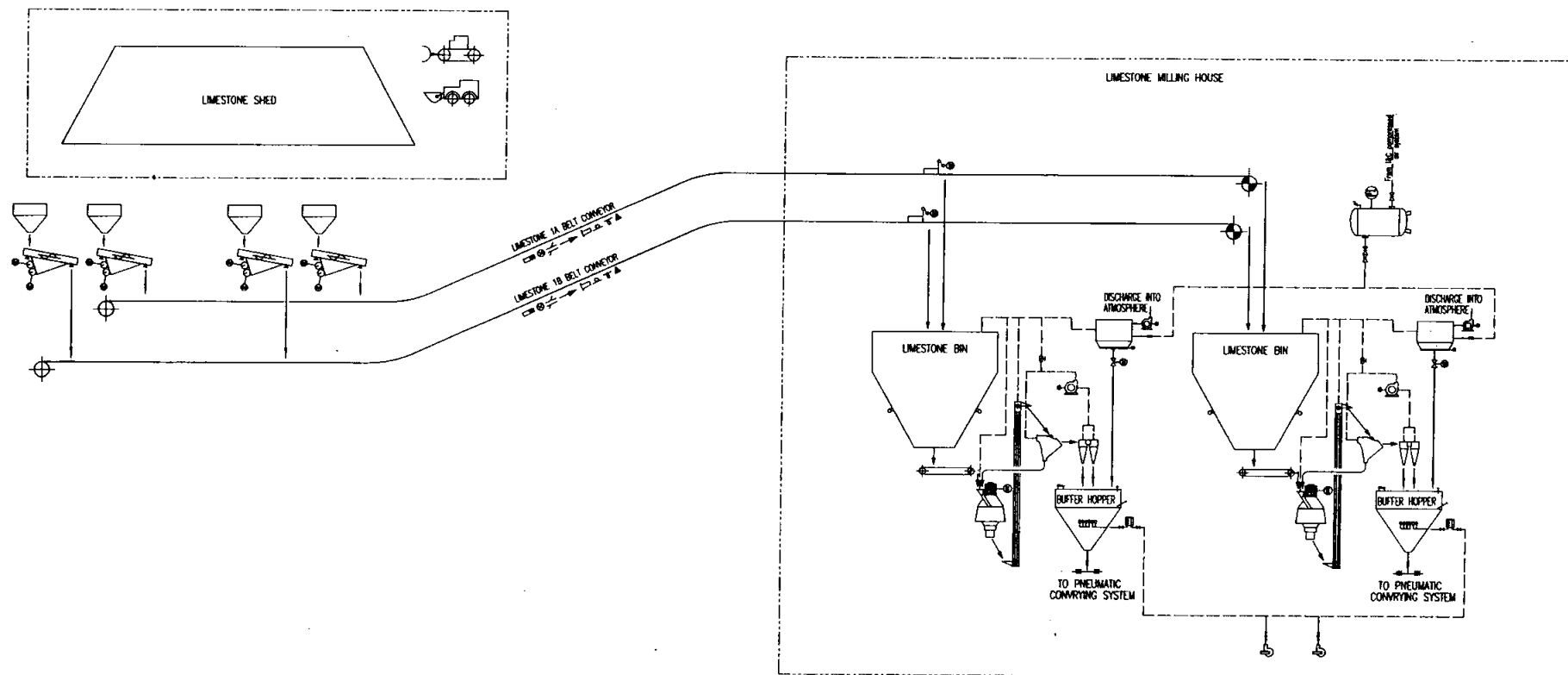
中国机械装备工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中国电力建设集团工程咨询有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CENTRAL SOUTHCHINA CO., LTD.	
This Phase II 1x330MW Coal Fired Power Plant in Block II	
设计 DESIGNED BY 日期 DATE 比例 SCALE	审核 CHECKED BY 日期 DATE 比例 SCALE
PROPOSAL 阶段 STAGE	
CONTROL SYSTEM CONFIGURATION OF POWER PLANT	
图号 DWG NO. 4730003-001	版本 REV 0

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 图样名称/Title Name

LEGEND

CONVEYING POWER PIPE	COOLING WATER PIPE
AIR PIPE	ONE VALVE
OIL PIPE	CHECK VALVE
LEVEL INDICATOR	PNEUMATIC ONE VALVE
PRESSURE INDICATOR	MANUAL MODULATOR VALVE
TEMPERATURE INDICATOR	BUY VALVE
ROCK VALVE	ELECTRICAL
ROCK BOUNDARY	SAFETY VALVE

	BULLDOZER				DOUBLE CYCLONE SEPARATOR
	VIBRATING FEEDER		BAG FILTER		POWDER CONCENTRATOR
	AIR HEATER		CIRCULATION FAN		VERTICAL ROLLER MILL
	BLOWER		AIR TANK		BUCKET ELEVATOR
SYMBOL	NAME OF EQUIPMENT	SYMBOL	NAME OF EQUIPMENT	SYMBOL	NAME OF EQUIPMENT



中国机械装备工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中国电力建设集团工程咨询有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING CENTRAL SOUTHERN CO., LTD.	
The Phase II 1x330MW Coal Fired Power Plant in block II	
设计 DESIGNED BY 日期 DATE 比例 SCALE	校核 CHECKED BY 日期 DATE 比例 SCALE
PROPOSAL 阶段 STAGE	
FLOW DIAGRAM OF LIMESTONE HANDLING SYSTEM	



圖例	名稱	圖例	名稱	圖例	名稱
	空氣器 Condenser		過濾器 Filter		止回閥 Check valve
	冷卻器 Cooler		油壓缸 Cyl pump		油壓閥 Barfthy valve
	一般空氣冷卻器 General air cooler		板門 Plate gate		油壓閥 Hydrate barfthy valve
	板門 Plate screen		減壓器 Reducer		油壓閥 Electric barfthy valve
	泵 Pump		電動機 Motor		油壓閥 Electric gate valve
	風門 Flap valve		副過濾器 Secondary filter		閘門 Gate valve

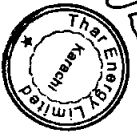
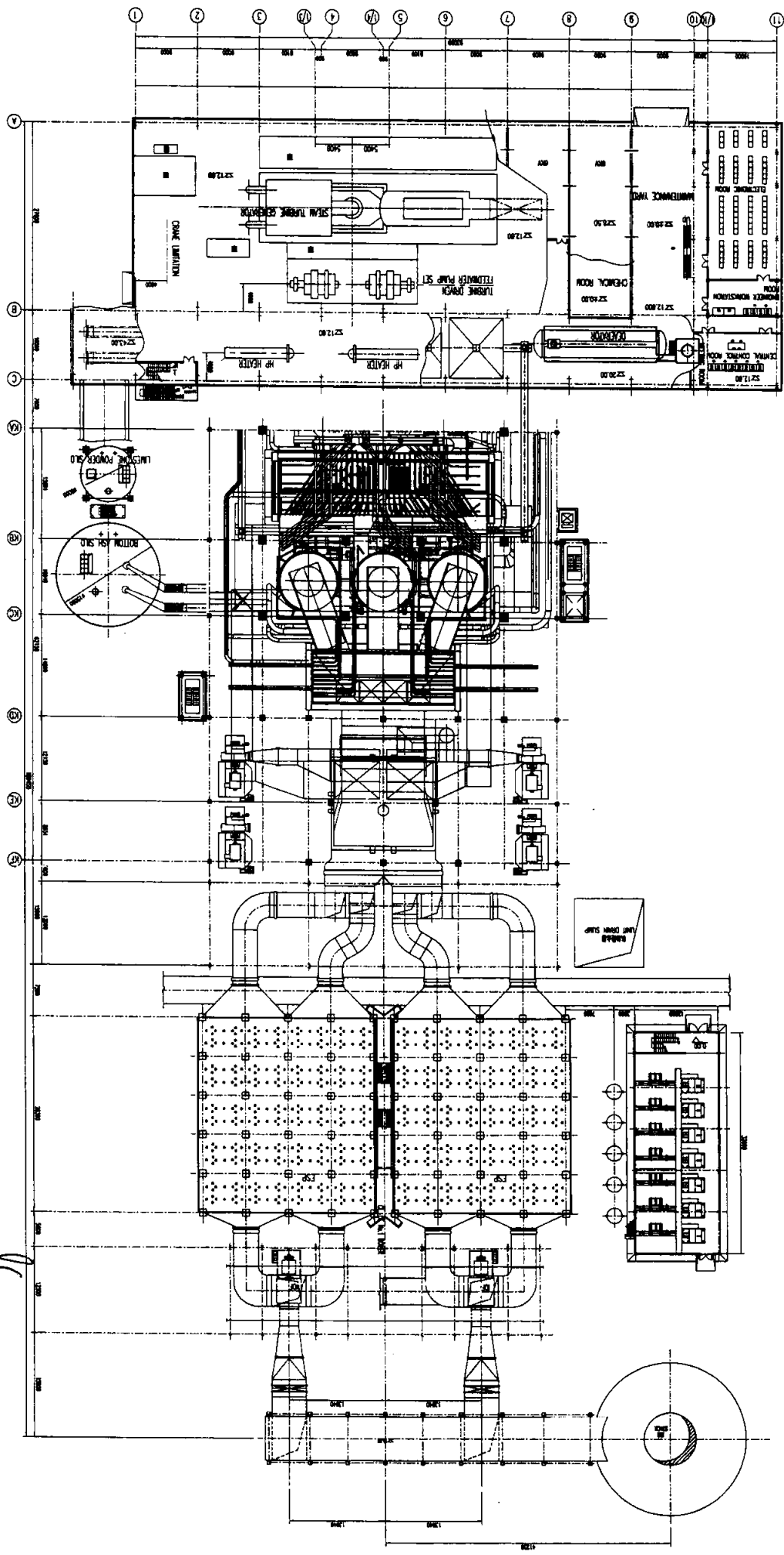
Note:
This is for 1x330MW unit's water supply system.



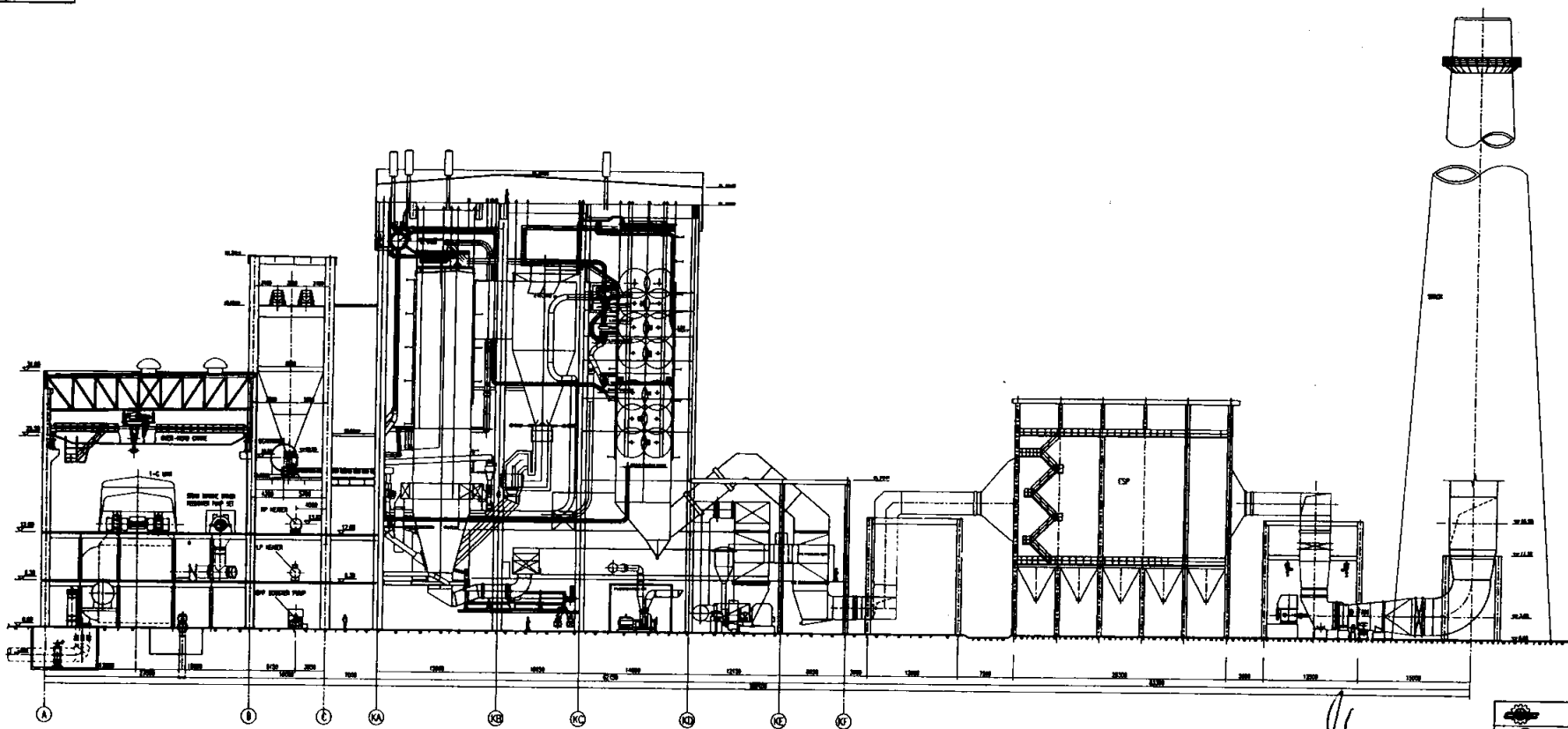
	中國機械設備工程設計有限公司 CHINA MACHINERY ENGINEERING CORPORATION	
	中國電力建設工程諮詢中南有限公司 CHINA POWER CONSTRUCTION ENGINEERING CONSULTING GROUP SOUTHERN CHINA LTD.	
The Phase II 1x250MW Coal Fired Power Plant in block II		標設 STAGE
批准 APPROVED BY 設計 CHECKED BY 校對 CORROBATED BY 日期 DATE 圖號 NO.	WATER SUPPLY SYSTEM 圖號 DWG NO.: 47-2043022-301 設計 版本 0	

NO.	REVISION	DATE	BY	CHKD.
1	ISSUED FOR CONSTRUCTION	15/05/2011	...	...
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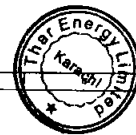
PLAN OF MAIN BLOCK



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 中國機械工程股份有限公司 CHINA MACHINERY ENGINEERING CORPORATION 中國電力工程設計院有限公司 CHINA POWER ENGINEERING DESIGN INSTITUTE CO., LTD. CHINA POWER ENGINEERING DESIGN INSTITUTE CO., LTD.	
This Phase 1 1000MW Coal Fired Power Plant in Block 1	
1. 1000MW 2. 1000MW 3. 1000MW 4. 1000MW 5. 1000MW 6. 1000MW 7. 1000MW 8. 1000MW 9. 1000MW 10. 1000MW 11. 1000MW 12. 1000MW 13. 1000MW 14. 1000MW 15. 1000MW 16. 1000MW 17. 1000MW	PROPOSAL 1. 1000MW 2. 1000MW 3. 1000MW 4. 1000MW 5. 1000MW 6. 1000MW 7. 1000MW 8. 1000MW 9. 1000MW 10. 1000MW 11. 1000MW 12. 1000MW 13. 1000MW 14. 1000MW 15. 1000MW 16. 1000MW 17. 1000MW
SECTION DRAWING OF MAIN BLOCK	
1. 1000MW 2. 1000MW 3. 1000MW 4. 1000MW 5. 1000MW 6. 1000MW 7. 1000MW 8. 1000MW 9. 1000MW 10. 1000MW 11. 1000MW 12. 1000MW 13. 1000MW 14. 1000MW 15. 1000MW 16. 1000MW 17. 1000MW	1. 1000MW 2. 1000MW 3. 1000MW 4. 1000MW 5. 1000MW 6. 1000MW 7. 1000MW 8. 1000MW 9. 1000MW 10. 1000MW 11. 1000MW 12. 1000MW 13. 1000MW 14. 1000MW 15. 1000MW 16. 1000MW 17. 1000MW



THAR ENERGY LIMITED (TEL)

Prospectus

1 General

Thar Energy Limited (TEL) is a wholly owned subsidiary of The Hub Power Company Limited ("HUBCO"). Through Thar Energy Limited (TEL), HUBCO is planning to build a project of 1x330 MW mine mouth plant based on indigenous coal to be mined from the coal fields of Thar Block II, which is a 95.5 square kilometer (km²) area of coal field awarded to Sindh Engro Coal Mining Company (SECMC) for exploration and mining of lignite primarily for power generation projects.

The design capacity is 330 MW gross, with the Net Capacity of approximately 300 MW based on indigenous coal of Thar block II coal fields.

2 Environmental Control

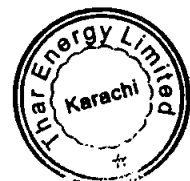
The Project will incorporate state of the art CFB Technology boiler that will not generate much NO_x due to its lower furnace temperature, in-furnace limestone dosing option to control SO_x, Electrostatic Precipitators (ESP) for PM control and waste water treatment units to minimize and treat liquid effluents generated from plant processes to ensure compliance with NEQS.

2.1 Environmental Control Technologies

2.1.1 Treatment of Particulate Matter using Electrostatic Precipitator (ESP)

The steam generator will be equipped with a dry electrostatic precipitator (ESP). The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon). Generally, ESPs are designed to have an efficiency greater than 99%. The ESP will limit the outlet flue gas particulate loading to below 50 ppm at all loads when burning design coal.

Description	Control Efficiency	Advantages
ESP is applicable to a variety of coal combustion sources and the negatively charged dry precipitator is most commonly used. The high-voltage fields apply large electrical charges to particles moving through the field. The charged particles move toward an oppositely charged collection surface, where they	≥ 99 %	High collection efficiency of 99% or greater at relatively low energy consumption. Low pressure drop. Continuous operation with minimum maintenance. Relatively low operational costs. Operation capability at high temperature (up to 700 °C) and high pressure (up to



accumulate. The accumulated particles are than removed by scrapper and collected at ESP hopper.		10 atm)

2.1.2 Treatment of SO₂ using in-furnace limestone dosing

SO₂ control will be provided by the injection of limestone in the CFB Boiler and converting sulfur to gypsum (calcium sulfate). SO₂ emissions of the plant will be below 850 mg/Nm³ and meet SEQS and IFC EHS guidelines for stack emissions.

Description	Control Efficiency	Advantages
In-furnace Limestone Injection	≥ 90%	Less Capital Cost as compare to separate desulfurization unit. Low Auxiliary power consumption and small area required.

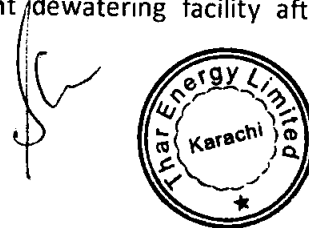
2.1.3 Reduction in NO_x levels CFB boiler technology

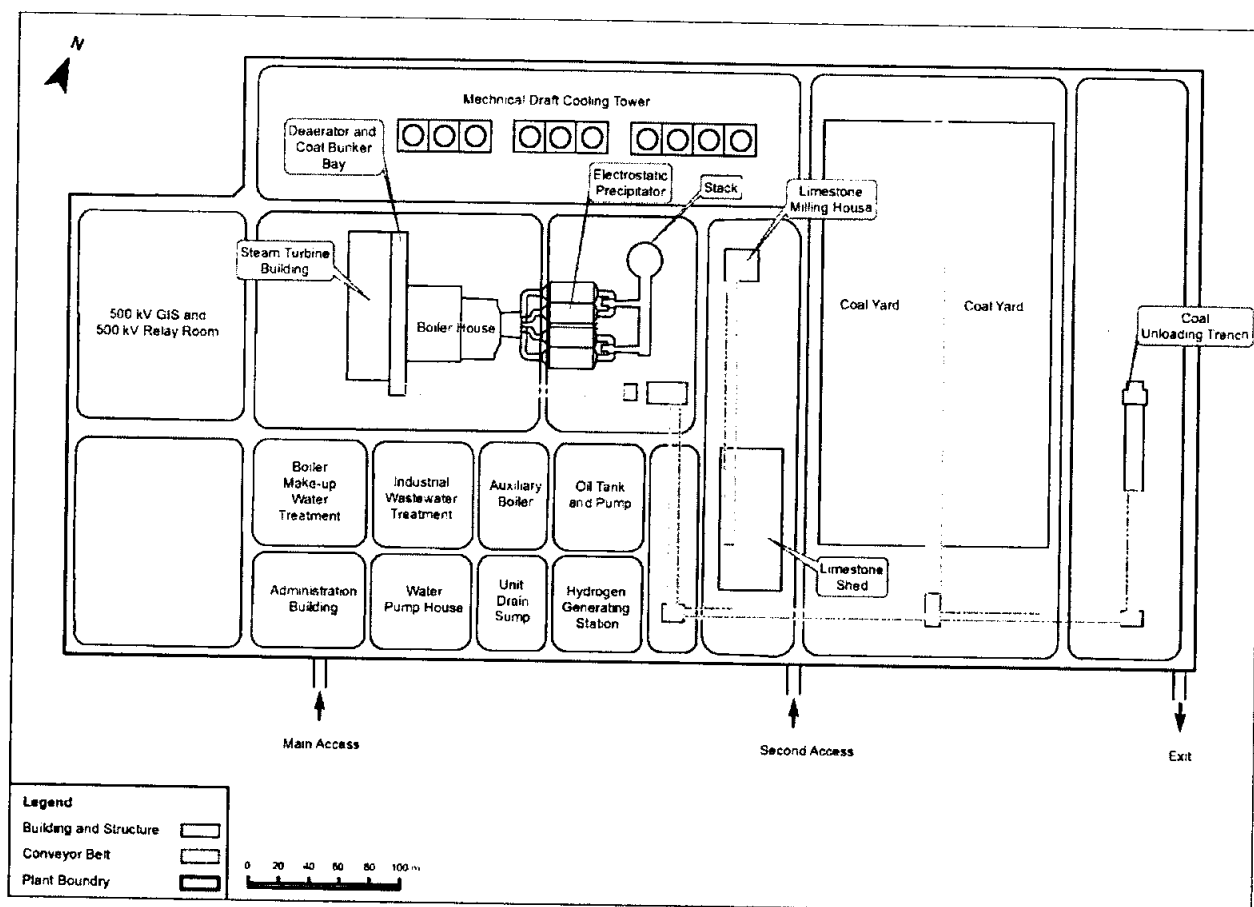
Control Technology	Description
In CFB boiler, combustion takes place at relatively low temperatures as compared to pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these low temperatures results in an effective suppression of NO _x and can meet the SEQS and IFC EHS limits of NO _x in the stack.	Limestone injection into furnace

3 Power Plant

3.1 Plant Layout

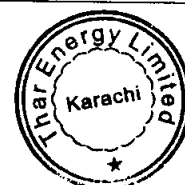
The Plant is located at Thar Coal Fields Block II, Tehsil Mithi, District Tharparkar, Sindh province of Pakistan, around 5 km distance from the open pit mine. The coal will be supplied from the mine and the transportation to the Power plant will be carried out by trucks. The unit will be cooled by the mechanical draft cooling tower. The main water supply will be from LBOD water, and the alternate water source can be mine water supplied from adjacent dewatering facility after treatment. Following is the simplified version of the proposed layout.





3.2 Main Technical Indexes

Item	Unit	Date
Gross power output	MW	330
Steam Data (for boiler) at BMCR		
Steam flow	t/h	1098
Steam pressure	bar(g)	174
Steam temperature	°C	540
Feedwater temperature	°C	282
Design Performance		
Boiler efficiency	%	91.0
Turbine heat consumption rate	kJ/kW.h	7988.6
Design coal consumption	t/h	275
Design coal LHV	kcal/kg	2674
Net efficiency of the power plant	%	37.1
Net power output	MW	300 (Approx.)



3.3 Main Equipment

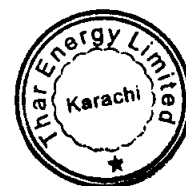
Project will have a Gross power of 1x330 MW with the Net power output of approximately 300 MW and auxiliary load of 9% approx. Efficiency of 37% as per the requirement of Up-front Tariff. Project equipment and technology is being designed to meet the 85% aggregate availability requirement of PPA (Power Purchase Agreement).

Main equipment includes, but not limited to the following equipment/systems:

- Circulating Fluidized Bed (CFB) Boiler
- Steam Turbine Generator Set (STG) and its excitation system.
- STG's Exhaust Vacuum System Steam Surface Condenser.
- Boiler Feed Water preheating "LP heating, Deaerator, BFW pumping, HP heating.
- Electrostatic precipitator (ESP) for Flue gas.
- One set of stacker/re-claimer for the coal handling system.
- Bottom Ash discharging, transporting system to bottom ash silo.
- Fly Ash discharging, transporting system to fly ash silos.
- Bed material transportation after storage bin in the power plant, pneumatic conveying & Feeding System.
- Circulating water system which will be composed circulating water pumps, cooling towers, filtration systems, automatic condenser cleaning system, filters valves, pipes, and other necessary instruments.
- Boiler make-up water treatment system
- All piping, insulation of necessary equipment and pipes, cabling, cable trays, tubing etc.
- Miscellaneous such as power plant's water and steam sampling, chemical dosing, field instruments.
- Condensate Polishing System.
- Step up transformer, unit auxiliary transformer, start-up/stand by transformer.
- 500 kV switchgear including indoor GIS, PT, LA equipment, control and protection.
- MV & LV switchgear and transformers for auxiliary electrical system.
- DC and UPS system.
- All kinds of cables (including control cables), cable trays, field boxes and junction boxes within the scope of supplies.
- Fire-fighting system.
- Evaporation ponds and Ash storage yard etc.
- Coal Yard

3.4 Fuel Specification

HSD will be used for ignition and start-up of the boiler, and temporary fuel is transported by truck to the power plant. Coal specs are given in the table below:

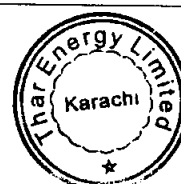


PARAMETERS	Design Coal
Total Moisture (% by weight)	49.5
Ash (% by weight)	7.0
Volatile Matter (% by weight)	24.5
Fixed Carbon (% by weight)	19.0
Carbon (% by weight)	30.89
Hydrogen (% by weight)	2.65
Oxygen (% by weight difference)	8.35
Nitrogen (% by weight)	0.44
Sulfur (% by weight)	1.07
Lower Heating Value (kJ/kg)	11198
SiO ₂ (% by weight)	25.45
Al ₂ O ₃ (% by weight)	15.20
Fe ₂ O ₃ (% by weight)	12.85
MgO (% by weight)	4.86
CaO (% by weight)	11.8
Na ₂ O (% by weight)	3.85
MnO(% by weight)	-
TiO ₂ (% by weight)	1.81
P ₂ O ₅ (% by weight)	-
SO ₃ (% by weight)	11.59
K ₂ O (% by weight)	0.41
Others	12.18
Base / Acid Ratio	0.84
Initial Deformation (°C)at Reduced Atm.	1220
Softening temperature (°C)	1284
Fusion Temperature (°C) at Reduced Atm	1412
Hardgrove grindability index (HGI)	75

3.5 Coal Consumption

Item	Value	Design coal
Hourly coal consumption	t/h	275
Daily coal consumption	t/d	6600

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Annual coal consumption	10 ⁴ t/a	204.765

3.6 Main Systems at the Plant

3.6.1 Coal Handling System

The coal handling system will be designed and built for 1x330MW unit. The design scope include all necessary accessories from coal unloading trench to coal bunkers in boiler house, including coal unloading trench, coal storage yard, crushing device, belt conveying system, weighing scale, sampling equipment, control system and all the other necessary auxiliary devices inside the plant.

It will be SECMC's responsibility to transport the coal under CSA with the size less than 350mm to power plant coal unloading trench by trucks. The dual-way belt conveyor will be equipped under the coal unloading trench and one rotary plow feeders will be set on each belt conveyor.

An open coal storage yard of appropriate capacity inside the plant will be provided. The height of coal pile is 10m. One boom bucket-wheel stacker/re-claimer with rails will be installed in coal yard, shuttling arrangement. Two bulldozers and one wheel loader will be provided for coal yard auxiliary work.

3.6.2 Ash Handling System

3.6.2.1 Fly Ash Handling System

The fly ash system removes the ash that accumulates in the ESP and economizer using a pneumatic pressure conveying system. The capacity is approximately 150% of the expected as quantities under BMCR of design coal.

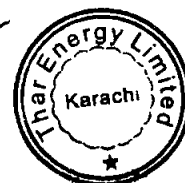
One vessel transmitter will be provided under each ESP and economizer hoppers. These vessels will be grouped to convey ash with a series or series-parallel connection by a mother ash conveying pipe.

In order to prevent blockage in hoppers of ESP, two fluidizing blowers and one electric heater will be equipped. Fluidizing blowers shall be one operating, one standby, and electric heater shall be continuous operating.

Two concrete ash storage silos will be provided for storing the fly ash. They can store more than 72 hours fly ash production of 1 boiler based on BMCR operation (as per design coal). Fly ash shall be discharged by dry ash unloaders into tank cars, or by dual-axle mixers into trucks, and then transported outside to landfill.

3.6.2.2 Bottom Ash Handling System

There are four bottom ash coolers under the boiler furnace. The temperature of the outlet is not more than 150°C. Bottom ash shall be directly sent to chain bucket conveyors, and then bucket elevators will transport bottom ash to bottom ash silo near the boiler area. The chain bucket conveyor and bucket elevator will be set as two lines, and one operating one standby. The total capacity of mechanical system shall be based on 250% approximately of the bottom ash quantity.



A steel cone bottom ash silo shall be set for the boiler. The valid volume can store more than 72 hours bottom ash production based on BMCR operation

3.6.2.3 Bed Material system

One bed material bin shall be set for the boiler. The bed material is shipped by trucks to the plant, and then unload to underground hopper then lifted to the bed material bin by bucket elevator with capacity of 50t/h. One set of wheel loader with capacity of 3t shall be set for each material bin. There shall be two sets of vessel under each bed material bin, each vessel has one pipe, bed material shall be conveyed to the splitter of boiler, and then splitter divides three ways to the boiler chamber.

3.6.3 Thermal System

3.6.3.1 Boiler

The boiler is of subcritical parameter boiler with single drum, with high temperature ash recycling, dry bottom ash discharging, balanced-draft, all steel structure type. Each boiler is equipped with one rotary air heaters.

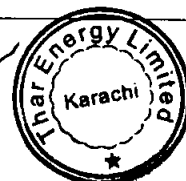
The boiler main parameters are as follows:

Boiler maximum continuous rating	1098t/h
Main steam pressure at outlet of superheater	17.5MPa(a)
Main steam temperature at outlet of superheater	540 °C
Reheat steam flow	907t/h
Reheat steam pressure at inlet/outlet of reheater	4/3.62MPa(a)
Reheat steam temperature at outlet of reheater	330/540 °C
Feed water temperature	282 °C
Coal consumption	275t/h
Boiler Efficiency (based on LHV)	91%

3.6.3.2 Turbine

Turbine Generator and auxiliary systems shall be designed in accordance with all the following data. Main Technical Parameters as BMCR condition are as follows:

Rated output at generator terminal exclusive of excitation load	300 MW
Initial steam pressure at inlet to main stop valve	16.67 MPa(a)
Initial steam temperature at inlet to main stop valve	538°C



Exhaust steam pressure at exhaust connection from turbine	6.9kPa
Circulating water temperature at inlet to condenser	27.6°C
Make up water rate	0%
Turbine speed	3000 rpm
Generator frequency	50 Hz
Generator power factor	0.8

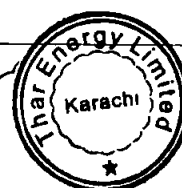
3.6.4 Electrical System

The electrical system in the power plant provides electrical service to safe and reliable operation for the power generation and distribution of the plant, it will includes the following sub-system and equipment:

- Generator and theirs outgoing system, including, IPB, PT& LA cubicle, bushing CT
- Step-up transformers (20/500kV), high voltage (20/6.3kV) unit auxiliary transformers (UAT) and HV (500/6.3kV) start-up/standby transformer
- 500kV switchyard including indoor 500kV GIS and 500kV PT & LA equipment
- Auxiliary electrical system including low voltage (6.3/0.4kV) auxiliary transformers, 6kV and 380/220V switchgear associated with relative control and protection system
- Emergency power system including diesel generator and relative electrical system
- Lighting system
- Cable and its raceway system
- Lightning and earthing system associated.
- DC and UPS system.
- Protections, Measuring and Synchronizing system
- Internal Communication system
- The delivery point at 500kV level is at the first outgoing transmission frame structure in fence of 500kV switchgear.

Main technical parameters of the Generator are as follows:

Rated capacity	330MW
Maximum continuous output power	match with turbine MCR
Rated power factor	0.8(lagging)
Rated voltage	20kV
Rated frequency	50Hz



3.6.5 Instrumentation and Control System

Power Project will be provided with a set of DCS system. DCS controls the following systems includes the following:

- Boiler proper and auxiliary systems
- Boiler proper and auxiliary systems
- Turbine proper and auxiliary systems
- Generator proper and auxiliary system
- Chemical sampling
- Condensate polishing etc

3.6.6 Cooling Water System

The process of cooling water system is described as:

The outlet of the cooling tower basin → C.W. pump → C.W. pressure steel pipe → Condenser → C.W. drainage pipe → Cooling tower

The C.W. pump house will be designed for 1×330MW unit. There are 2×50% C.W. pumps in the C.W. pump house. The Circulating water pumps will be vertical wet type. The flow of each C.W. pump will be about 6.03 m³/s, the head will be about 21m.

3.6.7 Boiler make-up water and Condensate Polishing Systems

3.6.7.1 Boiler Make-up Water Treatment System

Distillate water from the industrial water system → secondary RO unit → Cation exchanger → Anion exchanger → Mixed bed → Demineralized water tank → Demineralized water pump → Plant user.

3.6.7.2 Condensate Polishing System

The system adopts external regenerative type high speed mixed bed polisher. Medium pressure condensate polishing system will be designed for this project. 3×50% condensate polishing mixed beds will be provided for one unit and one (1) package of external regeneration equipment will be provided.

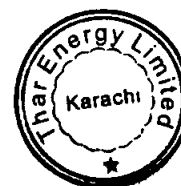
3.6.8 Flue Gas System

3.6.8.1 Combustion, Air/Flue Gas System

1) Primary air system

Primary air system supplies fluidizing air for the boiler to make coal in fluidized state and delivering air for coal feeding system.

Boiler will equipped with two sets of centrifugal, 50 percent capacity of BMCR primary air fans with inlet guide vanes, two inlet silencers and dampers, etc. There is a connection air duct between the outlets of primary air fans.



2) Secondary air system

The secondary air at outlets of secondary air fans via air preheaters will supply hot secondary air required by boiler combustion.

The boiler will be equipped with two sets of centrifugal, 50 percent capacity of BMCR secondary air fans with inlet guide vanes, two inlet silencers and dampers, etc.

3) Flue gas system

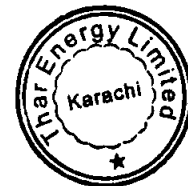
Combustion products enter the cyclones firstly. In the cyclones, the coarse fly ash is separated and returned to the furnace. The flue gas with fine fly ash passes through heat recovery area, is purified from dust in the ESP and discharges to the atmosphere via induced draft fans and stack.

One stack is installed in this project. Diameter and height of the stack is mentioned in ESIA report.

6) Coal feeding system

After crushed, the coal with qualified size will enter into the coal bunkers by the coal feed belt, then through the coal feeders and coal piping, the coal will be delivered to coal feed connections.

The coal feeding system adopts pressurized air distribution equipment to send coal into the furnace, and the coal distribution air is from hot preliminary air. The pressure of solid material is higher than that of furnace at the same height to prevent the returning of hot air from furnace.



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SCHEDULE - III

Project Details for 1x330

Thar Energy limited (TEL)

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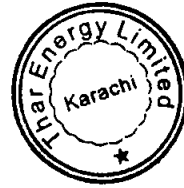
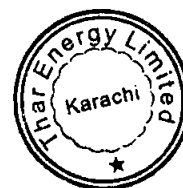


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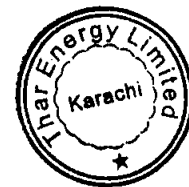
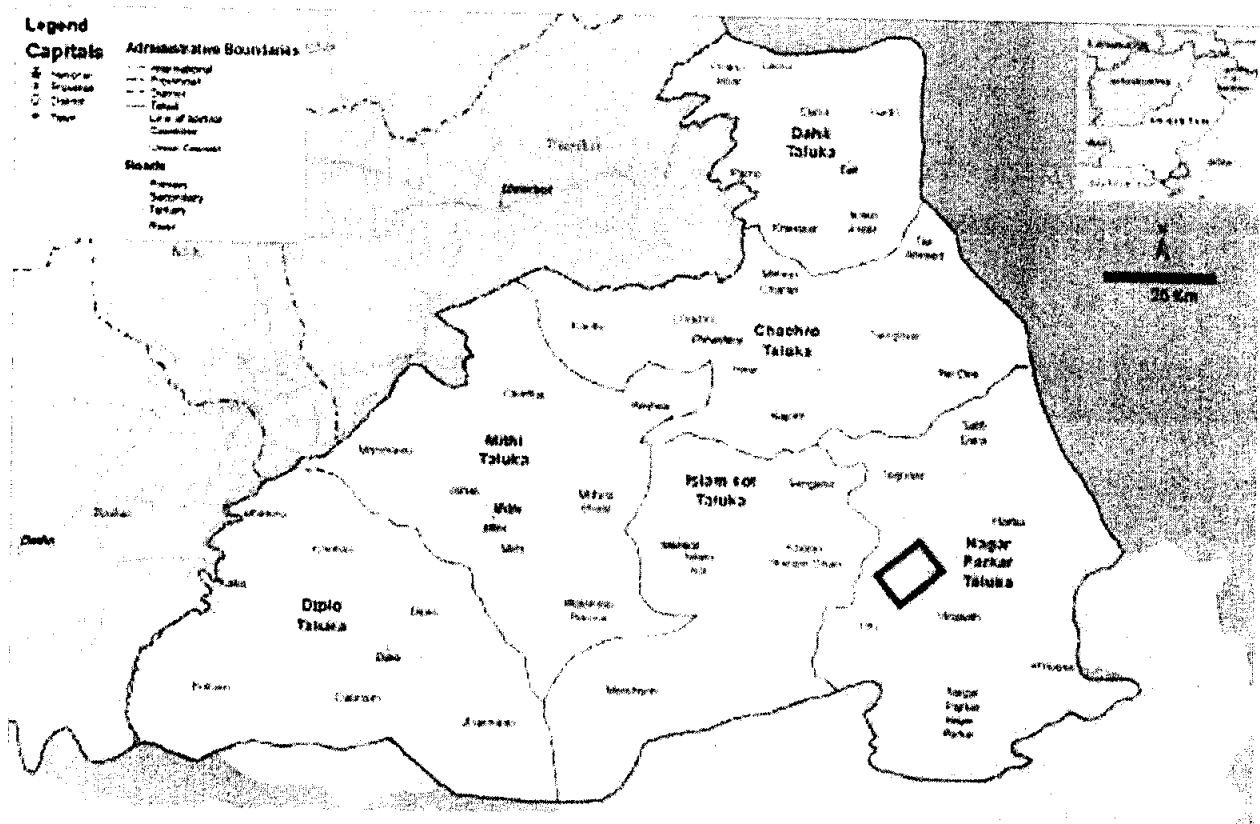
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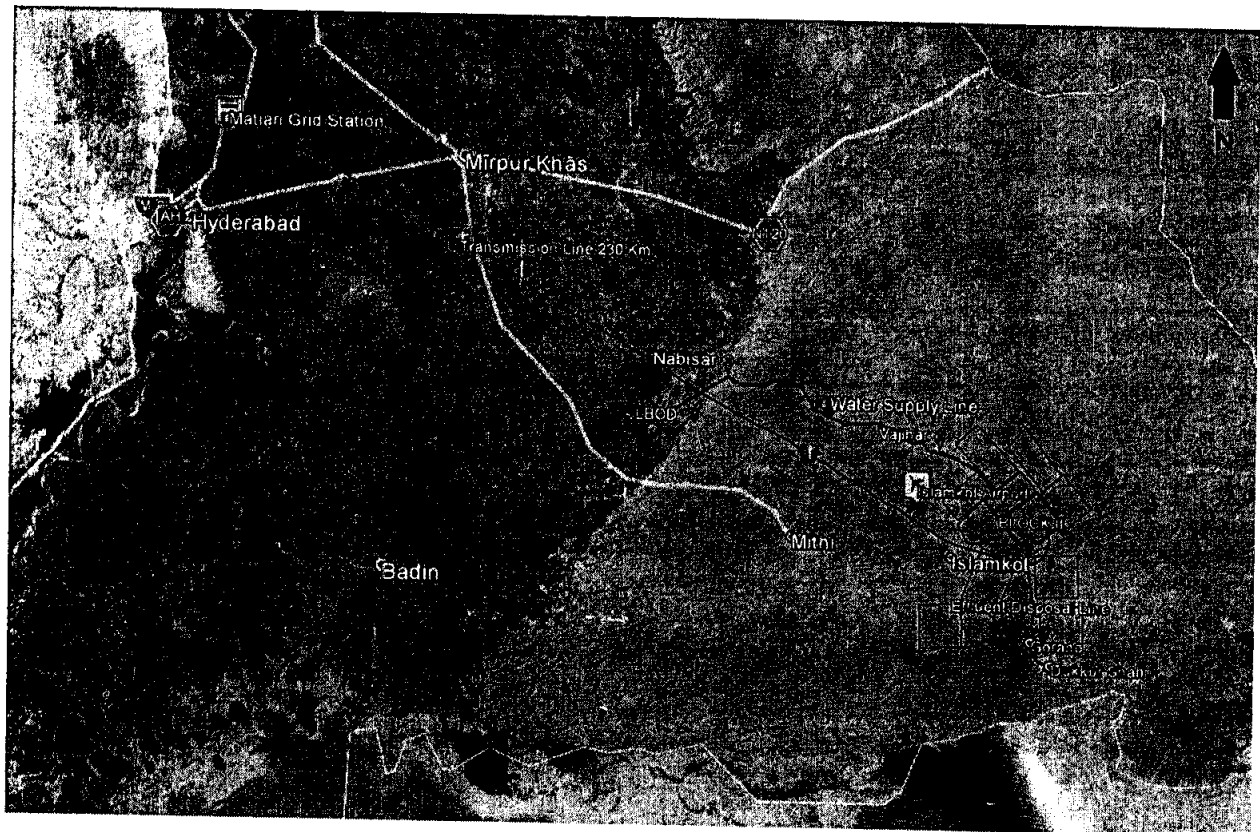
1 Location

1. The coal fired power plant consists of one unit of electric generating unit (330MW) located at Thar block II near Islamkot. The proposed power plant is situated near a lignite mine, approximately 5km north of the proposed mine and will be approached via constructed roads leading from the mine to the power plant. The area has been selected with a consideration of sub-optimal stripping ratio and hence the proposed area will not feature in the lignite coal mining extraction strategy and therefore will not impact the long term production of lignite fuel from block II.

The area outlined in red below reflects the Thar Block II where the Project is located and is approximately 5 Km north of the proposed Mine Project.



Following is a detailed map of the site:



2 Technology

- 2.1 TEL will install one unit of Three Hundred and Thirty MegaWatts (1x330MW). The Plant will be of sub-critical CFB boiler technology.

3 Fuel

- 3.1 Pakistan has lignite reserves of around 186 Billion tonnes and is ranked 7th amongst the lignite (coal) rich countries of the world. The country's largest coal reserves are located at Tharparkar District in the south-eastern province of Sindh, where about 175 Billion tonnes of total lignite (95%) has been identified.

The extension of the entire lignite bearing area is about 9100 km². Between the years 1992 and 2010, several reconnaissance and exploration programs have been carried out to determine, the extent of the lignite deposits at Thar and to define those blocks which may be mined.

Till 2010, some 200 boreholes had been drilled and 1000 material (mostly coal) samples were collected and analyzed. At present, the region has been divided into 12 blocks (which is an area of 1000 km²). Thar lignite is recognized as a major energy source, which has substantial potential to support energy production from indigenous resources.

Thar Coal Block II alone has total coal reserves of 2 Billion tons, out of which 1.57 Billion tons are exploitable as assessed by the Competent Persons Statement (CPS), the required professional assessment, conducted by RWE – Germany (which is one of the leading consultants in the world having significant expertise in lignite mining and associated power generation). It is estimated that exploitable reserves of 1.57bn tons can be used to produce 5000 MW for 50 years.

The reserves are based on the combined exploration results of drilling activities during the period of 1995/96, 2002 and 2010 and the resource modeling done by SECMC supervised by RWE Power International. The categorization of the resource follows the Australian JORC Code Guidelines and the "Australian Guidelines for Estimating and Reporting of Inventory Coal, Coal Resource and Coal Reserves".

HSD will be used for ignition and start-up of the boiler, and temporary fuel is transported by truck to the power plant. Coal specs are given in the table below:

PARAMETERS	Design Coal
Total Moisture (% by weight)	49.5
Ash (% by weight)	7.0
Volatile Matter (% by weight)	24.5
Fixed Carbon (% by weight)	19.0
Carbon (% by weight)	30.89
Hydrogen (% by weight)	2.65
Oxygen (% by weight difference)	8.35
Nitrogen (% by weight)	0.44
Sulfur (% by weight)	1.07
Lower Heating Value (kJ/kg)	11198
SiO ₂ (% by weight)	25.45
Al ₂ O ₃ (% by weight)	15.20
Fe ₂ O ₃ (% by weight)	12.85
MgO (% by weight)	4.86
CaO (% by weight)	11.8
Na ₂ O (% by weight)	3.85
MnO(% by weight)	-
TiO ₂ (% by weight)	1.81
P ₂ O ₅ (% by weight)	-
SO ₃ (% by weight)	11.59
K ₂ O (% by weight)	0.41
Others	12.18
Base / Acid Ratio	0.84

Initial Deformation (°C)at Reduced Atm.	1220
Softening temperature (°C)	1284
Fusion Temperature (°C) at Reduced Atm	1412
Hardgrove grindability index (HGI)	75

The supply of fuel for the Project is guaranteed from the adjacent mine being constructed by SECMC, which is expected to have sufficient volumes of coal to supply the fuel requirements over the operating life of the Project. Cost of Thar / Imported coal is passed through in tariff. The following figure reflects that the cost of Thar coal is expected to be higher compared to imported coal in the initial years when mine is expected to be operated at a capacity of 3.8 MTPA, however, with planned future expansions, the cost of Thar coal will go down. The following chart depicts the expansion plan of the Mine Project along with the improvement / reduction in the generation Tariff as well.

Trucks will be used to transport coal from the mine crusher which will crush the coal. The crushed coal will be delivered to the SECMC coal storage yard. From SECMC's coal stockyard, coal with a guaranteed size of less than 300mm will be transported to Power Plant's unloading trench. The terminal point will be the weighing bridge near the coal unloading trench at the Power Project. The IPP should have a total on-site coal storage capacity of 30 days inventory as will SECMC.

4 Emission Values

According to HSE guidelines for Coal-fired Power Plant, the emissions in stack will be as follows:

Parameter	Emission Limit Values (mg/Nm ³ , dry)
PM (Dust)	50
NOx	510
SOx	850

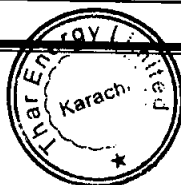
Note: Emission limit values are evaluated by taking the volumetric oxygen ratio in flue gas as 6 %.

4.1 Liquid Effluent Standards-NEQS:

Liquid effluents will be meet the following NEQS standards. The units are in mg/L or

otherwise mentioned.

Parameter	Limits for Discharge to Sea
Temperature Increase	$\leq 3^{\circ}\text{C}$
pH value	6-9
Biochemical Oxygen Demand (BOD) 5 at 20°C (1)	80**
Chemical Oxygen Demand (COD)(¹)	400
Total suspended solids (TSS)	200
Total dissolved solids (TDS)	3500
Grease and oil	10
Phenolic compounds (as phenol)	0.3
Chloride(as Cl^-)	SC***
Fluoride (as F^-)	10
Cyanide (as CN^-) total	1.0
An-ionic detergents (as MBAS) . (2)	20
Sulphate (SO_4^{-2})	SC***
Sulphide (S^{-2})	1.0
Ammonia (NH_3)	40
Pesticides(³)	0.15
Cadmium(⁴)	0.1
Chromium (trivalent and hexavalent) (⁴)	1.0
Copper (⁴)	1.0
Lead (⁴)	0.5
Mercury(⁴)	0.01
Selenium(⁴)	0.5
Nickel(⁴)	1.0
Silver(⁴)	1.0
Total Toxic metals	2.0
Zinc	5.0
Arsenic(⁴)	1.0



Barium ⁽⁴⁾	1.5
Iron	8.0
Manganese	1.5
Boron ⁽⁴⁾	6.0
Chlorine	1.0

5 Cooling Water Source

1. The cooling water make up is the main water requirement for the power project, the water will be provided by LBOD scheme (GoS is executing the scheme to provide 35 cusecs water for Thar based power plants).

The power plant systems will be designed so as to maximize the re-use of water, and generation of minimum possible wastewater, thus optimizing the total water requirements of the power plant.

2. The Project's main water requirement during operations will be for the makeup of cooling water; other uses will include the makeup of boiler feed water, industrial water and potable water supply. The water would be available from two sources i.e. the Left Bank Outfall Drainage (LBOD) and, as an alternative, groundwater (from dewatering of mine). In either case, the water shall require several stages of treatment before achieving a quality that is suitable for use.

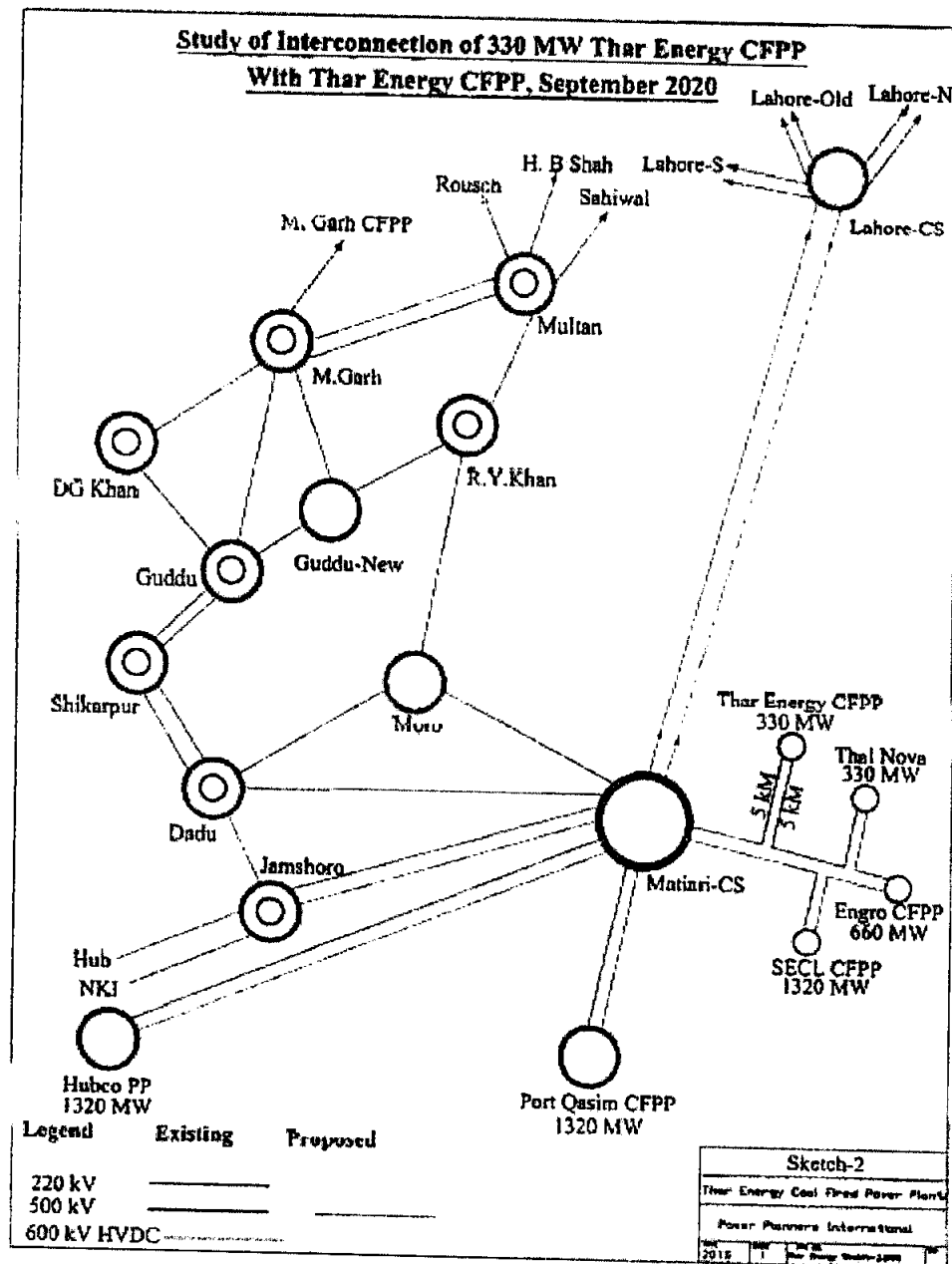
GoS was requested to provide a reliable source of water supply as part of infrastructure development for power generation in Thar Coal Fields, Islamkot. Accordingly, GoS is setting up a water supply and treatment scheme under which it will supply 35 cusecs of treated water from the Left Bank Outfall Drainage (LBOD), originating from the Indus River, to the Project under a long term Water Supply Agreement; Cost of Water (treatment & supply) is already covered in NEPRA Tariff. The LBOD is an existing saline drainage scheme disposing water in the Arabian Sea and, based on available data from the Sindh Irrigation department, the channel carries in excess of 100 cusecs raw water at all times. It is this channel that shall ensure continuous and reliable water supply to the Project. The treated water from this scheme shall serve as the primary source of water; the Project will be equipped with the capability to also operate from a guaranteed supply of canal quality water from LBOD.

As per the Water Use Agreement between Engro and Government of Sindh, Option holders for Phase II power plants have the first right of refusal for water. However, this right is only valid if the sponsors obtain Letter of Interest (LOI) from PPIB prior to March 17th 2016. The first right of refusal for water supply from LBOD scheme will expire in case sponsors are not able to fulfill this condition and it will become extremely to procure water for the power plant.

6 Interconnection with National Grid Company

6.1 Proposed Scheme

- 6.1.1 500 kV transmission lines for power evacuation from Thar Block II will be constructed by National Transmission and Dispatch Company (NTDC). These lines are planned to be connected to Matiari grid, 230 km away, from where the power will be transported to the load center of Pakistan in Punjab through HVDC transmission network.
- 6.1.2 A ± 600 kV HVDC Bipole of 910 km from Matiari Switching/Converter station to Lahore HVDC switching converter station



Infrastructure

1. An extensive road network has been developed in Tharparkar over the last 10 years due to which remote areas like Islamkot have become easily accessible by cars and commercial trucks. Salt is being harvested from salt lakes near Diplo, about 50 Km south of Islamkot and the same is being transported to Port Qasim (to a PVC/ caustic soda plant of Engro Polymer), Karachi, Hub and other destinations in heavy duty 22 wheeler, 70ft long trailers vehicles.

The Government of Sindh has started a massive road reconstruction program along the entire route from Karachi to Islamkot to facilitate the transfer of heavy mining machinery to the mine site. This reconstruction will have a double advantage as the same shall be used for coal transportation as well. The roads are being widened, some sections are being rebuilt from scratch, bypasses are being built around cities and hill tops are being flattened to reduce the gradient. All this makes it possible to deploy extra-long trailers and enable their safe and swift movement.

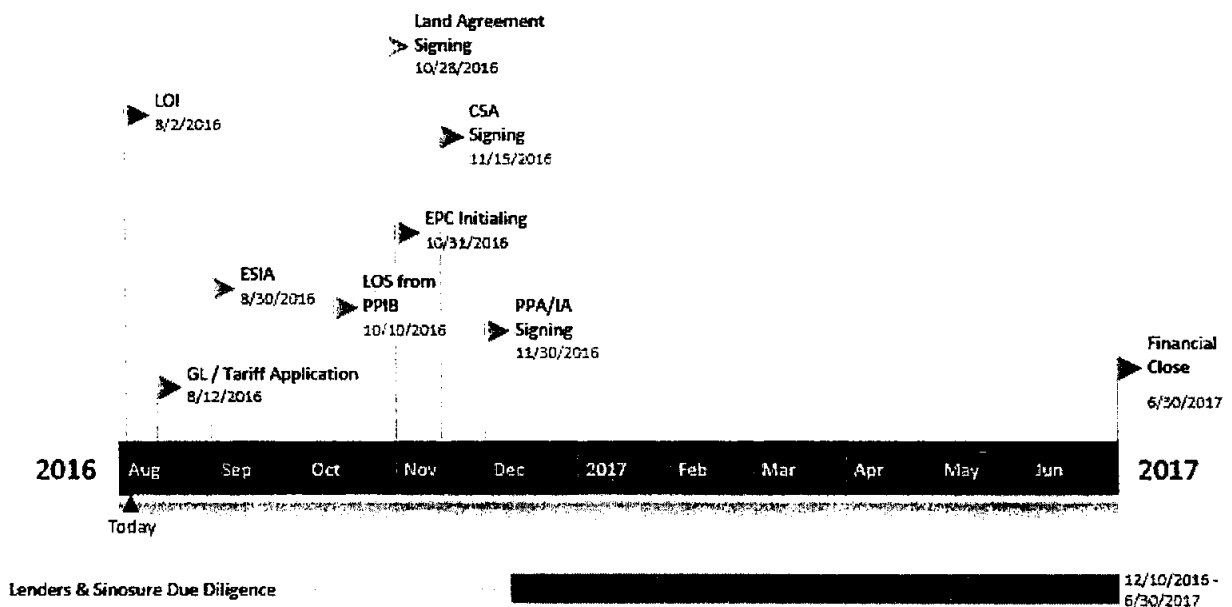
The reconstruction program is divided into two phases as indicated in the diagram above. Phase 1 includes improvement and widening of road network from Karachi Seaport to Wango Mor (225 Km). The status of phase 1 progress is that widening of roads, strengthening of bridges/culverts and construction of by-passes of villages and smaller cities has almost been completed and the target completion date is Dec 2015. Phase 2 includes improvement and widening of road network from Wango Mor to Thar Coalfield (125 Km). The current status of phase 2 progress is that more than 75% of the work has been completed. Work on the road from Islamkot to Thar Block II is underway. Target date for completion of Phase 2 work is February 2016.

Traffic volume along the routes is deemed to be manageable if the need to import coal arises. There will be a continuous flow of traffic for loading and unloading coal from the port to site and back. The trucks will have to cross through heavily crowded cities i.e. Sujawal, Gularchi, Badin and some small towns i.e. Nindo, Khoski and Shah di lag to reach Thar for which the government is in the process of constructing necessary by passes through these areas. Most of the bypasses have been completed and will come into operation within a few months and the remaining shall be completed before the commencement of the Project.

8 Project Cost

- 8.1 The Total Project Cost is as per the Coal Upfront Tariff dated 9th July 2014 (USD 497.7 Million)
- 8.2 The Total Equity is USD 124.4 Million (25%).
- 8.3 The Total Debt is USD 373.3 Million (75%). Majority of the debt will be raised from Chinese financial institutions whereas some portion may be raised from local banks.

9 Project Commencement and completion schedule with milestones



10 ESSA

10.1 Needs to be attached

11 Safety Plans, Emergency Plans

11.1 Safety Plan

11.1.1 Health and Safety Standards and Related Requirements

Contractor must ensure that Health and Safety requirements are met during all phases of the project and is to be considered as of critical importance. For this the contractor has to meet all the OSHA standard requirements mentioned in 29 CFR 1910. The following two sets of standards are of primary importance, but not limited to, and are to be met with special commitment and focus

- 1) 1910.119 Process Safety Management of Highly Hazardous Chemicals.
- 2) 1910.269 Electric Power Generation, Transmission, and Distribution.

Other OSHA standards listed in 29 CFR 1910 are to be met where applicable. The following table summarizes the various safety elements which OWNER consider to be fulfilled and managed during various phases of the project.

Element	Phase Of Implementation
Process Safety Information	Engineering, Procurement, Construction and Commissioning
Process Hazard Analysis	Conceptual Stage, On completion of basic engineering, On completion of design engineering followed by post Construction
Operating Procedures and Practices	Engineering, Construction and Pre-Commissioning
Employee Training	Construction and Pre-Commissioning
Contractors Safety	Construction
Pre-Startup Safety Review	Pre-Commissioning
Mechanical Integrity	Procurement, Construction, Pre-commissioning
Quality Assurance	Engineering, Procurement and Construction
Hot Work Permit, Confined space etc	Construction
Management of Change	Engineering and Construction
Incident Investigation	Construction
Emergency Planning and Response	Construction
Compliance Audits	Construction
Safety Personnel	Construction
Effective Communication	Construction

In addition, a comprehensive Safety Integrity Level (SIL) analysis shall be carried out by the contractor and all recommendations shall be incorporated in the design.

Hazard area classification shall also be done and all relevant design shall conform this classification.

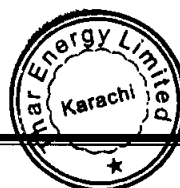
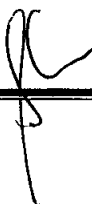
In addition a Safety Critical Top Level Document will be developed to identify Safety Critical equipment at site in order to meet requirements of Quality assurance and Mechanical Integrity elements during procurement, construction and future maintenance and installations and to define defeat protocol of such equipment during normal plant operation.

An equipment will be classified as Safety Critical if any one of the following eight criteria is met:

- A: Equipment Containing Hazardous Substances: The equipment which are part of the process circuit (enclosed by NODES that can be remotely and readily isolated) containing hazardous substances in threshold amounts (as determined in OSHA list of regulated chemicals) are included in the list of Safety Critical Equipment. It includes all "wetted" parts e.g. Vessels, Heat Exchangers, Piping Systems, Control valves, Pumps, etc.
- B. Containment Controls Equipment ensuring containment control will be placed under the Safety Critical Equipment List for each corresponding Unit. This include for example i) Relief devices such as PSV's, PSD's etc.(Note that all relief valves and

rupture disks are treated as Safety Critical, regardless of the substance handled, because of the concern for equipment failure/rupture hazards) ii) Conservation vents, emergency vents, overflow pots and their vent systems, if wetted by hazardous substances. iii) Check valves and excess flow valves. iv) Cathodic Protection for the underground lines.

- C. Shutdown Controls Equipment and systems ensuring shutdown controls at the Unit will be considered Safety Critical. This include for example i) Sensors, final control elements and their associated interconnecting hardware that make up interlock loops that mitigate hazardous events. ii) Manual emergency shutdown systems in hazardous substance services. iii) Process safety alarms and associated controls that involve operator action to prevent a process safety incident.
- D. Controlled Release Equipment/Systems: Operating equipment or systems associated with the controlled release of hazardous substances are Safety Critical. This include for example i) Liquid separators from relief devices ii) Flare and flare header systems iii) Scrubbing systems for hazardous substance release control iv) Overflow tanks for hazardous substances etc
- E. Safety Monitoring and Emergency Communication Systems: Unit will consider systems associated with the detection of or people's response to release of hazardous substances as Safety Critical. This include for example i) Detection systems provided for early detection of releases of hazardous substances. ii) Pipe leak detection system associated with hazardous substances service. iii) Emergency alarm systems and emergency radio and telephones. iv) Low O2 detectors for personnel protection in control rooms, etc.
- F. Active Mitigation Systems that need activation to reduce the potential of or minimize hazardous releases and process-related fires and explosions are Safety Critical. This include for example i) Fire protection systems directly associated with Safety Critical Process areas, including sprinklers, deluge systems, fire water supply, storage and piping distribution systems. ii) Explosion suppression systems and fire doors. iii) Area ventilation systems to dilute hazardous substances, to provide positive pressure to exclude hazardous substances from an area or for electrical classification purpose.
- G. Passive Prevention and Mitigation Systems that do not need activation but can reduce the potential of or minimize hazardous releases and process-related fires and explosions are Safety Critical. This include for example i) Secondary Containment Systems e.g., Dykes and Drainage Systems ii) Fire walls iii) Static protection used to prevent possible ignition sources.



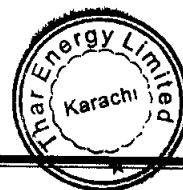
H. Service and Utility Systems designed to ensure reliable operation of a Critical circuit or equipment: Service and utility systems that help maintain safe operation or process shutdown are Safety Critical. This include for example i) Backup power supply systems providing emergency electrical power to another Safety Critical Equipment. ii) UPS for powered Safety Critical Controls. iii) Diesel generators for Safety Critical Equipment such as fire pumps, communication and control equipment with battery backup when batteries run down. iv) Batteries for normal communication systems that are needed during emergencies. v) Tracing system for containment control related devices etc

11.1.2 Fire Detection & Fighting Systems

In a coal power plant, the biggest process safety hazard is of fire and coal dust explosion. Due to this reason the fire detection and mitigation systems design and functioning is of critical importance. All firefighting equipment shall comply with relevant NFPA standard. The fire detection and mitigation systems shall include, but not limited to, the following

- 1) A fire and gas safety philosophy shall be formulated and shared with the owner.
- 2) All coal conveyors shall have fire/smoke detection systems for early detection.
- 3) Coal storage area to be provided with fire / smoldering detection and mitigation systems.
- 4) Area in the vicinity of coal pulverizes and their downstream hoppers and feeders need to be provided with dust detection systems to avoid explosive mixture formation.
- 5) Hydrogen generation unit room and its related supply unit (transformer) need to be provided with gas leakage detection system
- 6) All switchgear rooms, generator rooms, transformers, cable trenches, cable rooms and tariff metering rooms shall be equipped with adequate fire detection and suppression systems according to the standards
- 7) All the above detection systems need to be the part of a centralized monitoring system similar to Fire and Gas (F&G) detection system, in addition to local alarms and mitigation actions.
- 8) Boiler burner area shall have smoke/optical beam detectors
- 9) All liquid fuel and lubricating oil tanks shall have adequate fire detection and suppression system
- 10) A compressive water based firefighting system shall be designed comprising of, but not limited to, fire water tanks, pumps, fire water network and hydrants.
- 11) Adequate portable fire extinguishers shall be provided based on fire risk assessment

11.2 Emergency Response Plan



11.2.1 Objective:

The Company's foremost objective is to ensure that all activities at the site are carried out in a manner that its employees, neighboring community, plant equipment and the environment are not endangered. However, this is not enough; if in spite of maintaining high safety standards an emergency occurs, the Company fully expects its employees to respond skillfully in an organized and timely fashion to contain / minimize the consequences of such an event.

This plan is intended as an action guide and reference document to respond to serious emergencies at the site. The objectives of this plan are:

- a) Define lines of communication both internal and external to the project organization.
- b) Assign responsibilities of personnel who are in positions of leadership and / or are required to take specific actions.
- c) Make all persons knowledgeable of the actions they must take in event of an emergency.
- d) Provide essential information on the hazards, emergency handling equipment etc.

Through training and regular practice under simulated conditions, it is expected that this plan will enable the organization to respond effectively to emergencies.

11.2.2 Emergencies:

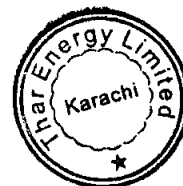
There are several types of emergencies that can occur at the site. Most emergencies can be handled by quick localized action of the operating staff. However, in other instances, the emergency may be beyond the handling capability of the immediate staff and / or could endanger human life, project equipment or the environment unless additional support is provided and proper precautionary steps are taken on time. This plan addresses such emergencies.

Such emergencies can occur as a result of fire / explosion at the site.

Fire (in some cases explosion) can occur due to ignition of combustible materials such as natural gas, oil spills etc. Other calamities such as floods, earthquakes, sabotage etc. could also cause conditions which result in fire / explosion.

11.2.3 Detection and Declaration of Emergency:

11.2.3.1 Detection:



Any employee (JV company or contractor) within the site on hearing an explosion or seeing a fire combustible gas release must take the following actions immediately:

1. Report to the JV Company Contact Person through phone, pager, walkie talkie or by rushing himself and provide the following information;
 - His name
 - Location and extent of unsafe condition.
 - Wind direction

11.2.3.2 Declaration:

On getting information about the unsafe conditions, the JV Company Contact Person will take the following actions to verify the seriousness of the reported incident.

1. He will immediately verify the wind direction.
2. He will then sound alarm to inform everybody about the unsafe condition.
3. He will get as close to the incident location as is safe, to verify the unsafe condition and to assess the magnitude or severity of the incident.
4. He must then decide
 - Can the emergency be contained by quick localized action without endangering employees, equipment or the environment?

11.2.4 End of Emergency:

After the emergency has been fully controlled, the Contact Person will obtain permission from the Emergency Control Center Leader to authorize sounding of all clear siren.

The alarm will be sounded again to declare end of the emergency.

11.2.5 Emergency Control Centre and Members:

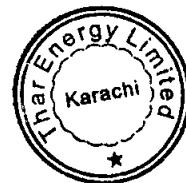
On declaration of an emergency, emergency control center will be developed with following role statements.

11.2.5.1 Role Statement of Personnel Working at Site

On hearing the emergency alarm all employees (either JV Company or contract) or visitors should take the following actions:

- Stop their assigned jobs in a safe manner.
- Vacate working area and assemble at a specific location.
- Stop all electrical Machines
- Stop use of telephone unless there is a serious emergency.

11.2.5.2 Role Statement of Contact Person



On getting information about the emergency, the contact person will take following actions.

- Inform all Emergency Control Members about the emergency.
- Verify wind direction.
- Approach emergency site taking safe route.
- Try to extinguish fire using portable fire extinguisher or water hose.
- Once the emergency has been handled, he will call any of the Emergency Control Members to get his permission to call the emergency over.

11.2.5.3 Role Statement of Emergency Control Members

On getting information about the emergency, each of the emergency control members will take following actions.

- Gather at a specified location.
- Keep in contact with the JV Company Contact Person.
- Guide the Contact Person on emergency handling.
- Decide to call the emergency over.

11.2.6 Emergency Control Equipment

The following will be considered as emergency control equipment.

11.2.6.1 Fire Extinguishers

Fire extinguishers will be placed at all strategic locations of the site. All types of fire extinguishers will be present on site i.e. CO2, Dry Powder etc. to handle various types of fire. Fire extinguisher trolleys will also be available at site.

11.2.6.2 Fire Water

Raw water which will be supplied for use at site will also be used as fire water. Some of the connections will be dedicated as fire point.

11.2.6.3 Fire Hose

Steel reinforced rubber hoses will be connected to the fire point. These hoses will be of 50 ft length. Spare hoses will also be available on site for extension of existing hoses.

11.2.7 Head Counting Procedure

To facilitate head count and closer monitoring, assembly locations will be made. Every employee (JV Company or contractor) will gather at the assembly location on hearing the emergency alarm. Contractor Supervisor will be responsible to do the head count.

11.3 Medical Emergency Plan

11.3.1 Objective:

Providing safe and healthy working environment to its employees is one of the top priorities of the company. For this purpose personal protective equipment and training is given to all employees. However this is not enough, in spite of all these efforts an accident can happen which may lead to serious injury to an employee. In addition to this an employee may suffer from an attack of angina, asthmas, high blood pressure stroke etc.

To deal with such type of emergencies the company will obtain an ambulance which will remain at the site all the time.

The main objective of this plan is to set up a line of actions against all type of emergencies in a manner that injured person / patient gets proper medical treatment well in time.

11.3.2 Type of Medical Emergencies

There are several types of medical emergencies than can happen at the site, these can be broadly categorized in two classes.

- Life Threatening Medical Cases
- Routine Medical Cases / Injuries

11.3.2.1 Life Threatening Medical Cases

These cases include heat attack, severe bleeding from an injury, third degree burns (covering more than 30% of body), stroke etc. Time is the most critical factor in such cases and it should be ensured that the patient is immediately shifted to the hospital.

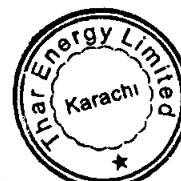
11.3.2.2 Routine Medical Cases / Injuries

This includes all cases other than life threatening one i.e. cut, fracture, first-degree burns, chemical inhalation etc.

11.3.3 Medical Emergency Handling Facility

Till the site boundary wall and temporary offices, the following will be the arrangement to handle medical emergency.

- Ambulance will be available at site.
- Contact with nearby hospital/clinic.



Once the site boundary wall has been constructed, the contractor will arrange a place for clinic; arrange a doctor and some paramedic's staff for handling medical emergencies.

11.3.4 Line of Action

Following should be the line of action in case of a Medical Emergency.

- Properly trained First Aider will provide First Aid to the patient/injured till the arrival of medical help.
- The patient/injured will be shifted to the nearby hospital/clinic on ambulance.
- An attendant will always accompany the patient/injured to the hospital.
- Security/Services Officer will be informed immediately who will contact the hospital for proper handling of the patient.
- Security/Services Officer will ensure availability of some alternate arrangement in the absence of ambulance.
- Security/Services Officer to inform the patients family and make arrangements to bring them to the hospital if required.

12 System Studies

12.1 Refer to Annexure U

13 Plant Characteristics

13.1 The following table illustrates the plant configuration

1.	Plant size installed capacity (Gross ISO)	330 MW
1.	Type of Technology	3 phase AC Synchronous machines
2.	Number of Units/Size	1x330 MW
3.	Unit make and model	-
4.	De-rated capacity at mean site conditions	-
5.	Auxiliary consumption	9% (29.7 MW)
6.	Commissioning and commercial operation date	-

7.	Expected life of the facility from COD	30 years

13.2 The following table illustrates the plant characteristics

1	Generation Voltage	20~26 KV
2	Frequency	50 Hz
3	Power Factor	0.85
4	Automatic Generation Control	To be provided later
5	Ramping Rate	To be provided later
6	Alternative Fuel	To be provided later
7	Auxiliary Consumption	9% (Approximately)
8	Time Required to Synchronize to Grid	To be provided later

13.3 Net capacity of the licensee's generation facilities

1.	Installed Capacity Gross ISO	330 MW
2.	De-rated Capacity at Mean Site Conditions	-
3.	Auxiliary Consumption	9% (Approx.)
4.	Net Capacity of the Plant at Mean Site Conditions	300 MW (Approx.)

14 Control, Metering, Instrumentation and Protection

14.1 The I&C system is designed to ensure safe, reliable, available economic and simple operation and easy coordination to different operation requirements.

14.2 This project plans to adopt turbine, boiler, generator and auxiliary workshops central control mode. The unit control room is arranged the unit monitoring console, network control console, auxiliary production system monitoring console, shift supervisor console, fire alarm panel, etc.

The unit is provided with a set of DCS system. DCS control following systems: boiler proper and auxiliary systems, turbine proper and auxiliary systems, generator proper and auxiliary system, chemical sampling, and condensate polishing, etc. The unit is monitored by on-duty operator through operator station, with assistants to complete the startup and shutdown operation, monitoring of normal operation and emergency handling of the unit. The backup control panel only retains a small number of necessary backup conventional instruments and operating equipment. Plant is planned to be equipped with several operator stations and LCD display (arranged on the backup panel).

The backup control panel, which separated from DCS, is configured to ensure operators safety shutdown unit when DCS fail. The backup control panel include following: Main Fuel Trip (MFT), Turbine Emergency Trip, Generator Trip, PCV, DC lube oil pump and so on. Those output signal of the backup control panel will be sent to equipment directly by using hardwire connections.

14.3 For more detail, please refer to Feasibility Study Report.

15 Training and Development

15.1 Training Plan

Thar Energy Limited (TEL), envisage on setting up Coal Fired Power Plant at Thar energy park, Sindh. Unit will have an installed capacity of 330MW.

The 1x330MW, Sub-critical, CFB boiler lignite based Coal Fired Power Plant will be a pioneering project in Pakistan from both Technology and type of fuel perspectives. In view of the dearth of Operation and Maintenance (O&M) of Power Plants, TEL intends to address these challenges through rigorous training of its O&M staff, to bring the competency of its staff to prevailing global practices in Power Plants worldwide.

The training of the O&M staff will be diverse, focusing on theoretical knowledge, specialized skill knowledge, practical, through simulators and hands-on experience.

15.2 Locations

Training will be carried out at the following locations:

- China at Training Institutes (Classroom)
- Original Equipment Manufacturers (OEM) Factories in China
- Middle Eastern/European Training Institutes (Classroom)
- Pakistan (Classroom and On-site)

- Visits to Power Plants in China and Pakistan

15.3 Schedules

The training process will start 1 year before the Commercial Operations Date (COD). During this period, industry experienced O & M staff consisting of Operators and Maintenance personnel shall be hired. After being trained both as Trainers and normal O& M Staff they shall:

- Monitor and supervise the construction and erection of the Power Plant.
- Get trained by Vendor Representatives during erection and commissioning.
- Trained Trainers shall educate their Juniors.

15.4 Training Methodology

15.4.1 Train the Trainer Concept

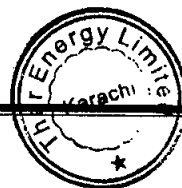
Following the train the trainer concept, the trainers will be given intensive training following teaching methods, the technology itself and the O&M procedures of the power plant. The training materials will include OEM Manuals and technical presentations by experienced engineers. A select group of around 40-50 trainees will be sent to China for acquired specialized knowledge, visit to the OEM factories followed by interaction with the Operation and Maintenance Departments of the Power Plant running on similar technology.

15.4.2 Training Materials

Extensive Training materials and equipment shall be used for training.

- Simulators.
- Specially prepared training courses.
- On Job Training.
- Vendor O&M manuals.
- Engineering Standards
- Presentations and Videos
- Workshop Demonstrations

15.4.3 Training in Pakistan



Training in Pakistan will comprise of class-room training, on-site training, simulator training and on-the-job training. The training will be carried out by specialized engineers and trainers from China, other O&M personnel who acquired training from China.

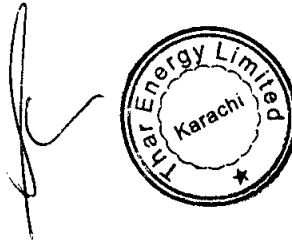
15.4.4 Post COD In-Plant Training

Post COD, a full fledged Training Department will be set up that would

- Constantly update the O&M personnel with the latest knowledge on Hub II Systems
- Persistently keep them abreast of the latest O& M requirements.
- Train newly hired staff.
- Refresh staff knowledge and competency to assume new roles.
- Train Management Trainees

16 Feasibility Report

16.1 Refer to Annexure P

A handwritten signature in black ink is positioned to the left of a circular stamp. The stamp features the text "Thar Energy Limited" around the top inner edge and "Karachi" in the center, with a small star at the bottom right.

**330 MW Coal-Fired Power Plant in
Energy Park, Block II
Thar Coalfields**

**Environmental and Social
Impact Assessment**

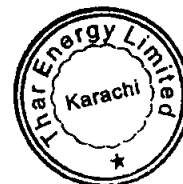
Final Report

HBP Ref.: R6V04HUP

August 9, 2016

Thar Energy Limited.

Karachi



Executive Summary

Thar Energy Limited (TEL) plans to establish a 1x330 megawatt (MW) Thar Lignite Coal-based mine mouth Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh. TEL is a fully owned subsidiary of The Hub Power Company Limited (HUBCO).

The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal which can be utilized to produce 100,000 MW for over 200 years. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines (see **Exhibit I**).

Sindh Coal Authority (SCA) has awarded a 95.5 square kilometer (km²) area of the coalfield, known as Thar Block II, to Sindh Engro Coal Mining Company (SECMC) for exploration and development of the coal deposits in the block

An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of about 2 km² (500 acres).

The Proposed Project

It is proposed to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters.

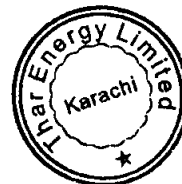
The proposed Project will be located on a 28 hectare (0.28 square km) plot located within the Energy Park, Block II of Thar Coalfields in Tharparker District of Sindh, as shown in **Exhibit II**. It is located adjacent to the under construction 2x330 MW Engro Powergen Thar (Private) Limited (EPTL) coal power plant (CPP).

The major systems in the proposed plant will include:

- ⑤ Coal handling and processing system
- ⑤ CFB boiler and environmental control equipment
- ⑤ Steam turbine and condenser
- ⑤ Electrical power generator and power export system
- ⑤ Cooling water system
- ⑤ Ash handling system
- ⑤ Utilities and waste management systems.

Emissions controls for pollutants of concern (NO_x, SO₂ and particulate matter) will be as follows:

- ⑤ In CFB boiler, combustion takes place at relatively low temperatures as compared to pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these low temperatures results in an effective suppression of NO_x



ensuring emissions to be below 510 mg/Nm³ to meet the SEQS and IFC EHS limits of NO_x in the stack

- ☞ SO₂ control will be provided by the injection of limestone in the CFB Boiler and converting sulfur to gypsum (calcium sulfate). SO₂ emissions of the plant will be below 850 mg/Nm³ and meet SEQS and IFC EHS guidelines for stack emissions.
- ☞ The steam generator will be equipped with a dry electrostatic precipitator (ESP). The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon). The ESP will be designed to have an efficiency greater than 99% and will be finalized based on the outlet flue gas particulate loading to achieve particulate matter emissions of below 50 ppm at all loads when burning design coal.

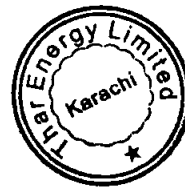


Exhibit I: Project Location within the Thar Coalfields

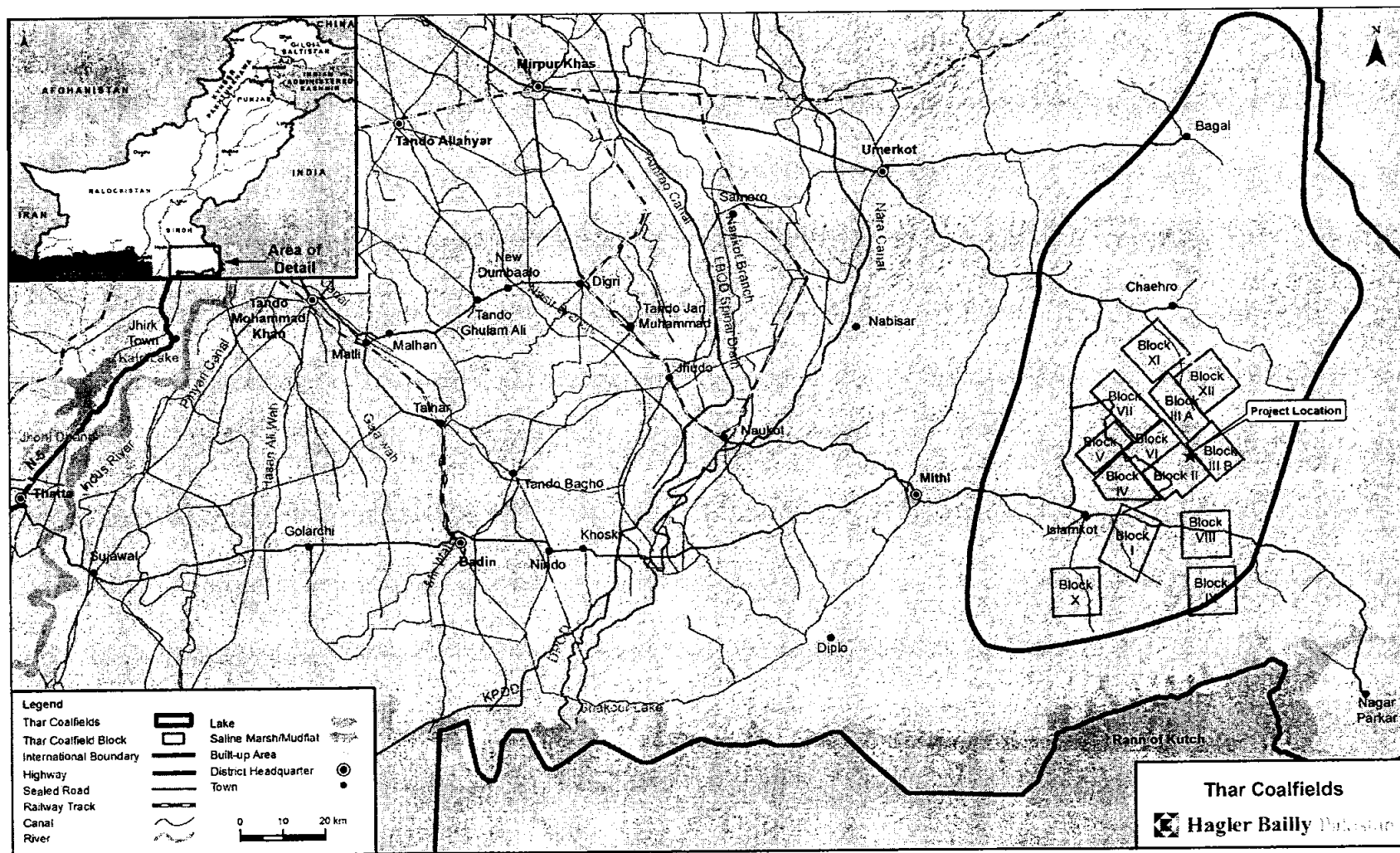
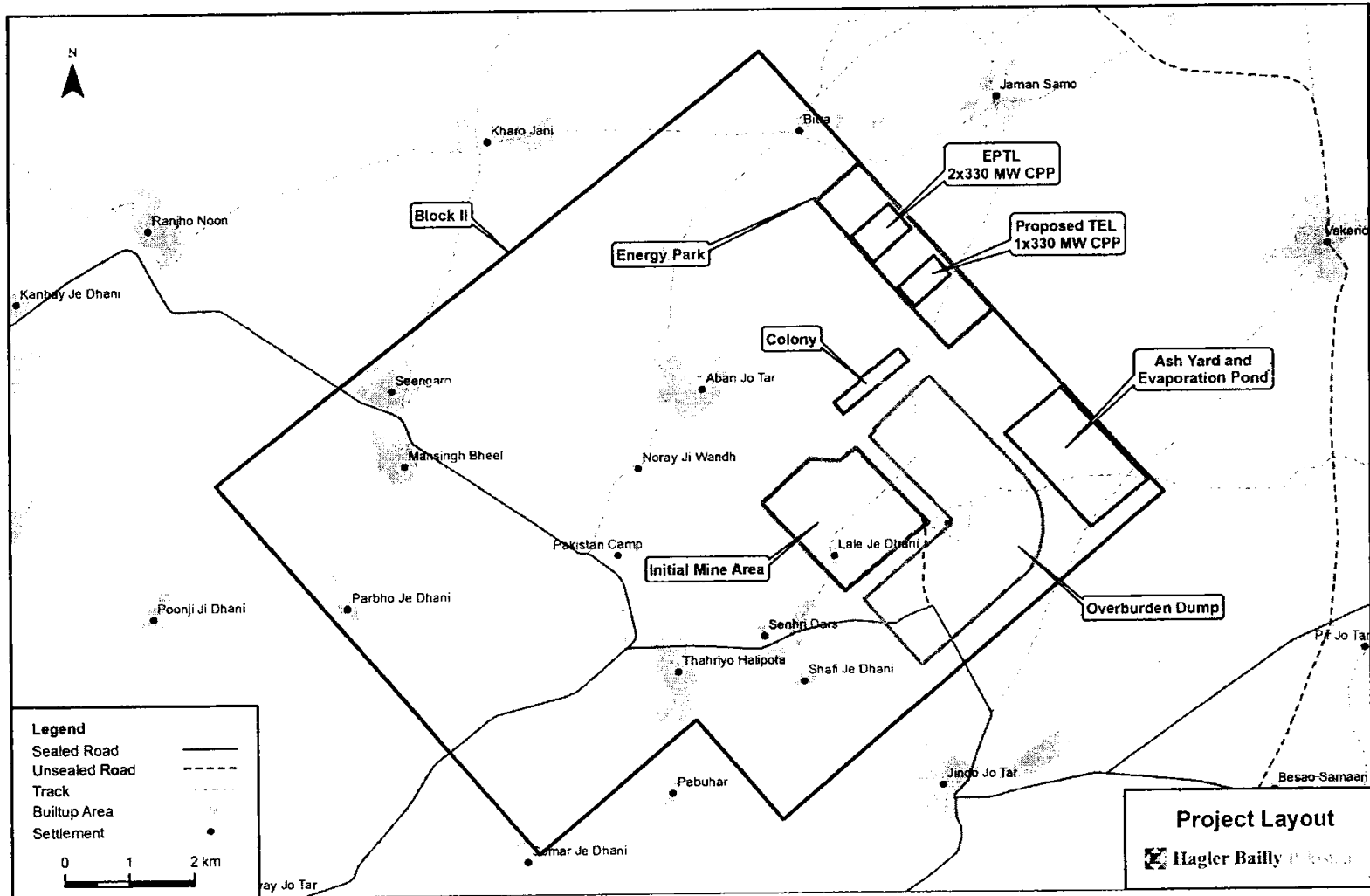


Exhibit II: Project Layout



Coal Consumption

The main fuel for the power plant will be Thar Lignite Coal from Block II mine. Based on the lower heating value (LHV) of 2675 kcal/kg, net plant thermal efficiency of 37%, plant gross capacity of 1x330 MW, and 85% availability factor approximately 1.9 million tons per year of coal will be consumed.

Water Consumption

The anticipated power plant demand for water is less than 800 m³/hour.

To meet the water requirements for mining and power generation activities at Thar, the Government of Sindh (GoS), through the Sindh Irrigation and Drainage Authority (SIDA), is constructing a water channel from a distributary of the Left Bank Outfall Drain (LBOD)¹ to supply water to the Thar Coalfields after necessary treatment and storage provision. As the GoS is developing this as an independent project it is not within the scope of the current Project and its impacts not evaluated as part of this ESIA.

LBOD treated water of 8.75 cusec (892 m³/hour) will be allocated as the main source of water supply to the project which based on preliminary water balance is sufficient to satisfy the needs of 1x330MW plant at all loads and in peak summers.

The water from mine dewatering activity, if available in sufficient quantity for the Project, can be used as a secondary water source after necessary treatment. For this a mine water treatment plant (Reverse Osmosis based) may be considered. In this case about 1100 m³/hour of mine water should be available before treatment to meet plant requirements.

To further reduce the plant water consumption (and reduce reject quantity) cooling tower blowdown treatment plant (Reverse Osmosis based) may also be considered.

Waste Disposal

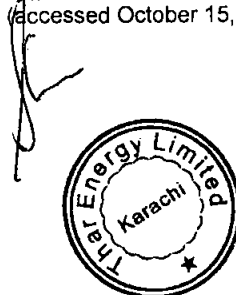
The major solid and liquid waste streams generated by the proposed coal power plant Project include ash-lime residue and waste water.

Ash-lime residue will be stored in the ash yard which will be developed in the area dedicated for this purpose in Block II (see **Exhibit II**). The dumped ash in the yard will be compacted, mixed with sand and given leaching protection by clay or geomembrane lining of the area. The Ash yard will be big enough to store ash lime residue for about 2

¹ The LBOD is an environmental improvement project which was conceived in the 1960s as a response to the problem of rising water tables and resulting waterlogging and salinity. The project area includes some of the most hard-hit areas on the left side of the Indus River in the arid zones of Sindh Province. The project's primary function is to remove and safely convey saline water to the sea through a network of drains. The project provides for the integrated development of irrigation and drainage which include an outfall for saline drainage effluent to the Arabian Sea, phased construction of three drainage subareas in Nawabshah, Mirpurkhas and Sanghar, remodeling of the Nara/Jamrao Canal system, and watercourse improvement in the arid zones in Sindh Province.

The World Bank. "Left Bank Outfall Drain Project Tackling Pakistan's Waterlogging and Salinity Problems." Projects and Operations.

<http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/0,,contentMDK:20017537~menuPK:64282137~pagePK:41367~piPK:279616~theSitePK:40941,00.html> (accessed October 15, 2014).



years until it is transported to the mine area when it is available for final disposal as backfill in the spent mine pit.

The maximum possible water from the coal power plant will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping. A sewage treatment plant will treat sewage from the housing complex and construction camp. Wastewater from the sewage plant will be discharged or recycled in appropriate processing streams. Wastewater from the industrial and sewage treatment plants will meet SEQS for liquid effluents.

Non-recycled wastewater from the Project will be disposed through third aquifer reinjection or via evaporation pond. Location of third aquifer reinjection of cooling water blowdown or RO treatment plant reject (if installed) will be finalized through separate study and effluent limits will be defined. The evaporation ponds will be installed to handle continuous streams of minor flow or streams of major flow in case of emergency. They will be in the vicinity of the ash yard within the designated area of Block II.

Air Emissions

Main gaseous emissions of concern from the coal power Project include sulfur dioxide (SO₂) and oxides of nitrogen (NO_x) along with particulate matter emissions (PM₁₀ and PM_{2.5}, which refers to particulate matter less than 10 and 2.5 microns respectively are pollutants of health concern). The release and dispersion of these pollutants is discussed in detail in later sections.

Description of the Environment

The Study Area selected for the ESIA includes sensitive receptors that are most likely to be impacted by the Project's development activities. This Study Area includes the Energy Park and an area within a 5 km radius around it

A detailed description of the existing environment, including the physical, ecological and socioeconomic baseline conditions, is described in the report. The description of the socioeconomic environment includes the area's population and households, education, health, water supply, agriculture, transport and communications, and occupations and income.

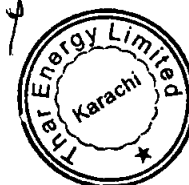
Physical Baseline

The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic.

Topography, Geology and Seismic Hazards

The topography of the Study Area is typical of the Thar Desert. It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. The dunes in the Study Area are at an average elevation of 101 m above mean sea level (amsl). The entire surface of the Study Area is covered by aeolian sands of the Quaternary. The Thar Desert lies at the north-western corner of the Indian Plate.

The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi. Based on the Global Seismic Hazard Assessment Program



(GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is between 1.6 and 2.4 m/s².

Climate

The seasons in the Study Area are classified as:

Summer (mid-March to mid-June)

Characterized by high temperatures, moderate rainfalls with moderate atmospheric humidity and high speed-winds that blow from southwest towards northeast.

Summer Monsoon (mid-June to mid-September)

The summer Monsoon, hereafter referred to as the Monsoon, is characterized by high temperatures (milder than summers), high rainfalls with high atmospheric humidity and moderate speed-winds.

Post-Monsoon Summer (mid-September to mid-November)

Characterized by moderately high temperatures, low rainfalls and low speed-winds blowing from southwest towards northeast.

Winter (mid-November to mid-March)

Characterized by moderate temperatures, dry conditions with low atmospheric humidity and a reduction in wind speeds blowing from northwest to southeast.

Air Quality Baseline

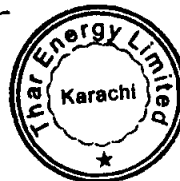
Ambient air quality is established using primary and secondary data along with modelled emissions of approved developments in the area. **Exhibit III** presents the current pollutant levels of the Study Area that are established based on measured data. Expected activities near the Study Area, that may influence the air quality baseline of the Project are shown in **Exhibit IV**

The influence of the 2 x 330 MW power plant was modelled and a simulated baseline for ambient air quality conditions expected to be present at the time of operation of the proposed Project is shown in and **Exhibit V**. The expected extent of dust emissions due to the mining activities are discussed in the report. In **Exhibit V** the measured baseline consists of average values of ambient air quality measurements made in the area, the modelled increment consists of modelled ambient air quality impacts of expected developments in the area, and simulated baseline consists of the sum of the measured and modelled baselines. Contour maps that show the spatial distribution of the simulated baseline of the Project are provided in the report.

Exhibit III: Baseline Ambient Air Quality in the Study Area ($\mu\text{g}/\text{m}^3$)

	NO_2	SO_2	PM_{10}	$\text{PM}_{2.5}$
Baseline Levels	3 ± 3	7 ± 6	140 ± 93^2	30 ± 40

² The reading of 780 $\mu\text{g}/\text{m}^3$ is removed as it was 5 times the median value and is likely a low occurring outlier.



	NO ₂	SO ₂	PM ₁₀	PM _{2.5}
SEQS (annual)	40	80	120	40
SEQS (24-hour)	80	120	150	75
IFC EHS (annual)	40	-	70 ^a	35 ^a
IFC EHS (24-hour)	-	125	150	75

Exhibit IV: Approved Developments

Block No.	Coal Mine	Power Plant	Source
Block II	up to 22 mtpa	2x330 MW	ESIA of Block II Mining Project ³ ESIA of Block II Power Plant Project ⁴
Block VI	2.5 mtpa	-	ESIA of Block VI Mining Project ⁵

Exhibit V: Ambient Air Quality Baseline (µg/m³)

Pollutant	Averaging Period	Measured Baseline	Modeled Increment	Simulated Baseline	SEQS	IFC EHS limits
SO ₂	24-hour (98 th percentile)	7	23.8	30.8	120	125
	Annual Average		7.1	14.1	80	-
NO ₂	24-hour (98 th percentile)	3	15.5	18.5	141	-
	Annual Average		4.6	7.6	101	40
PM ₁₀	24-hour (98 th percentile)	140	0.6	140.6	150	150
	Annual Average		0.2	140.2	120	70
PM _{2.5}	24-hour (98 th percentile)	30	0.2	30.2	75	75
	Annual Average		0.1	30.1	40	35

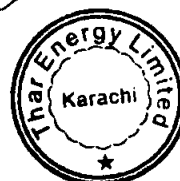
The following conclusions can be drawn:

- ☞ The 24-hour and annual concentrations of SO₂ and NO₂ are low and comply with both SEQS and IFC EHS limits.
- ☞ The 24-hour and annual concentrations of PM_{2.5} and 24-hour PM₁₀ are high due to the desert environment but comply with both SEQS and IFC EHS limits.

³ Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

⁴ Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Power Plant Project, Pakistan, January 2014

⁵ Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].



- ⑤ The PM₁₀ concentrations are above the annual limit. However, this does not necessarily mean that the concentrations exceed the limit as there is allowance in the limit for the concentrations to exceed limits for 8 days of the year.
- ⑤ Measured particulate matter readings show large variability (as seen from the large standard deviation). This is due to:
 - ⑤ Seasonal influence such as the monsoons, that result in large amounts of greenery in the Thar Desert which suppress dust emissions to dry and windy dust storms that result in large dust emissions.
 - ⑤ Location of measurement with reference to sand dunes, which can both shade from the wind and also are a source of dust emissions depending on whether the measurement location is upwind or downwind of the dune.
- ⑤ Based on initial modelling of the coal mine the coal mining operations will dominate in a 3 to 5 km area around the active mine pit and dump. However, the influence of the coal mines are not included in these results

Baseline Sound Levels

Baseline sound levels were established using a total of 7 readings of 24 hour each, 4 of which were primary data collected for this Study and the remainder available from secondary sources. The resulting baseline sound levels are shown in **Exhibit VI**. The sound levels are generally low and comply with limits.

Exhibit VI: Sound Level Baseline of the Study Area

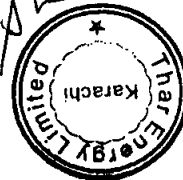
Location	Average <i>L_{eq}</i> (dBA)	
	Daytime	Nighttime
Desert Background	44.6	40.5
Village	49.4	43.0
Village & Road	52.2	48.6
SEQS	55	45
IFC Limits ⁶	55	45

Ecological Baseline

The ecological baseline includes nearby protected areas, habitat types and ecological resources.

The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar Desert varies between near sea level to more than 150 meters. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass. In the inter-dunal valleys, the

⁶ For IFC EHS limits, daytime is from 7 am to 10 pm, whereas for SEQs daytime is from 6 am to 10 pm. Values in this study were calculated based on SEQs daytime classification. Furthermore, IFC requires hourly *L_{eq}* to comply with the limit.



alluvial soil brought by rainwater is deposited in the depressions. The vegetation in Thar Desert is desertic and semi-desertic.

The Protected Area closest to the Study Area is the Rann of Kutch Wildlife Sanctuary. It is located 32 km from Study Area. The Rann of Kutch Ramsar Site is the only designated area of global conservation importance present in the vicinity of the Study Area, being a part of the 1.6 million hectares of wetlands of international importance stretching across the two countries of India and Pakistan.⁷

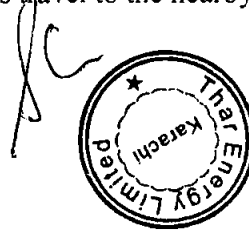
Detailed descriptions of the flora and fauna of the Study Area are presented in the report. The following conclusions can be drawn:

- ♦ Vegetation – there are no plant species of conservation importance in the Study Area.
- ♦ Mammals – none of the mammal species are of conservation importance based on the IUCN Red List of Threatened Species. However, according to Pakistan's National Red List, there are certain species which are of conservation importance, however, their distribution is widespread and not limited to the Study Area.
- ♦ Herpetofauna – there is at least one endemic species and possibly three. However, their distribution is widespread and they are not restricted to any habitat type, therefore, there is no species of conservation importance in the Study Area amongst herpetofauna.
- ♦ Birds – the main concern is with respect to vulture species and certain bird species such as the Laggar Falcon which are of conservation importance according to the IUCN Red List of Threatened Species.

Socioeconomic Baseline

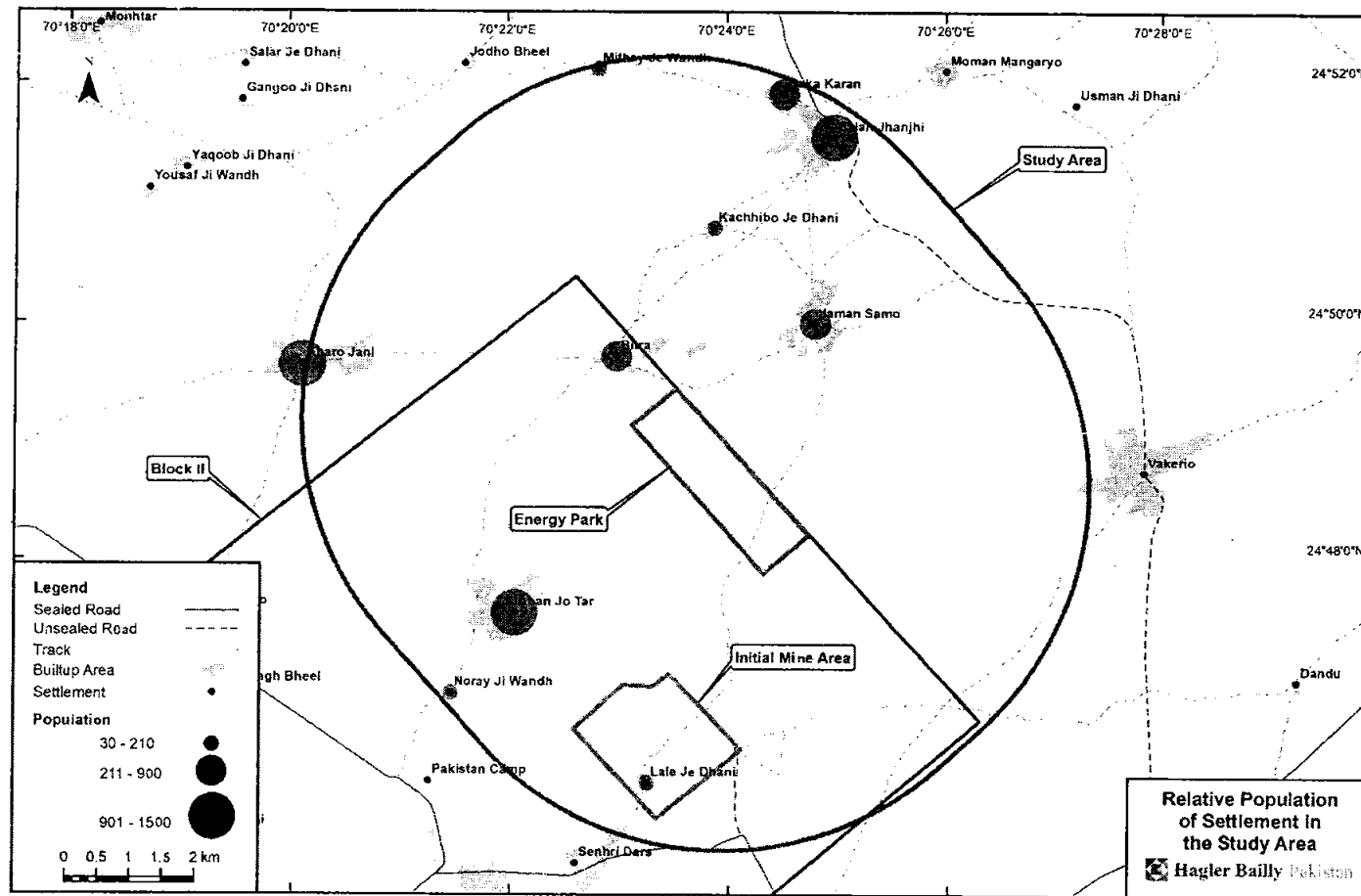
There are ten villages in the Study Area. The population of the area is estimated to be a little over 6,000 individuals. These villages and their relative populations are shown in **Exhibit VII**.

The area has a weak infrastructure when compared to other districts provincially and nationally. Water supply is one of the major problems faced by villages in the area. Most of the underground water is brackish. The villagers travel to the nearby towns of Mithi and Islamkot for health facilities.

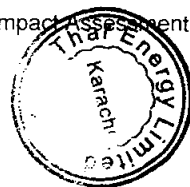


⁷ World Wildlife Fund (WWF). Desert wetlands, World Wildlife Fund Global, News and Stories (February 2003)

Exhibit VII: Population Distribution in the Study Area⁸



⁸ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014



Gender and Age Profile

The population pyramid has a broad base with a relatively large number (40%) of children (10 years of age or less), which indicates high birth rates. The sharp decline of the pyramid signifies a low life expectancy amongst the population of the Study Area, as those above 60 years of age account for only 4% of the population. The structure also shows that more than half (around 60%) of the population is 20 years of age or younger.

Ethnology and Religion

Hindus and Muslims form the two ethnic groups of the Study Area and are further split into multiple castes.

The main languages spoken in the Tharparkar District are Sindhi and Dhatki. In the Study Area, Muslims typically speak Sindhi and/or Dhatki as their primary language while Hindus primarily speak Dhatki only.

Governance

The Study Area falls within the Tharparkar District of Sindh Province. The District lies between 24° 10' to 25°45' N latitudes and 69° 04' to 71°06' E longitudes. There is a single local government at the District level called the District Government. The District Government consists of an elected District (*zila*) Council Chairman. The District administration comprises District offices including sub-offices at UC and town level (includes municipal and town committees).

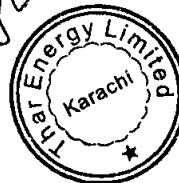
The District is bounded on the east by India (Jaisalmer District), whereas the northern and western peripheries are bounded by the Mirpurkhas and Badin districts respectively. In the south of Tharparkar, there is an extensive marsh, known as Rann, and the Indian district of Kutch.

Civil society organizations have been active in Tharparkar District since the 1960s. Save the Children Fund, now transformed into Thardeep Rural Development Program (TRDP), is the largest NGO in Sindh. It has staff, offices and programs in all *talukas* of the Tharparkar district, and a field office in the town of Islamkot near Thar coal field. and Participatory Village Development Programme (PVDP) works mostly with the *Kolhi* and *Bheel* scheduled castes. Other NGOs working in Tharparkar include the Trust for Voluntary Organizations (TVO), Baanhn Beli (helping hands) organization and the Marooara Coordination Council. Civil society groups in the area include the Press Club Mithi, Press Club Islamkot and Sindhi Adabi Sungat among others.

Livelihoods and the Local Economy

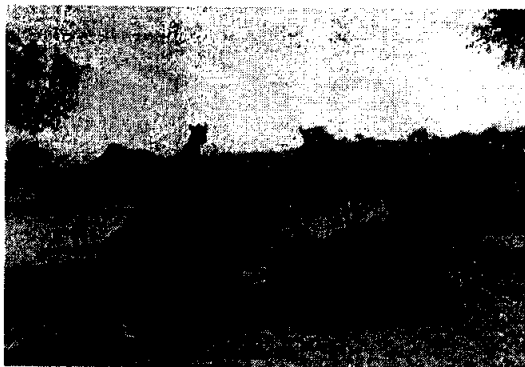
The majority (77%) of the employed population of the District was engaged in primary occupations such as agriculture and livestock according to the 1998 population census. Images of livestock are shown in **Exhibit VIII**. Other occupations in the district include woodwork, wool-weaving, leather work, jewelry-making, cloth-dyeing, embroidery, and snake-charming. The number of artisans has increased over the last decade to meet the demand for handicrafts.

Tharparkar has been consistently ranked as one of the most deprived districts provincially and nationally. The Annual Report on Poverty 2001 by the Social Policy Development



Center (SPDC) ranked Tharparkar as the most deprived district in Sindh and 84th out of 98 districts in Pakistan in terms of deprivation.

Exhibit VIII: Typical images of Livestock



Camels



Livestock use roads to access grazing areas.

Physical Infrastructure

The area has a weak infrastructure when compared to other districts provincially and nationally

Water supply is a major problem faced by villages in Tharparkar. Most underground water is brackish and saline, there are no rivers and perineal springs are rare. Rainwater is collected in large open channels called *tarais*, and small underground tanks called *tankas*. There are also wells in lower lying areas that collect rainwater. The main sources of drinking water for humans and livestock is from dug wells, which is supplemented by rainwater for a few months after the rainy season. The main mode of construction in rural Tharparkar consists of huts called *chaunras* with pointed thatched roofs of shrubs and grasses they are built on mud plastered platforms. The 1998 census reported that only 6.75% of the housing units were using electricity in Tharparkar.

Social Infrastructure

Literacy⁹ in Tharparkar district is low and shows high gender disparity. The 1998 population census reported the literacy rate of Tharparkar district at 18.32%; 28.3% for males and 6.9% for females. In rural areas, the literacy rate was 25.72% for males and a mere 4.8% for females.

A high maternal mortality rate of 800 deaths per 100,000 live births in 1992, and a high infant mortality rate (IMR) of the district in 1992 at 150 (deaths per 1,000 live births) indicates a lack of health facilities in the area.

Cultural Heritage

There are a large number of religious, archeological and cultural sites of significance in the Thar area. These include temples, forts, and tombs. The site closest to the Study Area

⁹ Literacy is defined as "all those persons ten years of age and above who could read and write in any language with understanding, as percentage of the population ten years and above."

is the Gad of Mirs (Talpur) in Block II. It is located in the south of Seengaro Village about 10 km southeast of the Energy Park.

Cemeteries exist in almost every village. Muslims and Hindus bury their dead in their respective cemeteries. Except the Thakurs, who first cremate their dead and the ashes are buried, people of all lower castes bury their dead

Mosques and shrines are places of Muslim worship. Hindu places of worship include temples and shrines. Temples are located in almost every village.

Public Consultation and Disclosure

Community consultations were conducted with the community members for all 10 settlements within the Study Area. Separate consultation sessions were arranged for the community women. Institutions identified as important stakeholders were also consulted. A combined list of stakeholders which were consulted for the Project is given in **Exhibit IX**. Key concerns raised by the stakeholders and complete logs of the consultations are presented in the report.

Exhibit IX: List of Consulted Stakeholders

No	Stakeholder Group	Stakeholders	Date of Consultation
1.	Villages within the Study Area	Baka Karan, Salah Jhanjhi, Kachhibo Je Dhani, Jaman Samo, Bitra, Mithay Je Wandh, Kharo Jani, Aban Jo Tar, Noray Ji Wandh and Lale Ji Dhani	May 12, to May 25, 2016
2.	NGOs	Participatory Village Development Programme, Baanhn Beli, Sukar Foundation, Social Welfare, National Commission For Human Development	May 24, to May 25, 2016
3.	Government	Assistant Commissioner Islamkot	May 24, 2016
4.	Civil Society	Press Club, Thar Coal Action Board	May 24, to May 25, 2016
5.	Other Developers in the Area	ThalNova Thar Power (Private) Limited (TNPTL)	May 27, 2016

Project Impacts and Mitigation Measures

Impacts for the construction and operation of the Projects are discussed in detail in the report. This is followed by a cumulative impact assessment of the expected coal mines and power plants in the area.

Impacts to Air Quality

Impacts to air quality can be assessed by comparing impacts to standards for stack emissions and to standards for ambient air quality.

Stack Emissions

The Project will be compliant with both SEQS and WFC guidelines for coal power plant emissions as shown in **Exhibit X**.

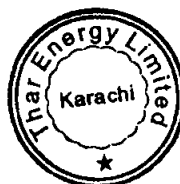


**Exhibit X: Compliance with SEQS and IFC Emission Standards
for Coal Fired Power Plants¹⁰**

Parameter	SEQS	IFC Guidelines	Proposed Project Emission Limits	Expected Project Emissions	Status
Sulfur Dioxide	500 tons per day	For NDA: 900-1500 mg/Nm ³ For DA: 400 mg/Nm ³	24.7 tons per day and 850 mg/Nm ³	17 tons per day and 584 mg/Nm ³	Compliant
Oxides of nitrogen	260 ng/J of heat input	For NDA: 510 mg/Nm ³ For DA: 200 mg/Nm ³	260 ng/J of heat input and 510 mg/Nm ³	168 ng/J of heat input and 381 mg/Nm ³	Compliant
Particulate matter	500 mg/Nm ³	For NDA: 50 mg/Nm ³ For DA: 30 mg/Nm ³	50 mg/Nm ³	23 mg/Nm ³	Compliant

NDA: Non Degraded Airshed

DA: Degraded Airshed

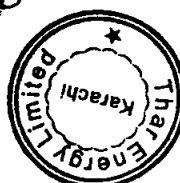
Ambient Air Quality

As there are a number of existing, planned, and foreseeable gaseous emission sources in the area, it is essential to consider their impacts on the ambient air quality in appropriate manner. This inventory of the sources and the scheme under which they are considered are discussed in **Exhibit XI** and the results provided in **Exhibit XII**. Project impacts were assessed based on the proposed Project emission limits.

Exhibit XI: Gaseous Emission Sources and their Assessment

Additional Sources	Approach	Section
Existing Natural Biomass Burning Traffic	Measured Baseline Measured	Section 4.3.6
Planned Projects 2x330 MW Plant, Block II	Simulated Baseline Modelled + Measured	Section 4.3.6
Proposed 330 MW Plant 1x330 MW Plant, Block II	Impact of Proposed Plant Incremental Impact of Proposed Plant based on proposed project emissions limits+ Simulated Baseline	Section 6.3.2
Second 330 MW Plant being developed Simultaneously 1x330 MW Plant, Block II	Impact of Second Plant Incremental Impact of Second Plant + Impact of Proposed Plant	Section 6.3.2

¹⁰ For NOx and SO2 the ambient values are much below the SEQS and recommended IFC EHS limits. Therefore it can be considered a NDA. However, the particulate matter is naturally high in the dusty desert environment. Measured PM₁₀ concentrations are 85% of the 24 hour SEQS and exceed the annual SEQS. Strictly speaking this falls into the category of a degraded airshed as national ambient air quality standards have been exceeded. However, since the particulate matter is naturally high with no major human sources of particulate matter in the area, this can also be considered an NDA



Dispersion modelling was used to quantify the impact of air pollutants on nearby sensitive receptors. The United States Environmental Protection Agency approved regulatory air quality model AERMOD was used to model dispersion of the total pollutant loads. A stack height of 180 m and flue gas temperature of 170°C was considered. Additional details of the assumptions and model inputs are given in the report.

Exhibit XII: Predicted Results ($\mu\text{g}/\text{m}^3$)

Pollutant	Avg Period	Simulated Combined Baseline	Impact of Proposed 1x330 MW Plant		Impact of Additional 1x330 MW Plant		SEQS	IFC EHS limits
			Increment	Ambient	Increment	Ambient		
SO ₂	24-hour (98 th percentile)	30.8	0.9	31.7	2.0	33.7	120	125
	Annual Avg.	14.1	1.7	15.8	0.9	16.7	80	-
NO ₂	24-hour (98 th percentile)	18.5	0.6	19.1	0.7	19.8	80	-
	Annual Avg.	7.6	0.9	8.6	0.5	9.1	40	40
PM ₁₀	24-hour (98 th percentile)	140.6	0.8	141.4	0.9	141.5	150	150
	Annual Avg.	140.2	0.3	140.5	0.3	140.5	120	70
PM _{2.5}	24-hour (98 th percentile)	30.2	0.3	30.5	0.3	30.5	75	75
	Annual Avg.	30.1	0.1	30.2	0.1	30.2	40	35

The following conclusions can be drawn:

Incremental Impact of SO₂ and NO₂ Emission

The 24-hour and annual concentrations of SO₂ and NO₂ will increase due to the proposed Plant. However, the incremental increase will be less than 10 $\mu\text{g}/\text{m}^3$ in all cases (SO₂ and NO₂, annual and 24-hour). The incremental impact of the second plant will be similar.

SO₂ and NO₂ Concentration after the Proposed Plant

The 24-hour and annual concentrations of SO₂ and NO₂ complies with both SEQs and IFC EHS limits. This is true for the proposed Plant as well the future projects envisaged at the time of this ESIA.

Incremental impact on PM₁₀ and PM_{2.5} Concentrations

There is no significant impact of the proposed plant on PM₁₀ and PM_{2.5} concentrations. The reason is as the plant is using high efficiency electrostatic precipitators that leave a minute amount of particulate matter in flue gas. As can be seen from **Exhibit XII**, the net increase even after both plant are operational will be less than 1 $\mu\text{g}/\text{m}^3$.



PM₁₀ and PM_{2.5} Concentration after the Proposed Plant

The ambient 24-hour and annual PM₁₀ concentrations meet both the SEQS and IFC EHS values but are high due to the natural sources in the Thar Desert. The 24-hour PM_{2.5} concentration complies with both SEQS and IFC EHS limits.

The air quality management of an area is the responsibility of SEPA under the Sindh Act. It is proposed that SEPA, working with the developers in Thar Coalfields, develop an ambient air quality management plan to mitigate the high concentration of natural dust in the area.

Impacts to Socioeconomic Environment

Impacts to the socioeconomic environment are summarized below and described in detail along with the proposed mitigation measures in the report:

Employment Impact

The Project will create additional job opportunities. It is expected that more than 100 staff positions will be created under the Project. Most of these positions will be skilled, having expertise in handling the new equipment and processes.

To maximize employment of people from within the Study Area in the operational phase of the Project, the Project will invest in vocational training programs that focus on the Study Area.

Increased Power Generation

Due to the Project, about 300 MW net power will be added to the grid system of Pakistan. The power generated by the Project would be supplied to various sectors that are currently impacted by the power shortages and bridge part of the energy shortfall faced by the country.

In-Migration

The increased job opportunities offered by the Project and by service providers to the Project will lead to an influx of job seekers in the Study Area. The influx of job seekers would lead to the development of informal settlements due to the absence of surplus housing facilities. The migrants can also effect the culture of the Study Area. This can possibly generate conflict between locals and the in-migrants. Mitigation measures to avoid this are detailed in the report.

Impacts to Ecology

Any ecological impact from the Project will be incremental over the impact of the mining activities in Block II. In the ESIA for the Block II Coal Mine, it is stated that other than potential impact on the vulture habitat, no significant impact of the mining on the flora and fauna of the area are anticipated.

The vulture population in the Indian subcontinent is declining due to existing threat to their population. The cause of this is presumably poisoning by the veterinary drug



Diclofenac, probably combined with other causes (Bird Life International 2010)¹¹. The birds feed on carcasses of animals treated with the veterinary drug.

Availability of nesting sites and food are principle factors that determine the population of vultures in an area. Clearing of land for power plant will reduce the potential habitat area of these vultures. While the trees for nesting and the feeding areas are widespread in the Thar Desert, a program for management of vulture population in the vicinity of the Energy Park supported by the Project will be required to contribute to the ongoing efforts of the Sindh Wildlife Department and other conservation groups in preventing the extirpation of this species from the Thar area.

Environmental Management Plan

The Environmental Management Plan (EMP) is the fundamental tool that ensures that all mitigation measures to reduce the impacts of the Project discussed in **Chapter 6** are consolidated, their implementation responsibilities identified and the resources required to implement the measures are provided. Further, the EMP includes monitoring measures as a feedback mechanism on implementation and effectiveness of the mitigation measures.

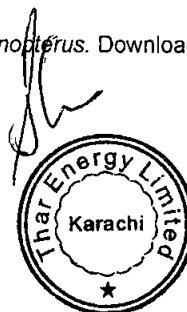
The EMP contains the following elements:

- ⊗ An institutional framework for effective implementation of the plan
- ⊗ The Mitigation Plan which summarizes the mitigation measures to be implemented.
- ⊗ A monitoring plan with guidelines on reporting and feedback
- ⊗ Suggested training programs to build capacity for the implementation of the EMP
- ⊗ A framework for the establishment of a grievance redress mechanism
- ⊗ Guidelines for the development of supplementary, content specific plans including:
 - ⊗ Construction Management Plan
 - ⊗ Coal Dust Management Plan
 - ⊗ Emergency Response Plan
 - ⊗ Waste Management Plan
- ⊗ Guidelines on how changes to the EMP and Project will be handled.

Conclusion

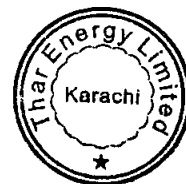
Major potential impacts of the Project are associated with air quality and changes to the socioeconomic environment. However, if the field activities, including the implementation of all mitigation measures and monitoring requirements as outlined in the Environmental Management Plan (**Chapter 7**), are carried out as described in this report, the anticipated impact of the Project on the area's natural and socioeconomic environment will be well within acceptable limits. The project will also comply with all the statutory requirements and standards listed in **Chapter 2** of this report.

¹¹ BirdLife International 2010. Species factsheet: *Neophron percnopterus*. Downloaded from <http://www.birdlife.org> on 27/6/2010.

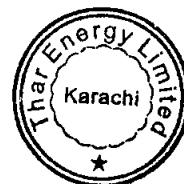


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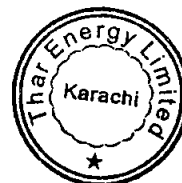
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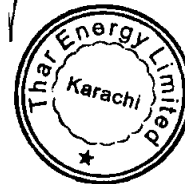
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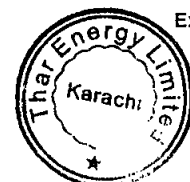


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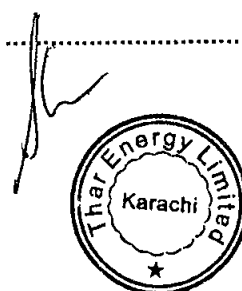


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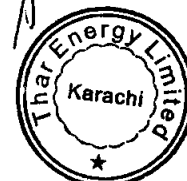


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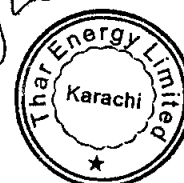
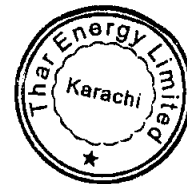


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1. Introduction

Thar Energy Limited (TEL) plans to establish a 1x330 megawatt (MW) Thar Lignite Coal-based mine mouth Power Plant (the 'Project') in the Energy Park associated with Block II, Thar coalfields in Sindh. TEL is a fully owned subsidiary of The Hub Power Company Limited (HUBCO).

This document identifies basic settings and design of the proposed project, prevalent national and international laws, regulations, physical, ecological and socioeconomic baseline conditions and assesses the environmental impact of the proposed Project. In accordance with the environmental regulations of Sindh, the results are presented as an Environmental and Social Impact Assessment (ESIA) for submission to the Sindh Environmental Protection Agency (SEPA) for review and grant of environmental approval.

TEL acquired the services of Hagler Bailly Pakistan (Pvt.) Ltd. (HBP) to undertake the ESIA study.

1.1 Project Setting

The Thar Coalfields are located in the Thar Desert in Sindh Province of Pakistan. The coal resources of the Thar Coalfields are estimated at 175 billion tonnes of lignite coal. The Government of Sindh (GoS) has, to date, identified 13 "blocks" for development of coal mines (**Exhibit 1.1**), however, currently the exploration and development work is being carried out in less than half of the blocks.

Sindh Coal Authority (SCA) has awarded a 95.5 square kilometer (km²) area of the coalfield, known as Thar Block II ('Block II'), to Sindh Engro Coal Mining Company (SECMC), which is jointly owned by the GoS and the Engro PowerGen Limited.

An 'Energy Park' is being developed within the limits of Block II. The Energy Park spreads over an area of the about 2 km² (500 acres) and is expected to contain six power plants, with a combined power generation capacity of about 4,000 MW.

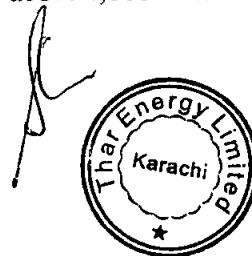
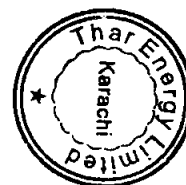
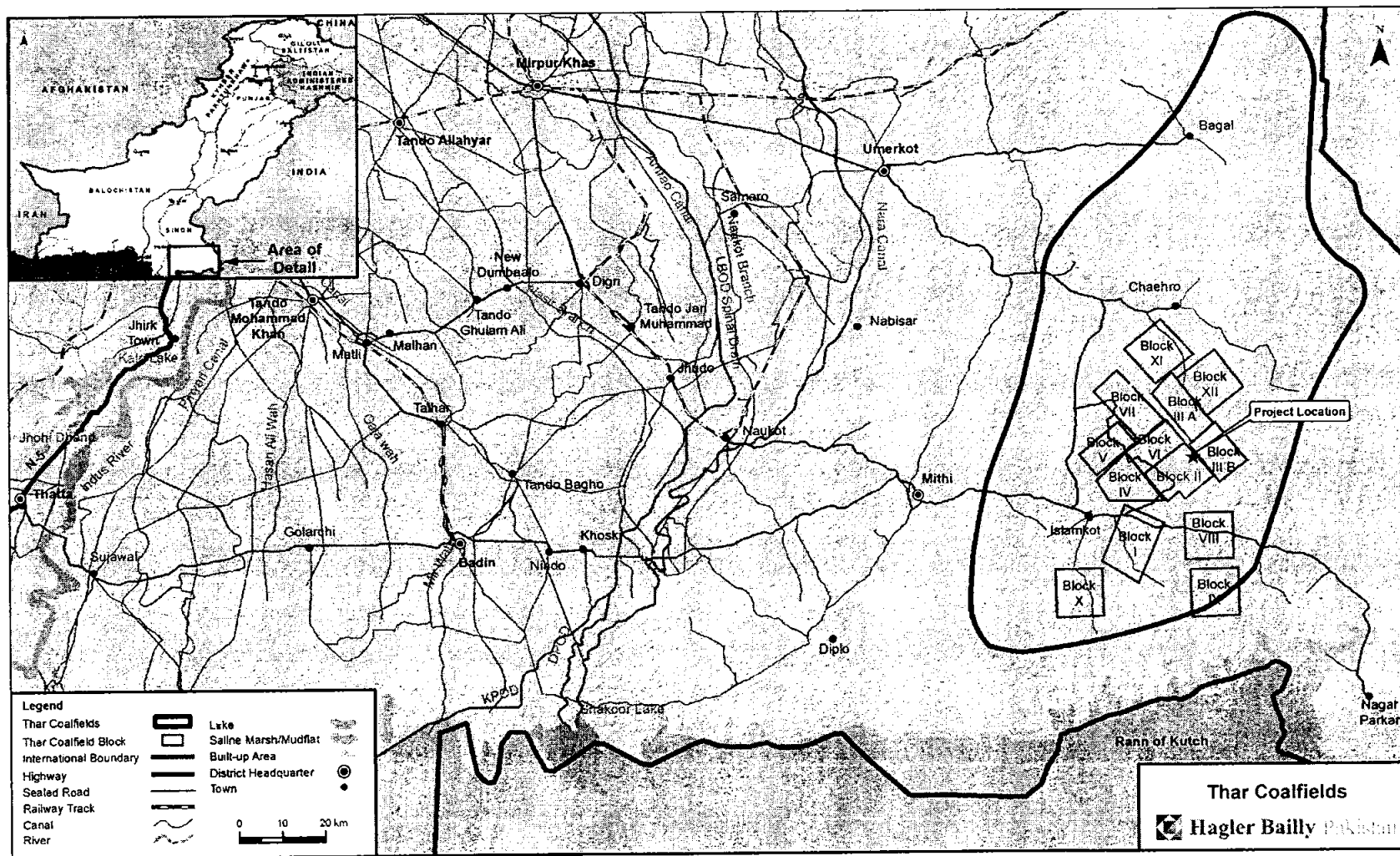


Exhibit 1.1: Project Location within the Thar Coalfields



1.2 Introduction to the ESIA Study

This ESIA was conducted to meet the regulatory requirements as set out in the Sindh Environmental Protection Act 2014 (Sindh Act 2014), and its associated rules and regulations. Wherever needed, reference is also made to the International Finance Corporation's (IFC) Performance Standards (PSs)¹² and Environmental, Health, and Safety Guidelines.¹³ The guidelines provided by these documents are considered as the best industry practice in environment.

1.2.1 Objectives of the ESIA

The objectives of ESIA are to:

- ⑥ Assess the existing environmental conditions in the Project area, including the identification of environmentally sensitive areas.
- ⑥ Assess the proposed Project activities to identify their potential environmental and social impacts, evaluate the impacts, and determine their significance.
- ⑥ Propose appropriate mitigation and monitoring measures that can be incorporated into the design of proposed activities to minimize any environmentally adverse effects as identified by the assessment.
- ⑥ Assess the proposed Project activities and determine whether they comply with the relevant environmental regulations of Pakistan.

The findings of the ESIA have been documented in the form of this report which is to be submitted to the SEPA as per regulatory requirements.

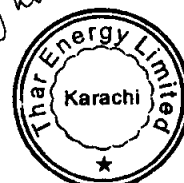
1.2.2 Scope of the ESIA

The scope of the ESIA includes an assessment of the environmental and social impacts of:

- ▶ Construction activities including, but not limited to, on-site civil works and installation activities of power plant, on-site coal yard, ash storage, and coal and ash transfer system.
- ▶ Disposal of waste from the construction activities;
- ▶ Unloading of coal and its handling at the Project site;
- ▶ Operation of the power plant; and
- ▶ Hiring of labor and labor issues during construction and operation of the power plant and the associated social issues.

¹² Available at www.ifc.org/sustainability 'Available at www.ifc.org/ehsguidelines'

¹³ Available at
http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/ehsguidelines



1.3 Exclusion from Scope of the ESIA

The impacts of some of the associated activities are excluded from the scope of the ESIA. The activities and the reason for the exclusion are as follows:

- ▶ The mining of coal and all associated activities: This is covered in the ESIA of Block II which is already approved.
- ▶ Sourcing and transport of water to the Plant from LBOD: This is in the scope of the GoS and is subject to a separate environmental assessment.
- ▶ Final disposal of liquid effluents: A combined General Drainage System for all power plants in the Energy Park will be developed and is subject of a separate study.
- ▶ Evacuation of power: This is in the scope of the National Transmission and Despatch Company and is subject of a separate environmental assessment.
- ▶ Acquisition of land or resettlement for the power plant site: This is covered in the ESIA of Block II which is already approved.

1.4 Organization of this Report

The ESIA report is organized in the following sections:

Chapter 1 (*Introduction*) provides an overview of the project, introducing the project proponent, and outlines the scope of this study.

Chapter 2 (*Legal and Policy Framework*) presents the legislative requirements that need to be followed while conducting an EIA.

Chapter 3 (*The Proposed Project*) contains information about key features of the proposed Project, such as its location and design.

Chapter 4 (*Description of the Environment*) documents in detail the existing physical, ecological and socioeconomic conditions around the Project site.

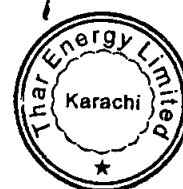
Chapter 5 (*Public Consultation and Disclosure*) presents the objectives and outcomes of the public stakeholder consultations that were conducted during the ESIA.

Chapter 6 (*Project Impacts and Mitigation Measures*) presents an assessment of the Project's impact on the physical, ecological, and socioeconomic environment, as well as recommended mitigation measures.

Chapter 7 (*Environmental Management Plan*) facilitates the implementation and monitoring of the mitigation measures identified in the environmental impact assessment.

Chapter 8 (*Analysis of Alternatives*) discusses alternatives to the proposed Project that were considered.

Chapter 9 (*Conclusion*) summarizes the findings and recommendations of this ESIA study and concludes the report.



2. Legal and Institutional Framework

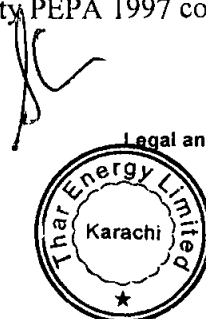
In Pakistan, the history of legislation drafted specifically to protect the environment dates back to 1980s. This section provides a brief historical and constitutional context followed by a detailed discussion of relevant laws.

2.1 Historical and Constitutional Context

The development of statutory and other instruments for environmental management has steadily gained priority in Pakistan since the late 1970s. The Pakistan Environmental Protection Ordinance, 1983 was the first piece of legislation designed specifically for the protection of the environment. The promulgation of this ordinance was followed, in 1984, by the establishment of the Pakistan Environmental Protection Agency (Pak-EPA), the primary government institution at that time dealing with environmental issues. Significant work on developing environmental policy was carried out in the late 1980s, which culminated in the drafting of the Pakistan National Conservation Strategy. Provincial environmental protection agencies were also established at about the same time. The National Environmental Quality Standards (NEQS) were established in 1993. In 1997, the Pakistan Environmental Protection Act (PEPA) 1997 was enacted to replace the 1930 Ordinance. PEPA conferred broad-based enforcement powers to the environmental protection agencies. This was followed by the publication of the *Pakistan Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations 2000* which provided the necessary details on the preparation, submission, and review of initial environmental examinations (IEE) and environmental impact assessments (EIA).

Prior to the 18th Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal list covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject. However, as a result of the 18th Amendment this subject is now in the exclusive domain of the provincial government. The main consequences of this change were as follows:

- ☞ The Ministry of Environment at the federal level was abolished. Its functions related to the national environmental management were transferred to the provinces. To manage the international obligations in the context of environment, a new ministry—the Ministry of Climate Change—was created at the federal level.
- ☞ The PEPA 1997 is technically no longer applicable to the provinces. The provinces were required to enact their own legislation for environmental protection. However, to ensure legal continuity PEPA 1997 continued to be the



legal instrument for environmental protection in the provinces till enactment of provincial laws.

All four provinces have enacted their own environmental protection laws. These provincial laws are largely based on PEPA 1997 and, hence, provide the same level of environmental protection as the parent law.

2.2 Sindh Environmental Protection Act 2014

The Sindh Environmental Protection Act 2014 (Sindh Act 2014) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. As per the law, the Sindh Environmental Protection Agency (SEPA) is responsible to implement the provisions of this Act in Sindh. The Sindh Act 2014 is applicable to a broad range of issues and extends to air, water, industrial liquid effluent, marine, and noise pollution, as well as to the handling of hazardous wastes. The articles of Sindh Act 2014 that have a direct bearing on the proposed Project are listed below. The details are discussed in the following sections.

Article 11 that deals with the Sindh environmental quality standards (SEQS) and its application

Article 13 that deals with hazardous substances

Article 14 that prohibits various acts detrimental to the environment

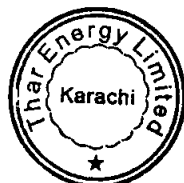
Article 17 that establishes the requirement for environmental impact assessment.

To implement the provisions of the Sindh Act 2014, *rules* and *regulations* are required.¹⁴ The key rules and regulations are:

1. National Environmental Quality Standards (Self-Monitoring and Reporting by Industries) Rules, 2001
2. Environmental Samples Rules, 2001
3. Sindh Environmental Protection Agency Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2014 (IEE-EIA Regulations 2014)

Guidelines are issued by the Pak-EPA for preparation of environmental assessment. The relevant guidelines are discussed in **Section 2.3**. All the rules, regulations, and guidelines issued under PEPA 1997 and discussed above remain valid after promulgation of Sindh Act 2014.

¹⁴ Rules and regulations are similar instruments but differ in their hierarchy. The power to make rules and regulations is given in the enabling law, PEPA 1997 and Sindh Act 2014 in this case. The rules are made by the government (federal or provincial, as the case may be) and require publication in the official gazette. Regulations are made by the government agency which is empowered by the law, environmental protection agencies in this case, and are not always published in the official gazette. Rules deal with relatively important matters such as delegation of powers and authorities, whereas regulations usually deal with procedural matters.



2.3 Requirements for Environmental Impact Assessment

The articles of Sindh Act 2014 that have a direct bearing on the environmental assessment of the proposed Project are:

Article 17(1): 'No proponent of a project shall commence construction or operation unless he has filed with the Agency¹⁵ an initial environmental examination or an environmental impact assessment, and has obtained from the Agency approval in respect thereof.'

Article 17(3): 'Every review of an environmental impact assessment shall be carried out with public participation...'

The IEE-EIA Regulations 2014 provides the necessary details on the preparation, submission, and review of the IEE and the EIA. Categorization of projects for IEE and EIA is one of the main components of the IEE-EIA Regulations 2014. Projects have been classified on the basis of expected degree of adverse environmental impact. Project types included in Schedule II of the regulations those that are likely to have potentially significant impact on the environment and thus an EIA is required for such projects, whereas those included in Schedule I as having potentially less adverse effects and therefore require an IEE. Coal fired power plants with capacity less than 50 MW is included in Schedule I (List of Projects requiring an IEE) whereas Coal power projects above 50 MW is included in Schedule II (List of Projects requiring an EIA). As the project involves development of a power plant of more than 50 MW, it falls within the category of Schedule II and an EIA has been prepared for it.

The word 'project' as defined in the Sindh Act 2014 includes new developments as well as modifications, expansions and rehabilitations of the existing projects. The proposed Project is considered a new development and not a modification to the existing Project because it will have its own separate staff, resources, financing, accounting, utilities, and administrative control. None of these items will be shared. Hence the existing project is not the subject of this EIA.

Regulation 9 of the IEE-EIA Regulations 2014 requires that '(1) Ten paper copies and two electronic copies of an IEE or EIA shall be filed with the Federal Agency; (2) Every IEE and EIA shall be accompanied by (a) an application, in the form set out in Schedule V; (b) copy of receipt showing payment of the review fee; (c) no objection certificates from the relevant departments in case of EIA shall be the part of reports; and (d) the environmental check list as per its guidelines.

The prescribed procedure for review of EIA by the EPA is described in Regulations 10–17 and is depicted in **Exhibit 2.1**. The key features are:

On acceptance of the EIA for review, EPA will place a public notice in national English and Urdu newspapers and in local language newspaper informing the public about the project and where it's EIA can be accessed. It will also set a date for public hearing which shall be at least 30 days after the publication of the notice.

¹⁵ The term 'Agency' refers to the Sindh Environmental Protection Agency.

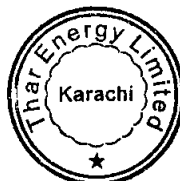
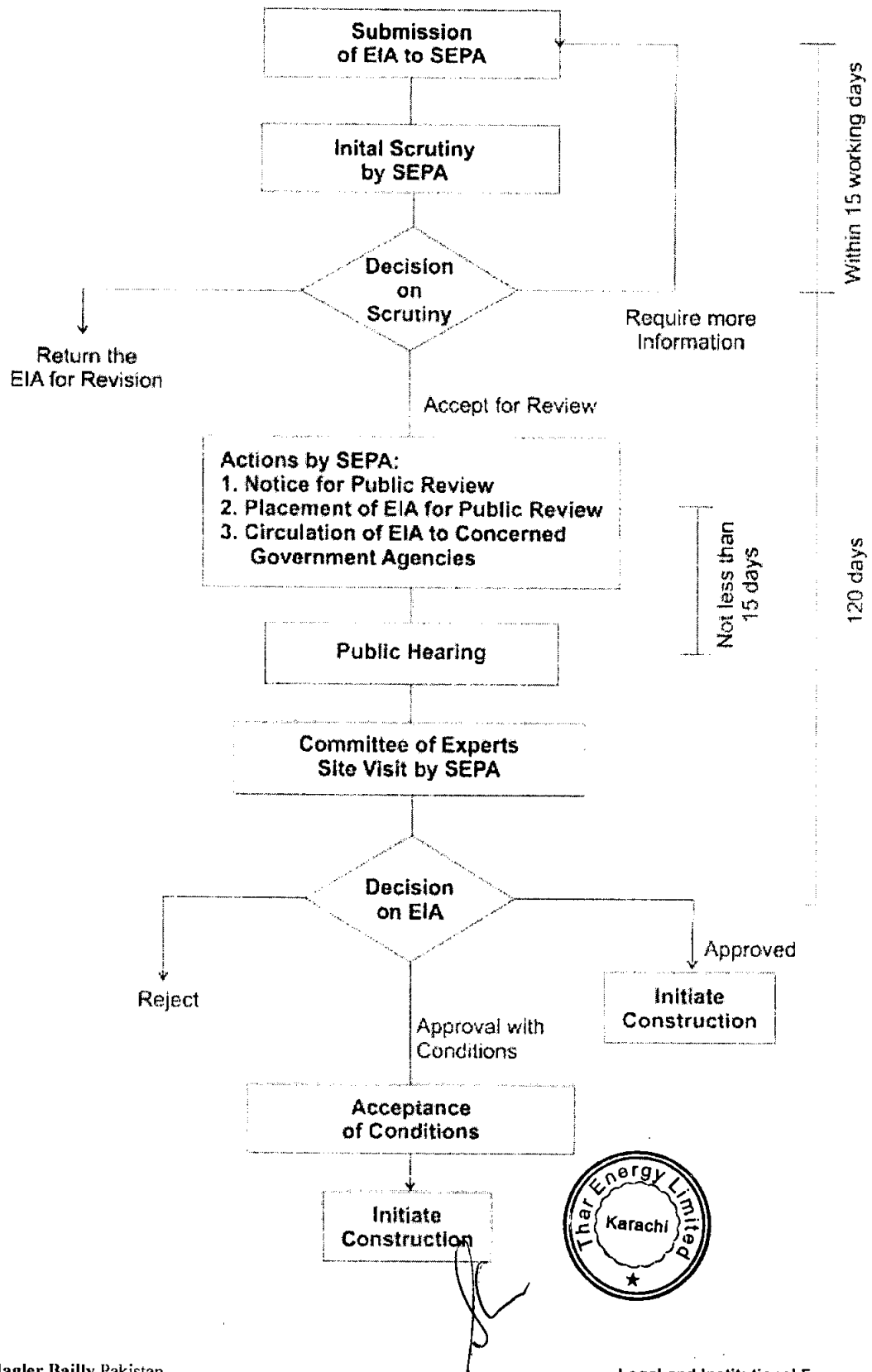


Exhibit 2.1: EIA Review and Approval Procedure



If it considers necessary, the EPA can form a Committee of Experts to assist the EPA in the review of the ESIA. The EPA may also decide to inspect the project site.

Article 17(4) of SEPA Act 2014 binds the SEPA to 'communicate its approval or otherwise ... within a period of four months from the date the environmental impact assessment is filed complete in all respects in accordance with the regulations, failing which ... the environmental impact assessment shall be deemed to have been approved, to the extent to which it does not contravene the provisions of this Act and the rules and regulations'.

Regulation 7 of the IEE-EIA Regulations 2014 pertains to the guidelines. It states that: '(1) The Agency may issue guidelines for preparation of an IEE or EIA or an environmental checklist, including guidelines of general applicability and sectoral guidelines indicating specific assessment requirements for planning, construction and operation of projects relating to a particular sector. (2) where guidelines have been issued under sub-regulation (1), an IEE or EIA shall be prepared, to the extent practicable, in accordance therewith and the proponent shall justify in the IEE or EIA or in environmental checklist any departure therefrom.' An EIA is required for thermal power generation over 100MW and for coal power projects above 50 MW.

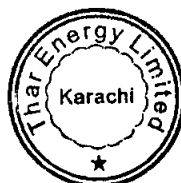
The relevant guidelines are the follows: *Policy and Procedures for the filling, Review, and Approval of Environmental Assessments* sets out the key policy and procedural requirement. It contains a brief policy statement on the purpose of environmental assessment and the goal of sustainable development and also states that environmental assessment be integrated with feasibility studies.

Guidelines for the Preparation and Review of Environmental Reports which cover the following:

- ⊗ Scoping, alternatives, site selection, and format of environmental reports;
- ⊗ Identification, analysis and prediction, baseline data, and significance of impacts;
- ⊗ Mitigation and impact management and preparing an environmental management plan;
- ⊗ Reporting;
- ⊗ Review and decision making;
- ⊗ Monitoring and auditing;
- ⊗ Project management.

Guidelines for Public Consultation which covers the following:

- ⊗ Consultation, involvement and participation;
- ⊗ Identifying stakeholders;
- ⊗ Techniques for public consultation (principles, levels of involvement, tools, building trust);
- ⊗ Effective public consultation (planning, stages of EIA where consultation is appropriate);



- ⊗ Consensus building and dispute resolution;
- ⊗ Facilitating involvement (including the poor, women, building community, and NGO capacity).

Guidelines for sensitive areas which identifies the sensitive areas.

3.1 Other Relevant Laws

2.3.1 Self-Monitoring and Reporting by Industry Rules 2001

Under the *National Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules 2001* (the 'SMART' Rules), industrial units are responsible for monitoring their gaseous and liquid discharges and reporting them to the relevant environmental protection agency (EPA). As coal-fired thermal power plants fall under Schedule I Category B of industrial categorization and reporting procedure for SMART, the respective environmental monitoring reports are required to be submitted on quarterly basis to the relevant authorities. The project proponents will report their emission and effluent to SEPA in accordance with the rules.

3.1.1 The Forest Act 1927

The Act empowers the provincial forest departments to declare any forest area reserved or protected. The act also empowers the provincial forest departments to prohibit the clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying, felling, and lopping. Vegetation clearing will be required in the site preparation for the power plant but since the area is not declared as a reserve forest this law will have no implication on the project.

3.1.2 Factories Act 1934

Particular sections of the act applicable to this project are:

- ⊗ Section 13(1): Every factory shall be kept clean and free from effluvia arising from any drain, privy or other nuisance.
- ⊗ Section 14(1): Effective arrangements shall be made in every factory for the disposal of wastes and effluents due to the manufacturing process carried on therein.
- ⊗ Section 16(1): In every factory in which, by reason of the manufacturing process carried on, there is given off any dust or fume or other impurity of such a nature and to such an extent as is likely to be injurious or offensive to the workers employed therein, effective measures shall be taken to prevent its accumulation in any work-room and its inhalation by workers and if any exhaust appliance is necessary for this purpose, it shall be applied as near as possible to the point of origin of the dust, fume or other impurity, and such point shall be enclosed so far as possible.
- ⊗ Section 16(2): In any factory no stationary internal combustion engine shall be operated unless the exhaust is conducted into open air and exhaust pipes are insulated to prevent scalding and radiation heat, and no internal combustion engine shall be operated in any room unless effective measures have been taken to



prevent such accumulation of fumes therefrom as are likely to be injurious to the workers employed in the work-room.

- ⊗ Section 20(1): In every factory effective arrangements shall be made to provide and maintain at suitable points conveniently situated for all workers employed therein a sufficient supply of whole-some drinking water.
- ⊗ Section 26(1) d(i): In every factory the following shall be securely fenced by the safeguards of substantial construction which shall be kept in position while the parts of machinery required to be fenced are in motion or in use, namely – (a) every part of an electric generator, a motor or rotary convertor.

3.1.3 The Sindh Irrigation Act 1879

This Act empowers the Government of Sindh (GoS) to use the natural sources of water such as lakes, rivers, and streams, for supply of water for irrigation and other purposes. It allows the government to develop the required infrastructure, for example, canals, channels, pipelines, for the supply of water. It also allows the government to charge fee for the supply of water and regulate the water supply.

3.2 Environmental Guidelines

3.2.4 World Bank/IFC Environmental, Health and Safety Guidelines for Thermal Power Plants 2008

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, based on environmental assessments and/or environmental audits as appropriate, with an appropriate timetable for achieving them.

This document includes information relevant to combustion processes fueled by gaseous, liquid, and solid fossil fuels and biomass and designed to deliver electrical or mechanical power, steam, heat, or any combination of these.

3.3 Institutional Framework

3.3.1 Sindh Government Institutions

Under the Sindh Act 2014, SEPA is an autonomous agency. For administrative purposes, it is part of the Forest, Environment and Wildlife Department of the Government of Sindh. SEPA is a regulatory agency with the following main functions:

- ⊗ Enforcement of Sindh Act 2014
- ⊗ Prepare environmental policies for approval of the GoS
- ⊗ Implement environmental policies
- ⊗ Publish annual state of the environment report for Sindh
- ⊗ Prepare or revise SEQs



- ☞ Ensure implementation of SEQS
- ☞ Establish systems and procedures for environmental management
- ☞ Promote research and studies on environmental issues
- ☞ Issue license for handling of hazardous substance
- ☞ Certify environmental laboratories
- ☞ Initiate legislation for environmental protection
- ☞ Provide assistance to government agencies in case of environmental accidents
- ☞ Providing advice to the government on issues related to environment
- ☞ Assist governments agencies in implementation of waste management schemes
- ☞ Provide guidance to public on environmental matters
- ☞ Assist education institutions in prescribing environmental curricula
- ☞ Undertake measures to enhance awareness on environment among general public
- ☞ Disseminate knowledge on environment
- ☞ Specify safeguards for the prevention of accidents which may cause pollution
- ☞ Review and approve mitigation plans and give guidance for clean-up operations
- ☞ Encourage the formation and working of nongovernmental organizations, community organizations and village organizations for environmental protection
- ☞ Carry out any other task related to environment assigned by the government.

SEPA will be responsible for the review and approval of the EIA of the proposed Project.

3.4 International Treaties

Important international environmental treaties that have been signed by Pakistan and may have relevance to the Project are listed in **Exhibit 2.2**. They concern: climate change and depletion of the ozone layer; biological diversity and trade in wild flora and fauna; desertification; waste and pollution; and cultural heritage.

Exhibit 2.2: International Environmental Treaties Endorsed by Pakistan

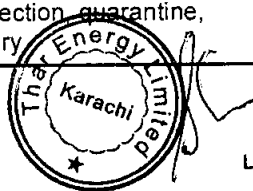
Topic	Convention	Date of Treaty	Entry into force in Pakistan
Climate change and the ozone layer	United Nations Framework Convention on Climate Change - the primary objective is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.	1992	1994
	Kyoto Protocol to the United Nations Framework Convention on Climate Change - enabled by the above Convention on Climate Change. It has more	1997	2005



Topic	Convention	Date of Treaty	Entry into force in Pakistan
	powerful and legally binding measures. It sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas emissions.		
	Vienna Convention for the Protection of the Ozone Layer - acts as a framework for the international efforts to protect the ozone layer with a primary objective to protect human health and the environment against adverse effects resulting from human activities that modify or are likely to modify the ozone layer.	1985	1993
	The Montreal Protocol on Substances that Deplete Ozone Layer and associated amendments - enabled by the Vienna Convention, it is designed to protect the ozone layer by phasing out the production and consumption of a number of substances believed to be responsible for ozone depletion.	1987	1993
Waste and pollution	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal - regulates the transboundary movement of hazardous waste and other waste with a stated purpose to protect human health and the environment against the adverse effects from generation and management of hazardous waste and other waste. The Convention provides for three sets of measures with binding obligations. These are: Strict control of transboundary movement of hazardous waste; Environmentally sound management of hazardous waste; and Enforcement and implementation of the provisions of the convention at international and national levels.	1989	1994
	International Convention on Oil Pollution Preparedness, Response and Co-operation	1990	1995
	Stockholm Convention on Persistent Organic Pollutants –seeks to protect human health and the environment from Persistent Organic Pollutants, which are chemicals that remain intact in the environment for long periods, become widely distributed geographically and accumulate in the fatty tissue of humans and wildlife.	2001	2008
Desertification	International Convention to Combat Desertification – with an objective to combat desertification and mitigate the effects of drought. It is supported by international cooperation and partnership arrangements, with the aim of achieving	1994	1997



Topic	Convention	Date of Treaty	Entry into force in Pakistan
	sustainable use of land and water resources and sustainable development in affected areas.		
Biodiversity and the protection of plants and animals	Convention on Biological Diversity – covering ecosystems, species, and genetic resources and also the field of biotechnology. The objectives are to conserve biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from genetic resources.	1992	1994
	Cartagena Protocol on Biosafety to the Convention on Biological Diversity - addresses potential risks posed by living modified organisms resulting from modern biotechnology.	2000	2009
	Bonn Convention on the Conservation of Migratory Species of Wild Animals - aims to conserve terrestrial, marine and avian migratory species throughout their range. It is concerned with the conservation of wildlife and habitats on a global scale.	1979	1987
	Memorandum of Understanding concerning Conservation Measures for the Siberian Crane - parties undertake to provide strict protection to Siberian Cranes, and identify and conserve wetland habitats essential for their survival.	1998	1999
	Convention on International Trade in Endangered Species of Wild Fauna and Flora - to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	1973	1976
	International Plant Protection Convention (1997 Revised Text) - to prevent the international spread of pests and plant diseases. It requires maintenance of lists of plant pests, tracking of pest outbreaks, and coordination of technical assistance between member nations.	1951/52	1954
	Agreement for the Establishment of the Near East Plant Protection Organization - to establish the Near East Plant Protection Organization (NEPPO), which promotes international co-operation with a view to implementing International Plant Protection Convention.	1993	2009
	Plant Protection Agreement for the Asia and Pacific Region and amendments – establishes the Asia and Pacific Plant Protection Commission to review and promote the region's progress in the implementation of the Agreement. Trade in plants and plant products are regulated by certification, prohibition, inspection, disinfection, quarantine, destruction, etc., as necessary	1955 (amended 1967)	1958 (amended 1969)



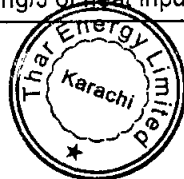
Topic	Convention	Date of Treaty	Entry into force in Pakistan
	Convention on Wetlands of International Importance especially as Waterfowl Habitat and associated protocols and amendments - to promote conservation and sustainable use of wetlands. The Ramsar List of Wetlands of International Importance now includes almost 1,800 sites (known as Ramsar Sites). There are currently 19 Ramsar sites in Pakistan.	1971 (amended 1987)	1976 (amended 1994)
Cultural heritage	Convention concerning the Protection of the World Cultural and Natural Heritage - requires parties to adapt a general policy on the protection of the natural and cultural heritage, to set up services for such protection, to develop scientific and technical studies, to take appropriate legal, technical, scientific and administrative measures and to foster training and education for such protection.	1972	1976

3.5 Environmental Standards and Guidelines Applicable to the Projects

The proposed Project is legally required to comply with the SEQS for gaseous emission, and liquid effluent, and SEQS for ambient air quality. The environmental standards applicable in Sindh are NEQS as developed by Pakistan Environmental Protection Agency prior to 18th Amendment. The only exception is the ambient air quality standards which Sindh Environmental Protection Agency has notified separately. In **Exhibit 2.3** and **Exhibit 2.4**, comparisons of SEQS and IFC Guidelines for key parameters of emission and ambient air quality are provided. **Exhibit 2.5** provides a comparison of SEQS and IFC Guideline limits for effluents. **Exhibit 2.6** provide SEQS guideline values for sound levels. The IFC Guidelines are legally not applicable to this project and is provided here for reference only.

Exhibit 2.3: Comparison of SEQS and IFC Guideline Limits for Emission of Key Pollutants from Stack of Coal Fired Power Plant

Parameter	Source of Emission	National Standards	IFC Guidelines (For Reference only)
Particulate matter	Boilers and furnaces: coal-fired	500 mg/Nm ³	For NDA: 50 mg/Nm ³ For DA: 30 mg/Nm ³
Carbon monoxide	Any	800 mg/Nm ³	-
Nitrogen Oxides	Coal-fired	1,200 mg/Nm ³ And for lignite fossil coal: 260 ng/J of heat input	For NDA: 510 mg/Nm ³ For DA: 200 mg/Nm ³



Parameter	Source of Emission	National Standards	IFC Guidelines (For Reference only)
Sulfur Dioxide	Power plant operating on oil and coal	500 tons per day 50 µg/m ³ increment to annual average	For NDA: 900-1500 mg/Nm ³ For DA: 400 mg/Nm ³

Notes:

- For additional parameters and explanation, see complete SEQs in **Appendix A**
- A "-" in the fourth column indicates that IFC has not provided any guidelines for the parameter
- NDA = Non-degraded airshed; DA = Degraded airshed (poor air quality); Airshed should be considered as being degraded if nationally legislated air quality standards are exceeded or, in their absence, if WHO Air Quality Guidelines are exceeded significantly
- In respect of emissions of sulfur dioxide and nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to SEQs for gaseous emissions, comply with the standards stated in SEQs for sulfur dioxide and nitrogen dioxides.

Exhibit 2.4: Comparison of SEQs and IFC Guideline Limits for Ambient Air Quality

Pollutants	Time-weighted Average	Sindh Standards (µg/m ³)	IFC Guidelines (µg/m ³) (For Reference)
Sulfur Dioxide (SO ₂)	Annual Average	80	—
	24 hours	120	125
Oxide of Nitrogen as (NO)	Annual Average	40	—
	24 hours	40	—
Oxide of Nitrogen as (NO ₂)	Annual Average	40	40
	24 hours	80	—
Ozone (O ₃)	1 hour	130	—
Suspended Particulate Matter (SPM)	Annual Average	360	—
	24 hours	500	—
Respirable particulate Matter. PM ₁₀	Annual Average	120	70
	24 hours	150	150
Respirable Particulate Matter. PM _{2.5}	24 hours	75	75
	Annual Average	40	35
Lead (Pb)	Annual Average	1	—
	24 hours	1.5	—
Carbon Monoxide (CO)	8 hours	5,000	—
	1 hour	10,000	—

Notes:

- For additional parameters and explanation, see complete SEQs in **Appendix A**
- A "-" in the fourth column indicates that IFC has not provided any guidelines for the parameter or they are to be established by the environmental assessment

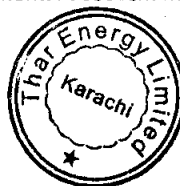
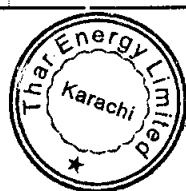


Exhibit 2.5: Comparison of SEQs and IFC Guideline Limits for Effluents
(mg/l, unless otherwise defined)

Parameter	SEQs (Into Inland Waters)	IFC Guidelines (For Reference)
Temperature increase	=<3°C	—
pH value	6 to 9	6 to 9
Five-day bio-chemical oxygen demand (BOD) at 20°C	80	—
Chemical oxygen demand (COD)	150	—
Total suspended solids (TSS)	200	50
Total dissolved solids (TDS)	3,500	—
Grease and oil	10	10
Phenolic compounds (as phenol)	0.1	—
Chlorides (as Cl')	1,000	—
Fluorides (as F')	10	—
Cyanide total (as CN')	1	—
Anionic detergents (as MBAS)	20	—
Sulfate (SO ₄)	600	—
Sulfides (s')	1.0	—
Ammonia (NH ₃)	40	—
Pesticides	0.15	—
Cadmium	0.1	0.1
Chromium (trivalent and hexavalent)	1	0.5
Copper	1	0.5
Lead	0.5	0.5
Mercury	0.01	0.005
Selenium	0.5	—
Nickel	1	—
Silver	1	—
Total toxic metals	2	—
Zinc	5	1.0
Arsenic	1	0.5
Barium	1.5	—
Iron	8	1.0



Parameter	SEQS (Into Inland Waters)	IFC Guidelines (For Reference)
Manganese	1.5	–
Boron	6	–
Chlorine	1	0.2

Notes:

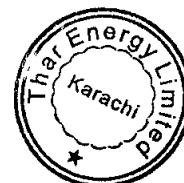
1. A "–" in the third column indicates that IFC has not provided any guidelines for the parameter or they are to be established by the environmental assessment.
2. IFC General Guidelines describes "temperature of wastewater prior to discharge does not result in an increase greater than 3 °C of ambient temperature at the edge of a scientifically established mixing zone which takes into account ambient water quality, receiving water use and assimilative capacity among other considerations".

Exhibit 2.6: Sindh Environmental Quality Standards for Noise

No.	Category of Area/Zone	Effective from 1st July, 2010		Effective from 1st July, 2012	
		Limit in dB(A) Leq*			
		Day Time	Night Time	Day Time	Night Time
1.	Residential are (A)	65	50	55	45
2.	Commercial are (B)	70	60	65	55
3.	Industrial area (C)	80	75	75	65
4.	Silence zone (D)	55	45	50	45

Note:

1. Day time hours: 6.00 am to 10.00 pm
2. Night Time hours: 10.00 pm to 6.00 am
3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts and courts.
4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
5. dB(A) Leq: time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.



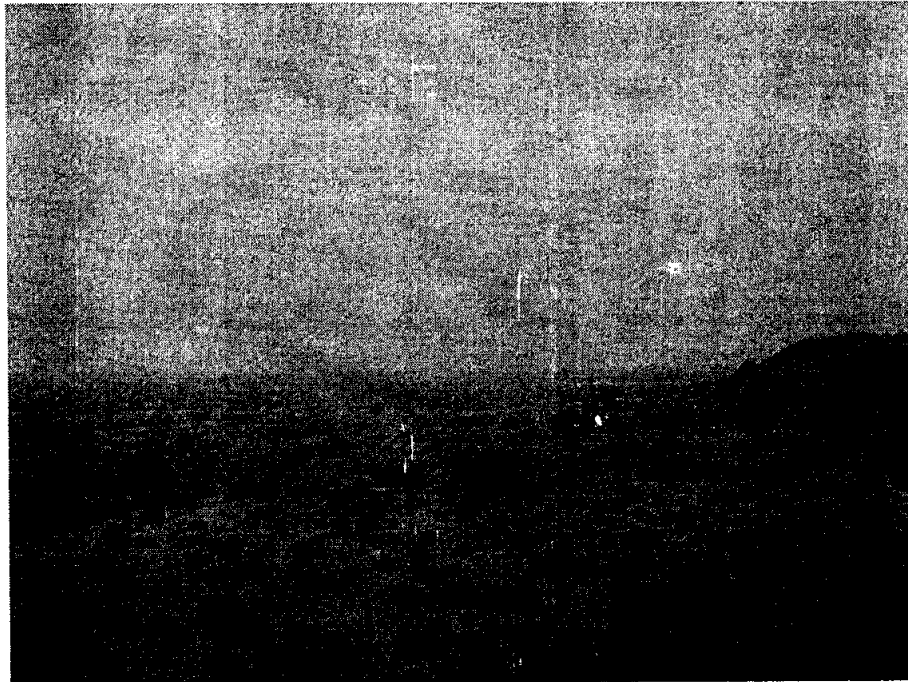
3. The Proposed Project Design

This section provides a description of the proposed Project including the location, technology used, environmental controls, raw materials required and waste generated.

3.1 Project Location and Layout

The proposed Project will be located within the Energy Park, Block II of Thar Coalfields in Tharparker District of Sindh. A photograph of the Project site is shown in **Exhibit 3.1** and a map of the location is given in **Exhibit 3.2**.

Exhibit 3.1: Project Site as seen from Bitra



The major systems in the proposed plant will include:

- ⑤ Coal handling and processing system
- ⑤ CFB boiler and Environmental Control Equipment
- ⑤ Steam turbine and condenser
- ⑤ Electrical power generator and power export system
- ⑤ Cooling water system
- ⑤ Ash handling system
- ⑤ Utilities and waste management systems.

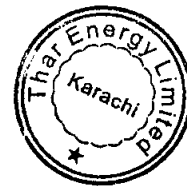
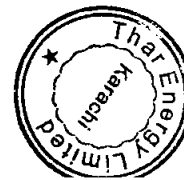
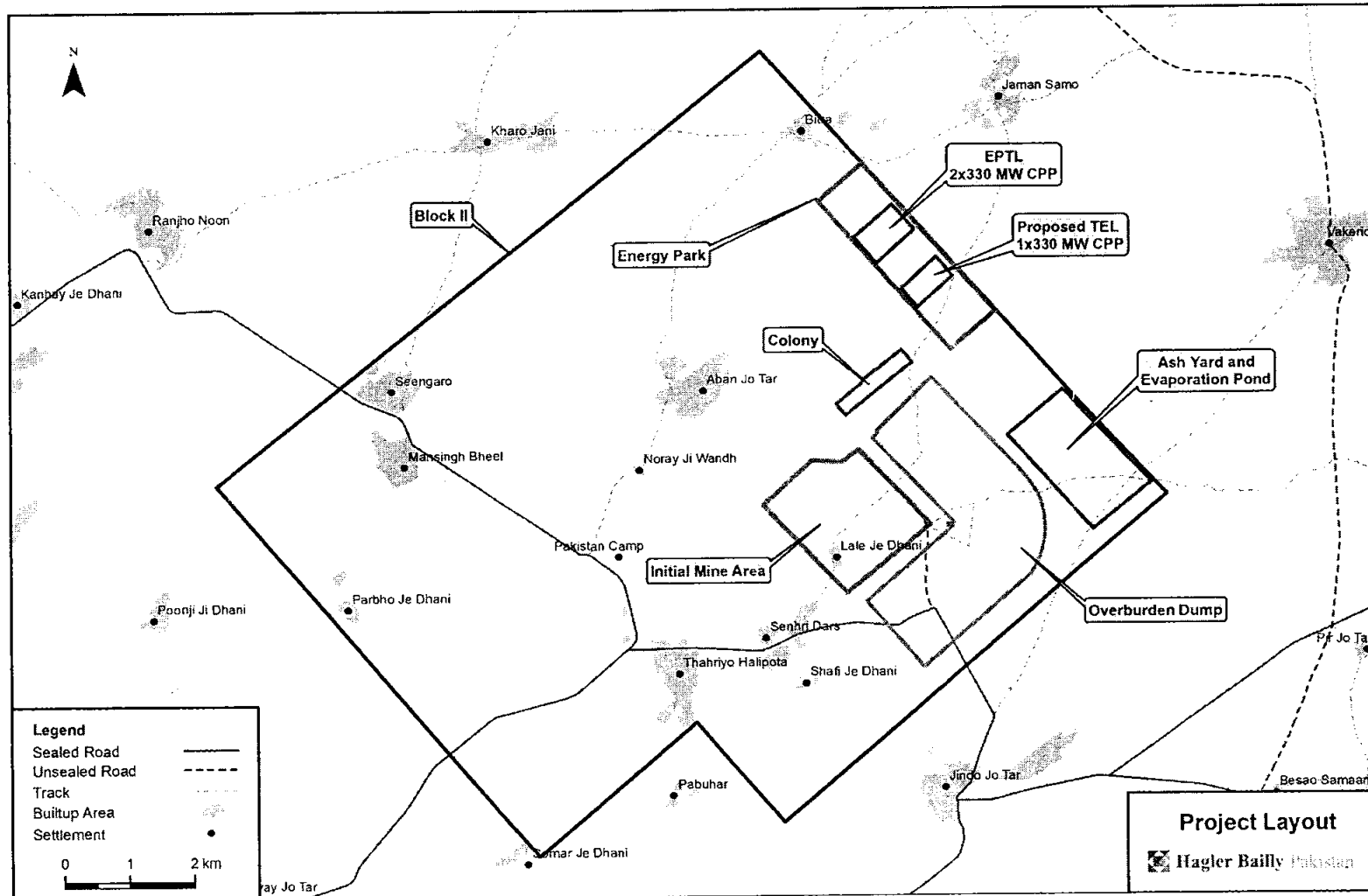


Exhibit 3.2: Project Layout



3.2 Project Technology

It is proposed to develop a 1 × 330 MW coal based power plant utilizing circulating fluidized bed (CFB) boiler technology with sub-critical steam parameters. Plant specifications are summarized in **Exhibit 3.3**. A block diagram of a CFB power plant is shown in **Exhibit 3.4**. A simplified layout of the power plant is shown in **Exhibit 3.5**. The main components are described below.

Exhibit 3.3: Power Plant Specifications

<i>Plant Specifications</i>	<i>Approx. Value</i>	<i>Unit</i>
Gross Capacity	330	MW
Net Capacity	300	MW
Availability factor	85	%
Efficiency on LHV ¹⁶	37	%
LHV of Coal	2675	kcal/kg
Coal Consumption ¹⁷	1.9	million tons per year

3.2.1 Combustion Chamber

The vertical combustion chamber is at the core of the CFB boiler. Fuel (in this case coal) and fine grained limestone are fed into the combustion chamber.

The bed material circulating in the combustion system consists primarily of the particles of coal ash, bed makeup material (such as sand), gypsum and excess calcined limestone. The 'bed' is where the coal or fuel spreads for combustion. A high pressure preheated air supply from the bottom lifts the bed material and coal particles and combustion takes place while it is suspended. Combustion of this suspended bed is known as 'fluidized bed combustion'.

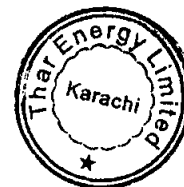
3.2.2 Cyclone

Fine particles of partly burned coal, ash and bed material are carried along with the flue gases to the upper areas of the furnace and then into a cyclone. In the cyclone the heavier particles separate from the gas and fall to the hopper of the cyclone returning it to the furnace. Hence the name 'Circulating' as the unburnt material is circulated back into the furnace. The hot gases from the cyclone pass to the heat transfer surfaces and go out of the boiler after particles removal.

The long solids residence time in the furnace resulting from the collection/recirculation of solids via the cyclone, plus the vigorous solids/gas contact in the furnace caused by the fluidization airflow, result in better combustion efficiency, even with difficult-to-burn fuels, such as Thar coal.

¹⁶ Lower Heating Value

¹⁷ Based on above values in the table



3.2.3 Electricity Generation

Heat released from the combustion of coal in the CFB sub-critical boiler will be used to generate steam at a pressure of around 175 bar and 540 °C. The steam will then be fed into the steam turbine, where it will rotate the turbine to generate mechanical energy. The steam, after passing through the turbine, will be condensed back to water and to be re-injected into the boiler after passing through condensate polishing system. The rotating steam turbine will operate the power generator, which will generate electricity. The voltage of the electricity will then be stepped-up and exported through the high tension transmission system of 500 kV.

The maximum furnace exit gas temperature will not exceed 950 °C. The flue gas exit temperature from the air heater at all load conditions will not be lower than 10 °C above the sulfuric acid dew point temperature.

3.2.4 Cooling System

The main components of the circulating water system are cooling towers, circulating water pumps, condenser and its associated valves, and instrumentation and controls.

Cooling towers will be installed to cool the heated circulating water by evaporation that occurs when water droplets are brought into direct contact with the upwards-flowing ambient air. Either mechanical draft or natural draft cooling towers can be used for the coal fired project. To maintain required water quality parameters, water from the cooling tower basin will be continuously removed through blowdown and dumped into the wastewater collection basin for reuse in various plant services, such as ash handling and coal dust suppression. The remaining non-recyclable water will be disposed through the 50 cusec drainage and wastewater effluent channel being constructed by the GoS scope.

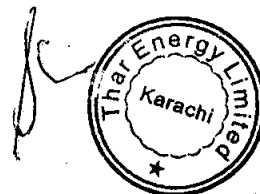
The tower structure is generally constructed of a combination of reinforced concrete, the tower fill PVC or treated wood. The hyperbolic natural draft tower is extremely dependable and predictable in its thermal performance. Air flow through this tower is produced by the density differential that exists between the heated (less dense) air inside the tower and the relatively cool (more dense) ambient air outside. Mechanical cooling towers of large size usually employ induced draft fans to meet the high air flow requirement for cooling.

3.2.5 Emission Controls

Emissions controls for pollutants of concern (NO_x, SO₂ and particulate matter) are as follows.

NO_x:

Combustion takes place at relatively low temperatures when compared with pulverized coal boilers (typically 800 °C - 900 °C). The staged combustion combined with these temperatures results in an effective suppression of NO_x-formation and can be controlled below the SEQS/NEQS limit for lignite coal of 260 ng of NO_x per joule of energy.



SO₂

SO₂ control will be provided by the injection of limestone in the CFB Boiler and converting sulfur to gypsum (calcium sulfate). The efficiency of the system will meet limit SO₂ stack emissions to 850mg/Nm³.

Particulate Matter

The steam generator will be equipped with a dry electrostatic precipitator (ESP). The purpose of the ESP will be to minimize loading of particulates (fly ash and unburned carbon). The ESP will limit the outlet flue gas particulate loading to below 50 ppm at all loads when burning design coal.

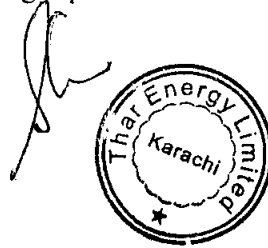


Exhibit 3.4: Schematic of CFB Power Plant

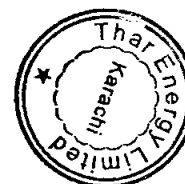
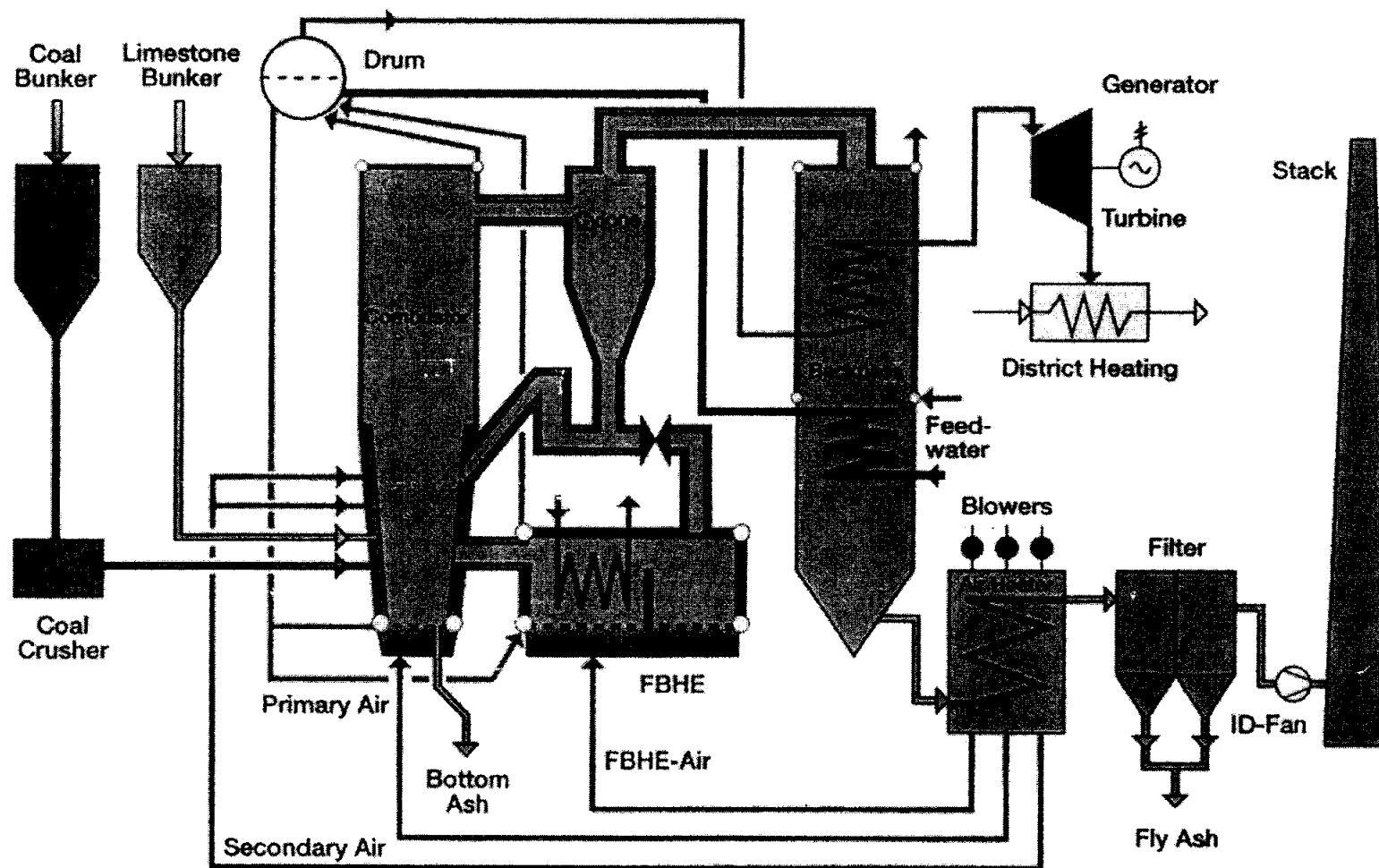
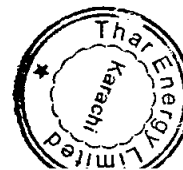
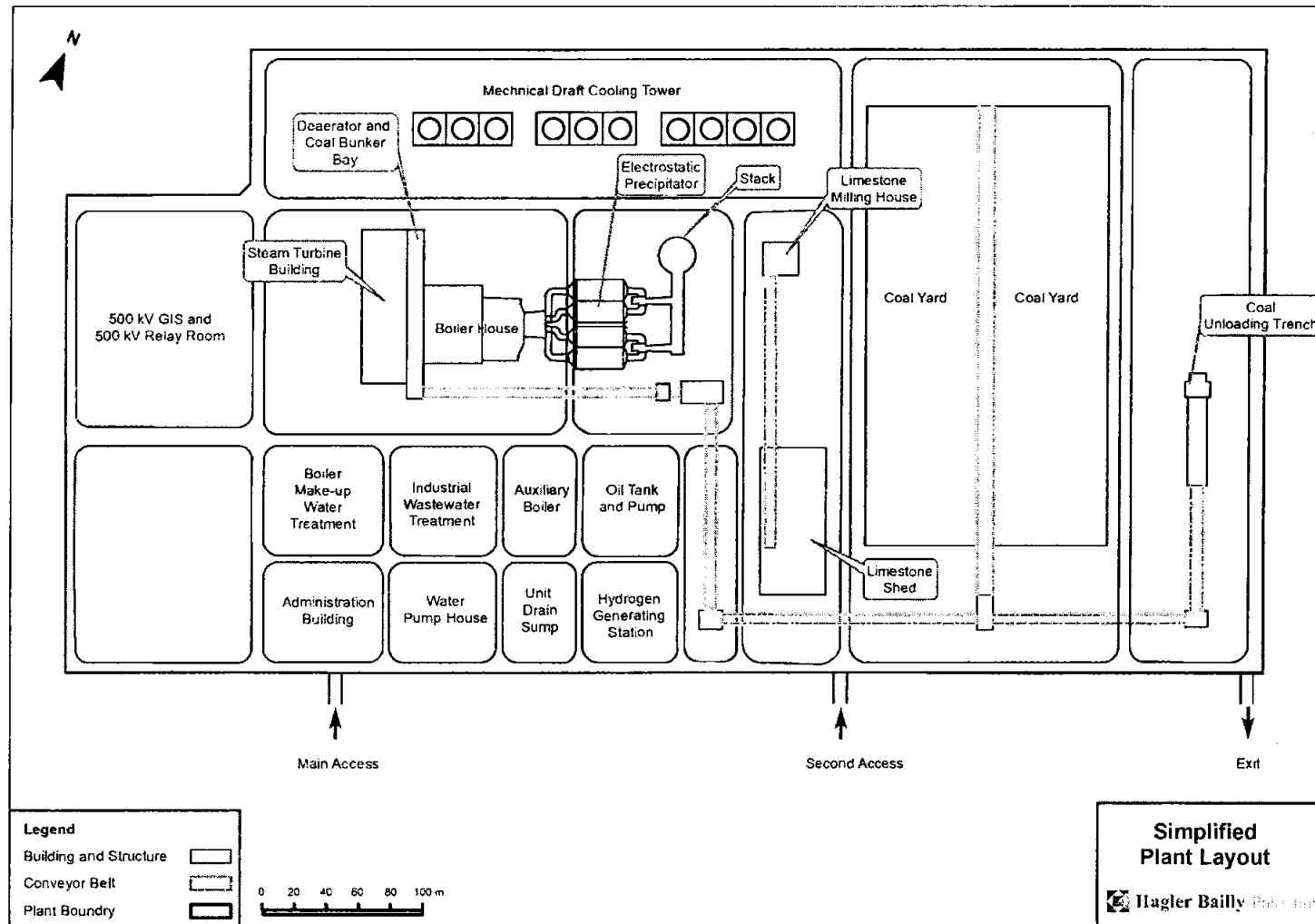


Exhibit 3.5: Simplified Plant Layout



3.3 Raw Material Inputs

The major inputs required for the proposed coal power plant Project are coal, limestone and water.

3.3.1 Coal

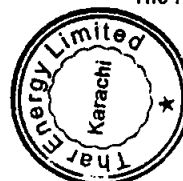
The main fuel for the power plant will be Thar Coal from Block II mine. The design specification of the fuel is given in **Exhibit 3.6**. Based on the lower heating value (LHV) of 2675 kcal/kg, net plant thermal efficiency of 37%, plant gross capacity of 1x330 MW, and 85% availability factor approximately 1.9 million tons per year of coal will be consumed.

Coal will be transported via truck to the Project site after preliminary crushing and storage at the mine stockyard which is less than 5 km from the Power Plant. Coal for the power plant will be received at the coal stockyard at the Project site. The coal yard within the project site will have a capacity of not more than 30 days of coal consumption. The height of the coal stockpile will be around 10 meters and the stockyard will be equipped with a wind breaker and water sprinkling system for coal dust suppression

Exhibit 3.6: Design Specification of the Fuel¹⁸

Coal Quality of Thar Block-II Lignite for Power Plant Design		Design Coal
A	Calorific Value	
i	Net calorific value, kcal/kg (kJ/kg)	2,675 (11,198)
B	Proximate Analysis	
I	Moisture (a.r)	49.5%
II	Ash (a.r)	7.0%
III	Volatile matter (a.r)	24.5%
IV	Fixed carbon (a.r)	19.0%
C	Ultimate Analysis	
I	C (a.r)	30.89%
II	H (a.r)	2.65%
III	N (a.r)	0.44%
IV	O (a.r)	8.35%
V	S.t (a.r)	1.07%
D	Ash analysis	
i	Silica (as SiO ₂)	25.45
ii	Alumina (as Al ₂ O ₃)	15.20
iii	Titanium oxide (as TiO ₂)	1.81

¹⁸ Hagler Bailly Pakistan. *Environmental Impact Assessment of Thar Coal Block II Power Plant Project*. Prepared for Thar Power Company. January 2014



Coal Quality of Thar Block-II Lignite for Power Plant Design		Design Coal
iv	Iron oxide (as Fe ₂ O ₃)	12.85
v	Calcium oxide (as CaO)	11.8
vi	Magnesium oxide (as MgO)	4.86
vii	Sodium oxide (as Na ₂ O)	3.85
viii	Potassium oxide (as K ₂ O)	0.41
x	Sulphur oxide (as SO ₃)	11.59
xi	Base / Acid Ratio	0.84
E Ash fusibility characteristic		
i	Initial deformation temperature, °C at reduced atm	1,220
ii	Softening temperature, °C	1,284
iii	Fusion temperature, °C at reduced atm	1,412
F Hardgrove grindability index (HGI)		75

a.r = as received

3.3.2 Water

The water source and requirements for the proposed coal power Project are discussed in this section.

Water Source

To meet the water requirements for mining and power generation activities at Thar, the Government of Sindh (GoS), through the Sindh Irrigation and Drainage Authority (SIDA), is constructing a water channel from a distributary of the Left Bank Outfall Drain (LBOD)¹⁹ towards the Thar Coalfields. Water will be treated and stored at Nabisar station. The raw water storage at Nabisar will be of 15 days based on 100 cusec water flow and the treated water storage will be 30 days based on 35 cusec flow. From there it will be pumped through underground piping to Vejihar water reservoir where the water storage capacity is 15 days. From Vejihar the water will be pumped through underground piping to the Project site. The expected water quality is given below in Exhibit 3.7. An indicative route of the water channel from the LBOD to Thar Coalfield is shown in Exhibit 3.8.

¹⁹ The LBOD is an environmental improvement project which was conceived in the 1960s as a response to the problem of rising water tables and resulting waterlogging and salinity. The project area includes some of the most hard-hit areas on the left side of the Indus River in the arid zones of Sindh Province. The project's primary function is to remove and safely convey saline water to the sea through a network of drains. The project provides for the integrated development of irrigation and drainage which include an outfall for saline drainage effluent to the Arabian Sea, phased construction of three drainage subareas in Nawabshah, Mirpurkhas and Sanghar, remodeling of the Nara/Jamrao Canal system, and watercourse improvement in the arid zones in Sindh Province.

The World Bank. "Left Bank Outfall Drain Project Tackling Pakistan's Waterlogging and Salinity Problems." Projects and Operations.

<http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/0,,contentMDK:20017537~menuPK:64282137~pagePK:41367~piPK:279616~theSitePK:40941,00.html> (accessed October 15, 2014).



LBOD treated water of 8.75 cusec (892 m³/hour) will be allocated as the main source of water supply to the project which based on preliminary water balance is sufficient to satisfy the needs of 1x330MW plant at all loads and in peak summers. To further reduce the plant water consumption (and reduce reject quantity) cooling tower blowdown treatment plant (Reverse Osmosis based) may be considered. As the GoS is developing this as an independent project it is not within the scope of the current Project and its impacts are not evaluated as part of this ESIA.

Water from the mine dewatering of the Block II coal mine will primarily be used by the 2x330 MW EPTL coal power plant. If additional water from mine dewatering is available in sufficient quantity it may be used as a secondary water supply for the Project after necessary treatment. For this a mine water treatment plant (Reverse Osmosis based) may be considered. In this case about 1100 m³/hour of mine water should be available before treatment to meet plant requirements.

Exhibit 3.7: Expected Water Quality from LBOD after Treatment

<i>Design Parameter</i>	<i>Unit</i>	<i>Expected Value</i>
pH		4.8
Color	H.U	<5.0
Turbidity	NTU	0.55
Conductivity	μS/cm	205
Total Dissolved Solids (TDS)	mg/l	98
Total Suspended Solids (TSS)	mg/l	<0.1
Total Alkalinity	mg/l	20
Total Hardness	mg/l	50
Nitrate	mg/l	6.3
Nitrite	mg/l	0.005
Ammonia	mg/l	0.04
Chloride	mg/l	87

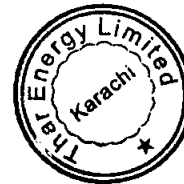
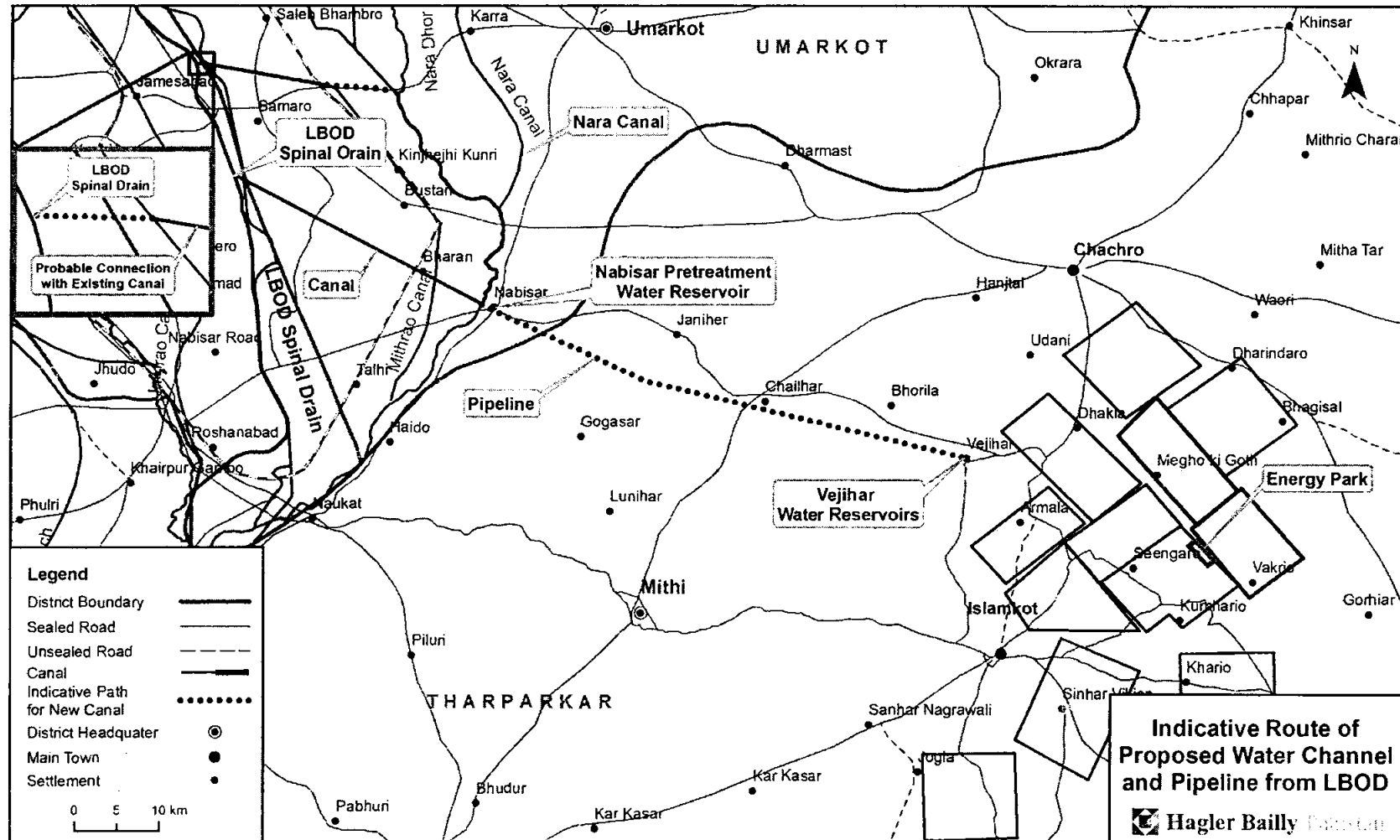


Exhibit 3.8: Indicative Route of the Proposed Water Channel from LBOD to Block II



Water Demand Estimate

The Project will require 740 m³/h of water supply. The breakdown of water requirements are shown in **Exhibit 3.9**.

If water from mine dewatering is used an additional 304 m³/h will be required due to losses in treatment of the mine water. The water balance of the power plant will remain the same and require 740 m³/h for both sources of water supply.

Exhibit 3.9: Power Plant Water Demand (1x330 MW)

Item	Makeup water required (m ³ /h)
Evaporation loss (cooling tower)	531
Continuous blowdown	60
Wind loss (cooling tower)	42
Steam loss (boiler)	36
Tower Blowdown	17
Dual axle mixer water	15
Washing water (main block, precipitator, roads, dry ash)	9
Sanitary water	3
Make up water for HVAC	1
Dosing water	1
Contingency margin	25
Total water demand	740

3.3.3 Limestone

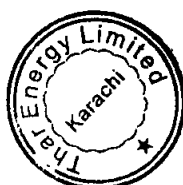
Limestone is a key input to control SO₂ production. The project site will house a limestone preparation facility for feeding in CFB boiler. In plant limestone storage will have approximate capacity equivalent to 30 days and will be finalized based on lime stone supply.

3.4 Waste Materials

The major waste streams generated by the proposed coal power plant Project include ash, waste water and gaseous emissions.

3.4.1 Ash

Bottom ash is what remains after combustion in the furnace and consists of noncombustible matter in the inputs. The bottom ash will be evacuated from the bottom of the furnace. Fly ash is a product of combustion and is made of fine particles. The fly ash will be collected by means of an electrostatic precipitator (ESP). The ESP is installed downstream of the furnace.



Ash residue will be stored temporarily in the combined ash yard until it is transported to the mine area (see **Exhibit 3.1**) for final disposal. It will be used as backfill in the spent mine pit. The dumped ash in the temporary yard will be compacted, mixed with sand and given leaching protection by considering clay or geomembrane lining in the area. Lining selection will also be based on the geotechnical data and aquifer depth.

The mine area is at a distance of around 5 km. The ash residue transportation will be via truck.

3.4.2 Wastewater

The maximum possible water from the plants will be treated and stored for recycling in the process streams, suppressing coal and ash dust, and for landscaping. A sewage treatment plant will treat sewage from the housing complex and construction camp. Wastewater from the sewage plant will be discharged or recycled in appropriate processing streams. The industrial wastewater treatment system will meet the requirement to treat the regeneration waters etc. The water after treatment from industrial wastewater unit will be re-used. Wastewater from the sanitary and industrial water treatment plants will meet SEQS limits for liquid effluents (see **Exhibit 2.5**).

Wastewater disposal of power plants developed in the Energy Park will be through a General Drainage System being developed by the Energy Park. It is likely that wastewater will be reinjected into the third ground water aquifer. As a backup, or in instances where concentrations of pollutants are high in the effluent, it will be disposed into an evaporation pond. The evaporation pond will have a capacity of approximately one month of effluent disposal. The wastewater disposal through the General Drainage System is an independent combined project and is not part of this Project, hence its impact are not evaluated in this ESIA.

3.5 Air Emissions

Main gaseous emissions of health concern from the coal power Project include sulfur dioxide (SO₂), oxides of nitrogen (NO_x) and particulate matter. A summary of key parameters related to air emissions, including stack specifications and emission rates, are presented **Exhibit 3.10**. The release and dispersion of these pollutants is discussed in **Chapter 6**. The dispersion modelling was performed at the emission rates based on Project limits. The expected values are

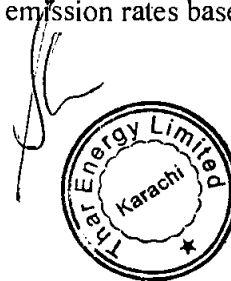
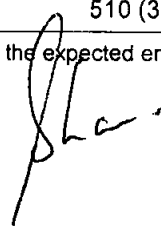
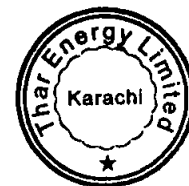


Exhibit 3.10: Estimated Air Emission Parameters (1 × 330MW)

Parameters	Value	Units
Stack Specifications		
Height	180	m
Inner diameter	5.76	m
Flue Gas Specifications		
Exit velocity	20.8	m/s
Exit temperature	170	°C
Flow rate	543	m³/s
Emission Rates		
	Modelling Rate (Expected Rate)	
SO ₂	850 (584)	mg/Nm³
PM	50 (23)	mg/Nm³
NO ₂	510 (381)	mg/Nm³

Modelling rate is at the proposed Project limits, expected rate is the expected emission rate of the Project.

4. Description of the Environment

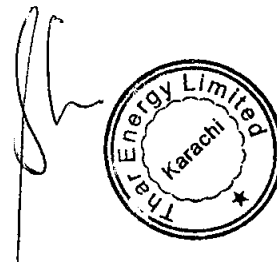
This section describes the Study Area's existing environment including the physical, ecological and socioeconomic baseline conditions. The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic. The ecological baseline includes nearby protected areas, habitat types and ecological resources. The description of the socioeconomic environment includes the area's population and households, education, health, water supply, agriculture, transport and communications, and occupations and income.

4.1 Methodology for Developing the Baseline

As a number of mining and power projects have been approved in the Thar area, the 'baseline' for the proposed Project takes into account the potential impact of these developments on the environment. This approach is especially used in developing air quality baseline.

4.2 Study Area

The Study Area selected for the ESIA includes sensitive receptors²⁰ that are most likely to be impacted by the Project's development activities. This Study Area includes the Energy Park and an area within a 5 km radius around it and is depicted in **Exhibit 4.1**.



²⁰ Sensitive receptors include, but are not limited to, residential areas, schools, places of worship, wetlands, and habitats. These are areas which are more susceptible to the adverse effects of an anthropogenic activity such as noise, air emissions, traffic influx, and privacy issues.

Exhibit 4.1: Study Area



4.3 Physical Baseline

The physical baseline includes geomorphology, water resources, climate, air quality, noise levels, and traffic.

4.3.1 Topography

The topography of the Study Area is typical of the Thar Desert. It has an undulating relief with areas of higher ground consisting of elongate and parabolic sand dunes, running parallel to the prevailing northeasterly winds. A topographical map of the Study Area is shown in **Exhibit 4.2**. The dunes in the Study Area are at an average elevation of 101 m above mean sea level (amsl). Dunes are interspersed with areas of very flat plain being approximately 90 m amsl. There are no river courses close to the Study Area, although there are small ephemeral channels that capture run-off during and after large rainfall events. Significant temporary water bodies exist along the southern margins of the Thar Desert, particularly in the Great Rann of Kutch, approximately 30 km from the edge of the Study Area (see the Ecology Baseline in **Section 4.4**).

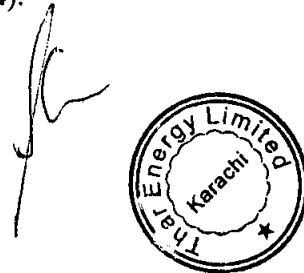
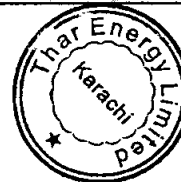
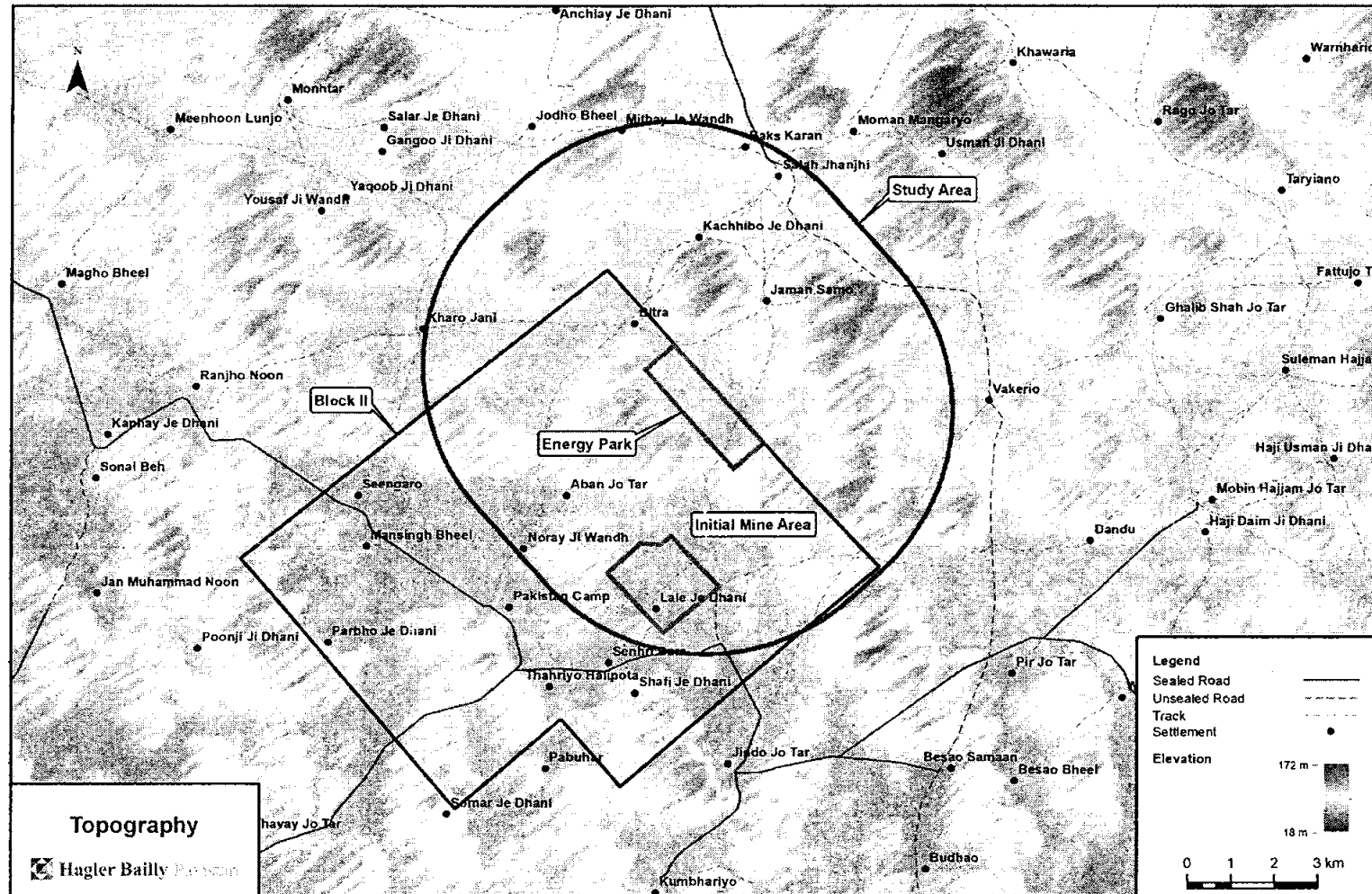


Exhibit 4.2: Topography



4.3.2 Visual Character

The visual baseline documents the current aesthetic and visual conditions of the proposed Project site as seen from the nearby receptors.

To document the visual baseline, a survey was conducted at the locations listed in **Exhibit 4.3** and shown in **Exhibit 4.4**. The survey was conducted from April 25 to 27, 2016.

Exhibit 4.3: Visual Survey Locations

ID	Coordinates	Elevation (m amsl)	Location	Date of Survey	Direction of Image Center	Rationale
V1	24° 49' 14.0" N 70° 24' 15.1" E	100	Near Jaman Samo	May 14, 2016	Southwest	View of Project site area
V2	24° 49' 29.3" N 70° 23' 04.1"E	139	Bitra	May 13, 2016	Southeast	View of Project site as seen from Bitra (village)
V3	24° 47' 41.1" N 70° 22' 18.6" E	107	Aban Jo Tar	May 13, 2016	Northeast	View of Project site as seen from Aban Jo Tar (village)

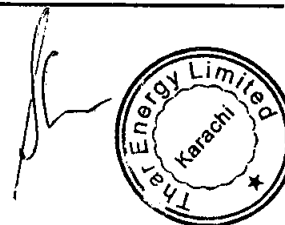


Exhibit 4.4: Visual Sampling Locations

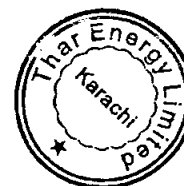
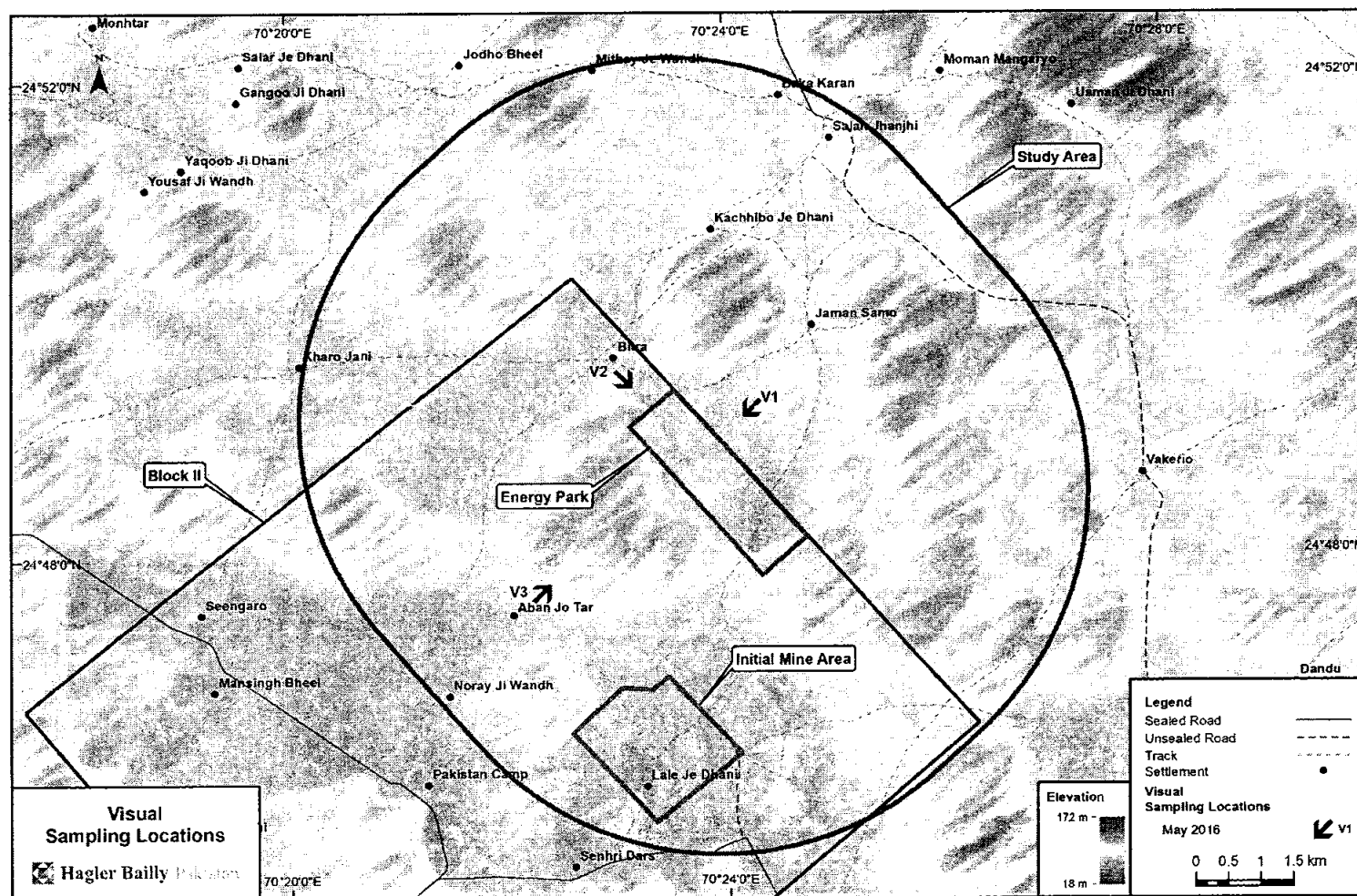
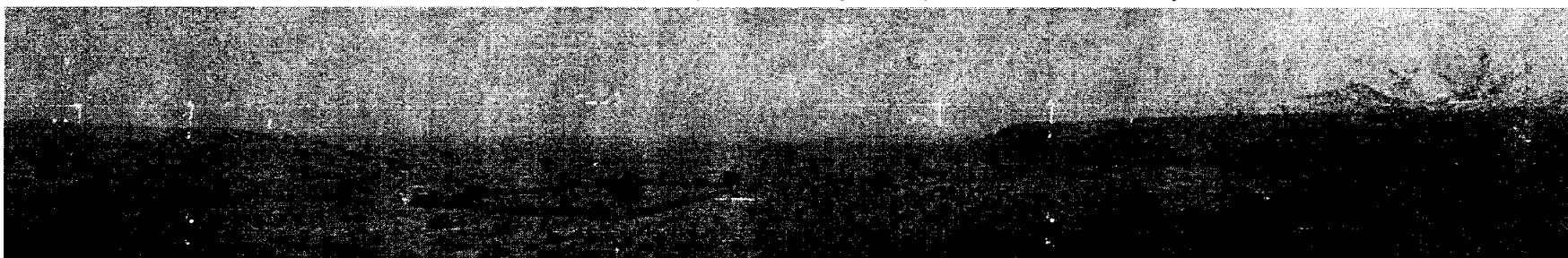


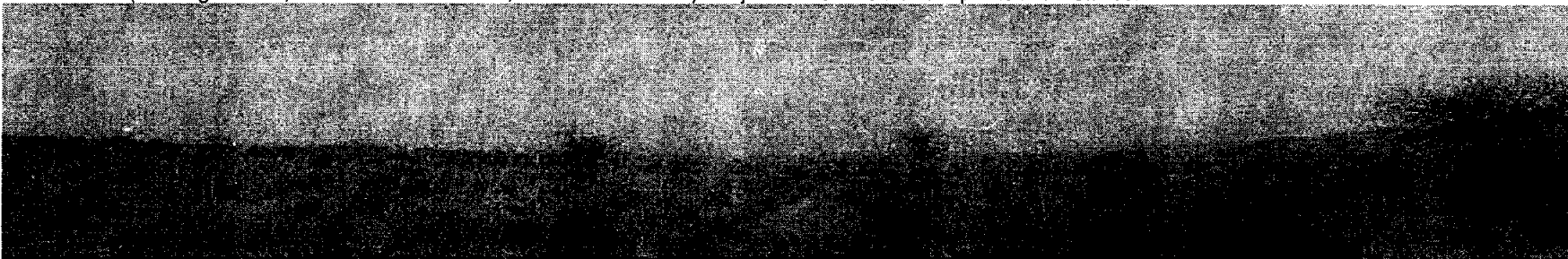
Exhibit 4.5: View of the Project Site from nearby Receptors



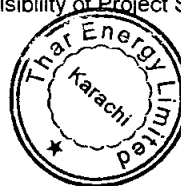
View from V1 (180 degree view, at 100 meters elevation, centered southwest). The undulating landscape and shrubs block visibility to the site.



View from V2 (180 degree view, at 139 meters elevation, centered southeast). Project site is visible on the plains at a distance.



View from V3 (180 degree view, at 107 meters elevation, centered northeast). Dunes block visibility of Project Site from Aban Jo Tar



4.3.3 Geology

The Thar Desert is covered by parabolic sand dunes and intervening playas²¹. A map of the surface geology and the extent of the Thar Coalfields area is shown in **Exhibit 4.6**. The entire surface of the Study Area is covered by aeolian sands of the Quaternary.

Elongate parabolic dunes are dominant within the Study Area, often with small playas within their noses (see **Exhibit 4.7**)²². The entire Study Area is covered by these, with little to no outcrop of rock. The last major phase of extended aeolian accumulation of the higher dunes in Thar occurred about 13,000 years ago²³.



²¹ Playa is a typically desert basin with no outlet which fills with water to form a temporary lake after rainfall.

²² J. Laity, *Deserts and Desert Environments* (Wiley-Blackwell: 2008)

²³ Chawla, S., et al., "Thermoluminescence chronology of sand profiles in the Thar desert and their implications," *Quaternary Science Reviews* 11 (1992), 25–32

Exhibit 4.6: Surface Geology and Extent of Thar Coalfields

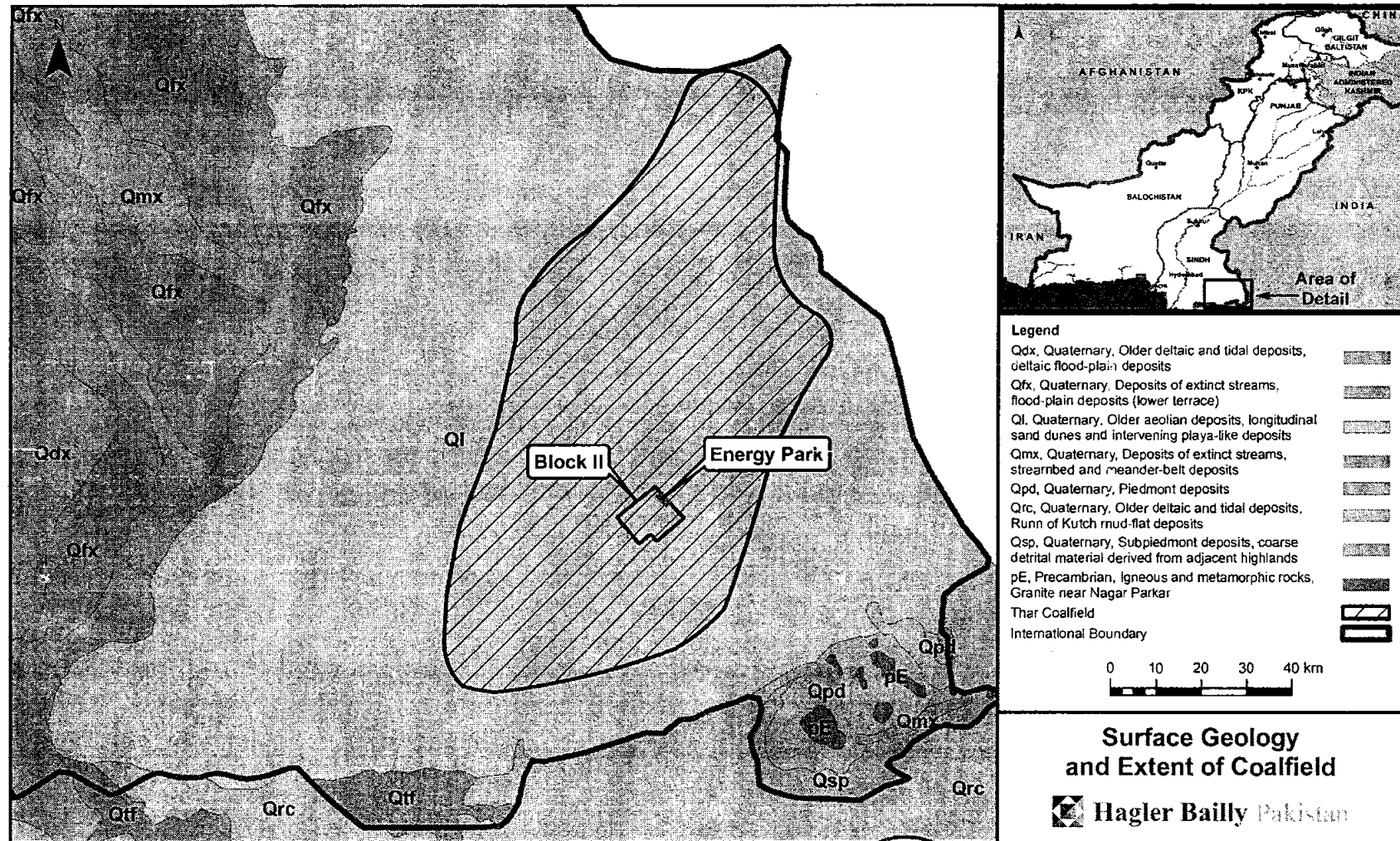
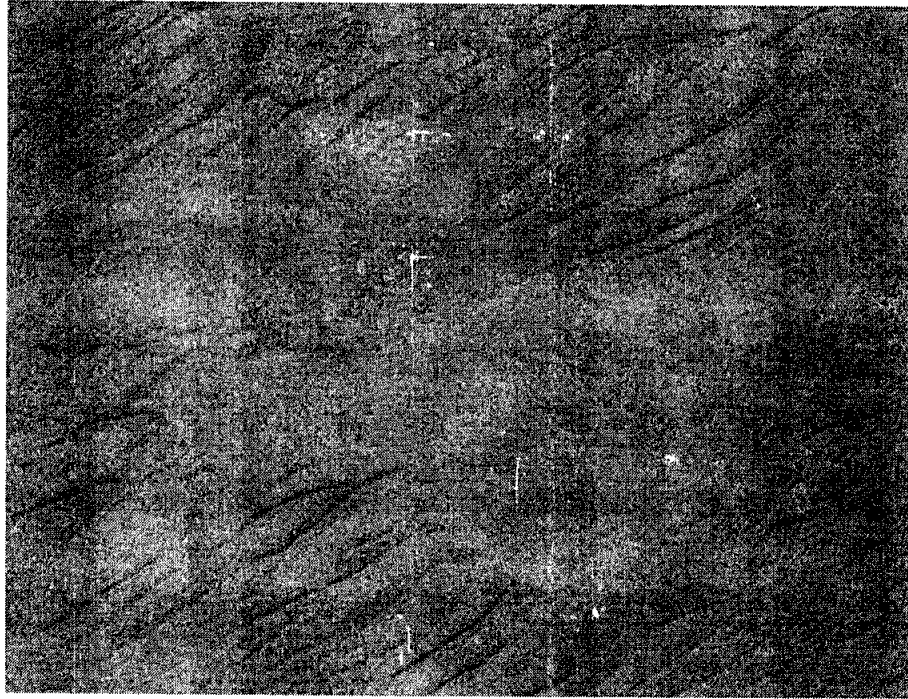


Exhibit 4.7: Characteristic Parabolic Sand Dunes in Study Area²⁴

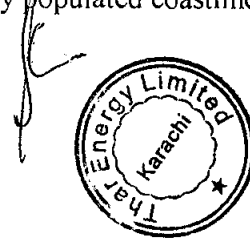


4.3.4 Tectonics, Earthquakes and Tsunamis

The Thar Desert lies at the north-western corner of the Indian Plate. The Study Area is approximately 300 km from the active continental subduction zone faults south-west of Karachi (**Exhibit 4.8**).

Based on the Global Seismic Hazard Map Project (GSHAP), the peak ground acceleration (PGA) of 10% in 50 years is between 1.6 and 2.4 m/s² (**Exhibit 4.9**).

The Rann of Kutch fault extends south of the India-Pakistan border. In 1819 an earthquake of 7.7 to 9.2 on the moment magnitude scale (M_w) and perceived Modified Mercalli Intensity (MMI) scale intensity of XI (extreme) occurred along the fault. This triggered a tsunami causing at over 1,500 deaths along the sparsely populated coastline of Kutch.



²⁴ Google Earth Imagery

Exhibit 4.8: Major Tectonics and Earthquakes of Southern Pakistan

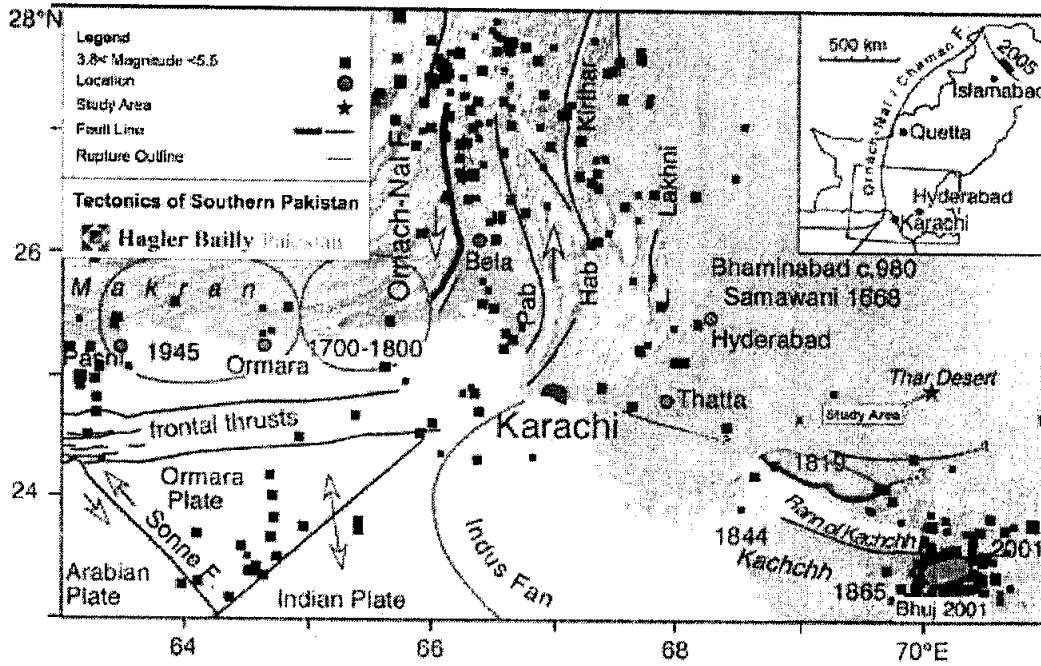
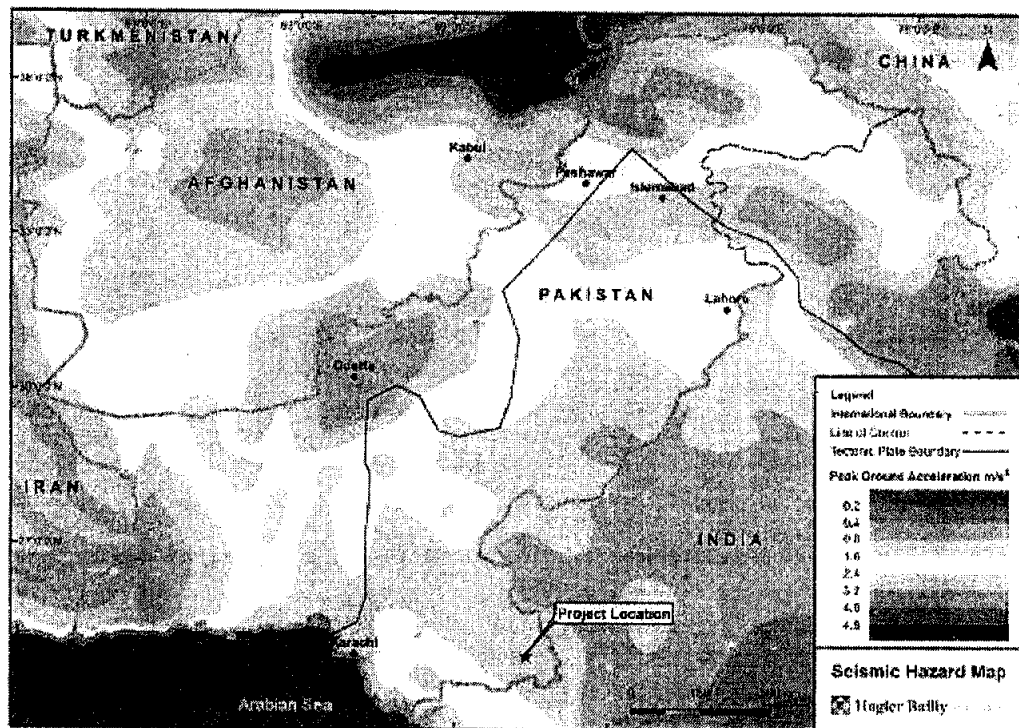


Exhibit 4.9: Seismic Hazard Map of Pakistan²⁵



²⁵ Giardini, D., Grünthal, G., Shedlock, K. M. and Zhang, P.: The GSHAP Global Seismic Hazard Map. *Annali di Geofisica* 42 (6), 1225-1228, 1999.

4.3.5 Climate

A regional climate overview is established using the available data from nearby weather stations. The location of the stations, their distances from the Project site, and other relevant information is presented in **Exhibit 4.10**.

Exhibit 4.10: Summary of Weather Datasets

	<i>Badin</i>	<i>Chor</i>	<i>Mithi</i>	<i>Synthetic</i>
World Meteorological Organization ID	41785	41685	41786	—
Established	1929	1930	2004	—
Coordinates	24° 38' N 68° 54' E	25° 31' N 69° 47' E	24° 45' N 69° 48' E	24°51' N 69°47' E
Distance from Site	155 km east	95 km northwest	64 km east	0 km
Data	1961-1990 (30 years)	1961-1990 (30 years)	2004-2014 (11 years)	2012-2014 (3 years)
Rationale of selection	While these are distant from the Study Area, data are available for 30 years, providing good long-term averages of regional climate, and good for generally verifying other datasets.		Closest Pakistan Meteorological Department operated weather station from Project site, with relatively long term data record.	Synthetic data specific to Block III (relevant to air quality modelling)

The monthly trends in weather parameters obtained from each weather station are tabulated and shown in **Exhibit 4.11** to **Exhibit 4.21**.

Exhibit 4.11: Mean Monthly Temperature Statistics

<i>Month</i>	<i>Badin</i>		<i>Chor</i>		<i>Mithi</i>		<i>Synthetic</i>
	<i>Max (°C)</i>	<i>Min (°C)</i>	<i>Max (°C)</i>	<i>Min (°C)</i>	<i>Max (°C)</i>	<i>Min (°C)</i>	
January	25.8	8.7	26.5	5.4	27.1	5.8	16.4
February	28.6	11.6	29.2	8.7	30.6	9.9	18.8
March	34.0	16.8	34.5	14.3	36.4	16.2	24.1
April	38.4	21.8	39.1	20.1	40.0	21.6	28.5
May	39.8	25.5	41.5	24.5	41.1	25.4	30.9
June	38.0	27.5	39.7	27.2	39.7	27.1	32.1
July	35.1	27.0	36.2	26.8	37.1	26.7	31.7
August	33.6	26.1	34.5	25.7	35.0	25.3	30.1
September	34.4	24.9	35.7	23.9	35.8	24.3	29.7



Month	Badin		Chor		Mithi		Synthetic
	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Max (°C)	Min (°C)	Average (°C)
October	35.8	21.7	37.1	18.5	37.5	19.7	27.8
November	31.9	15.9	33.0	11.9	34.2	13.0	22.8
December	26.7	10.1	27.9	6.6	28.9	7.2	17.8

Exhibit 4.12: Monthly Temperature Profile

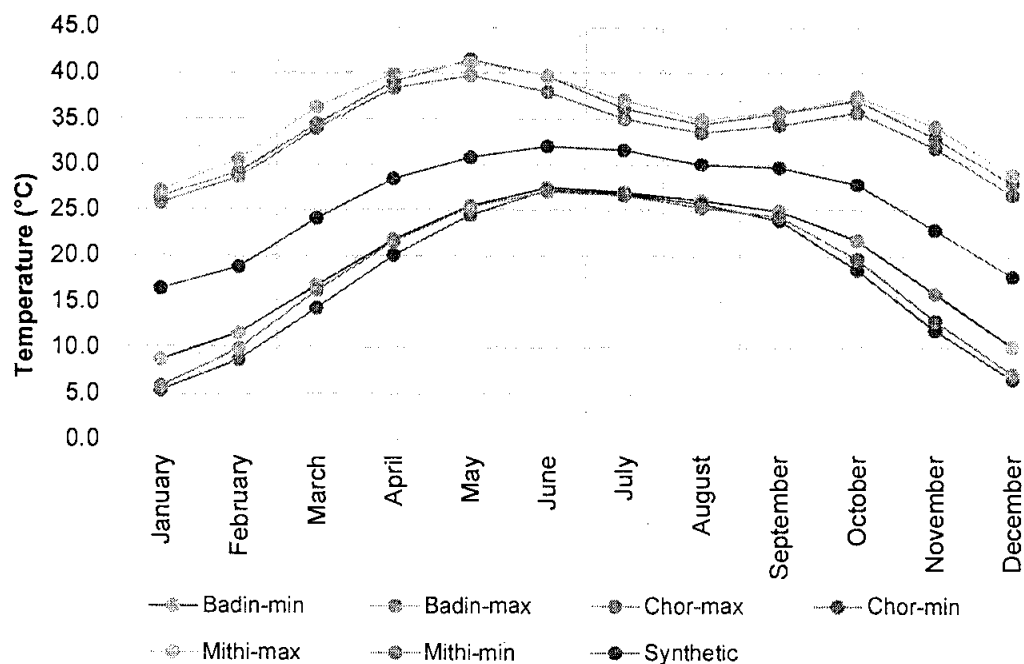
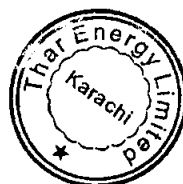


Exhibit 4.13: Mean Monthly Relative Humidity

Month	Badin		Chor		Mithi		Synthetic	
	(%)		(%)		(%)		(%)	
	5 AM	5 PM	5 AM	5 PM	5 AM	5 PM	5 AM	5 PM
January	73	31	71	27	70	27	57	32
February	71	28	71	27	69	21	59	29
March	77	25	70	23	71	18	67	26
April	79	25	72	21	74	19	85	25
May	80	33	78	25	77	29	93	22
June	80	47	81	40	78	40	91	30
July	84	59	84	56	80	49	92	34
August	85	63	86	59	84	56	93	36
September	87	55	87	49	83	50	89	32



Month	Badin		Chor		Mithi		Synthetic	
	(%)		(%)		(%)		(%)	
	5 AM	5 PM	5 AM	5 PM	5 AM	5 PM	5 AM	5 PM
October	84	38	79	33	75	27	63	25
November	77	35	72	30	69	25	59	32
December	74	34	72	30	70	24	59	35



Exhibit 4.14: Mean Monthly Relative Humidity

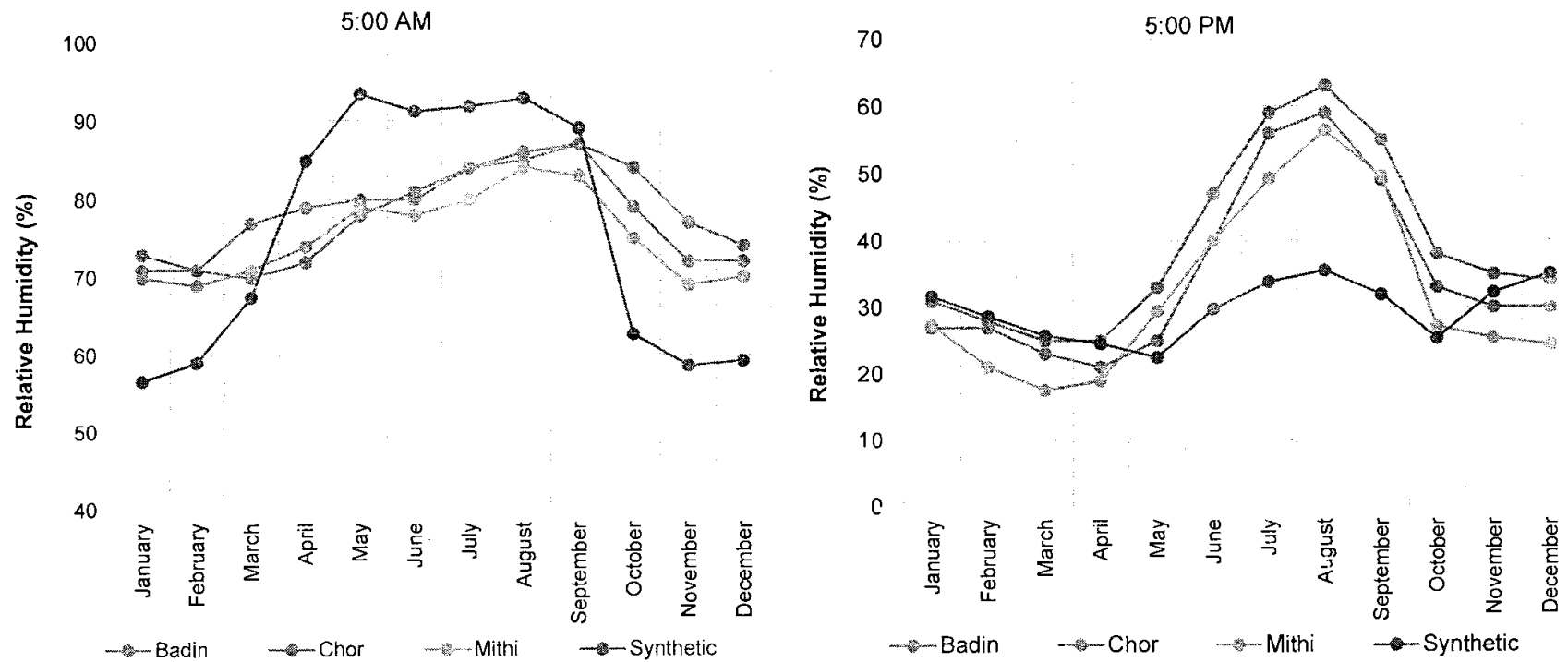
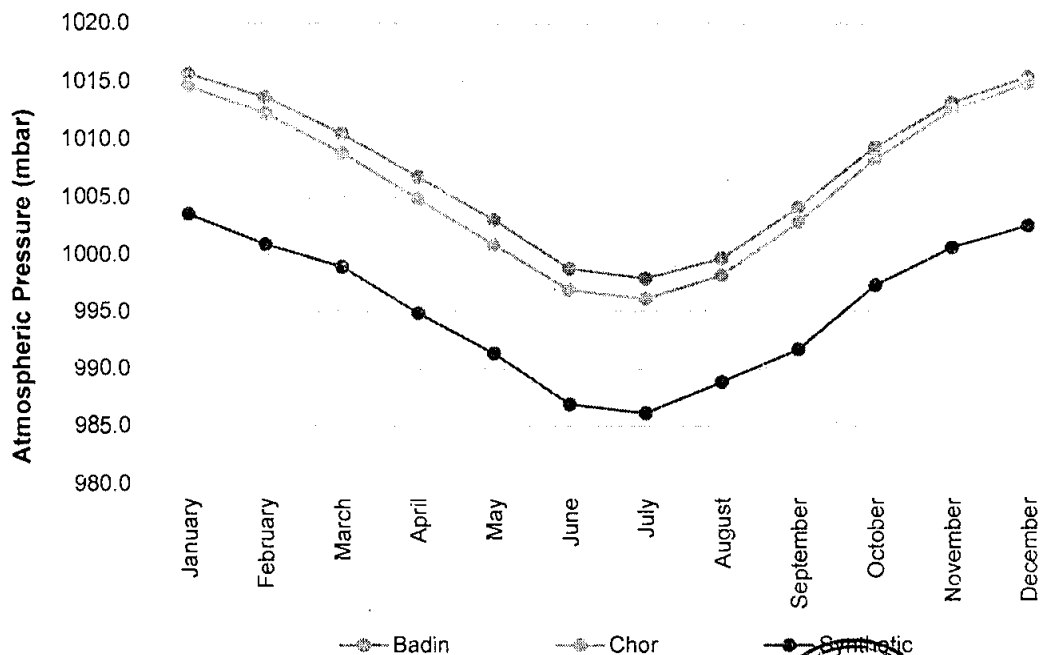


Exhibit 4.15: Mean Monthly Atmospheric Pressure

Month	Badin (mbar)	Chor (mbar)	Mithi ²⁶ (mbar)	Synthetic (mbar)
January	1015.65	1014.60	—	1003.57
February	1013.65	1012.25	—	1000.94
March	1010.50	1008.85	—	998.97
April	1006.75	1004.90	—	994.89
May	1003.10	1000.90	—	991.35
June	998.80	996.90	—	986.90
July	997.95	996.15	—	986.14
August	999.70	998.20	—	988.86
September	1004.20	1002.90	—	991.71
October	1009.35	1008.30	—	997.35
November	1013.20	1012.50	—	1000.68
December	1015.45	1014.90	—	1002.64

Exhibit 4.16: Mean Monthly Atmospheric Pressure



²⁶ Mithi Station atmospheric pressure data was not available.

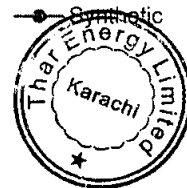
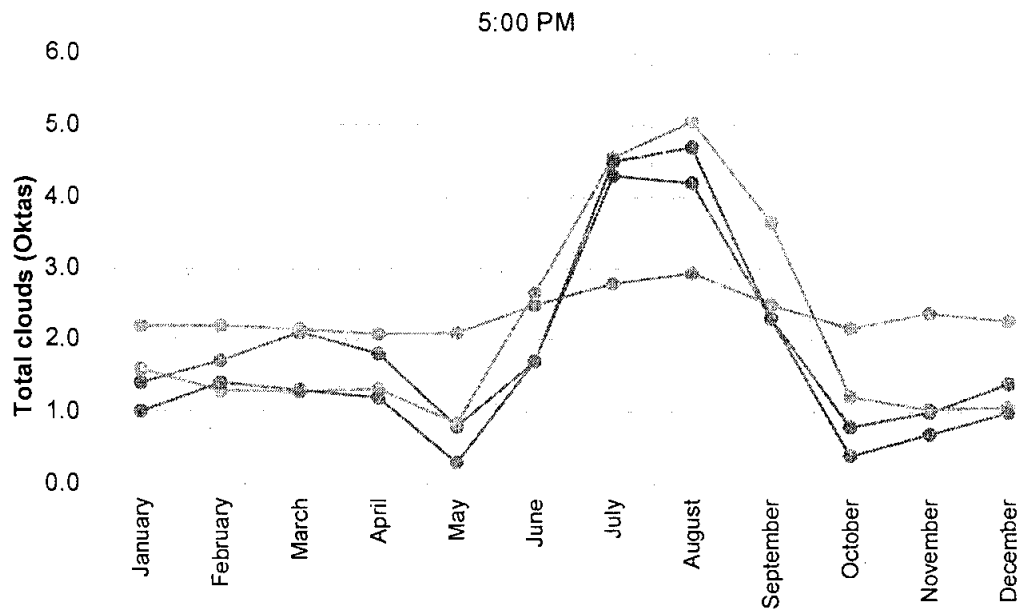


Exhibit 4.17: Mean Monthly Total Clouds Cover

Month	Badin (Oktas)		Cho (Oktas)		Mithi (Oktas)		Synthetic (Oktas)	
	5 AM	5 PM	5 AM	5 PM	5 AM	5 PM	5 AM	5 PM
January	0.5	1.0	0.8	1.4	—	1.6	2.2	2.2
February	0.8	1.4	1.0	1.7	—	1.3	2.1	2.2
March	0.7	1.3	1.1	2.1	—	1.3	2.1	2.1
April	0.8	1.2	1.1	1.8	—	1.3	2.1	2.1
May	1.1	0.3	1.1	0.8	—	0.8	2.0	2.1
June	1.9	1.7	2.3	1.7	—	2.7	2.1	2.5
July	3.7	4.5	3.9	4.3	—	4.6	2.4	2.8
August	3.6	4.7	3.7	4.2	—	5.1	2.6	2.9
September	1.4	2.3	1.6	2.3	—	3.7	2.4	2.5
October	0.8	0.4	0.6	0.8	—	1.2	2.1	2.2
November	0.4	0.7	0.4	1.0	—	1.0	2.2	2.4
December	0.5	1.0	0.7	1.4	—	1.1	2.2	2.3

Note: "—" indicates that data was not available

Exhibit 4.18: Mean Monthly Total Clouds Cover



—●— Chor —●— Synthetic —●— Mithi —●— Badin

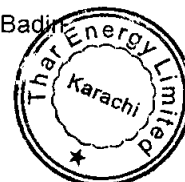
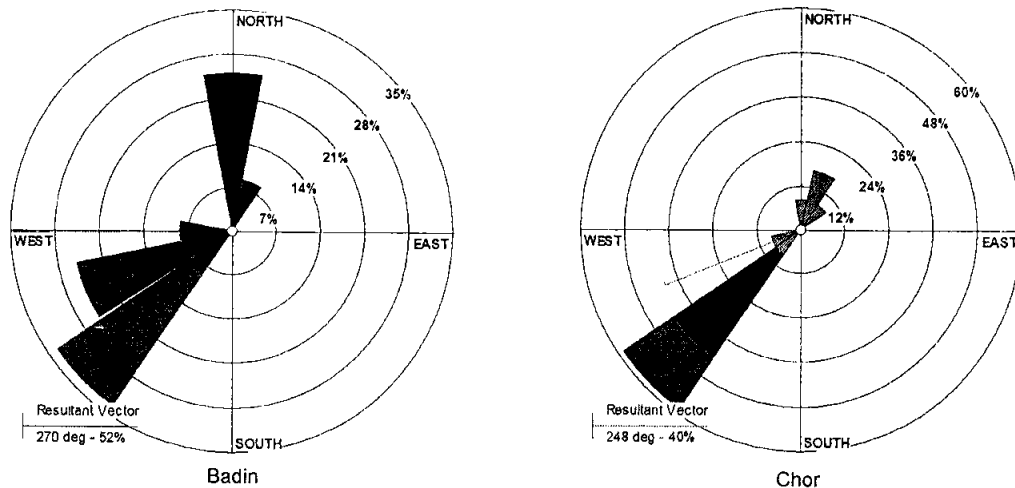


Exhibit 4.19: Mean Monthly Wind Speed and Wind Direction

Month	Badin		Chor		Mithi*		Synthetic	
	WS (knots)	WD (degree)	WS (knots)	WD (degree)	WS (knots)	WD (degree)	WS (knots)	WD (degree)
January	4.20	9	2.60	21	6.10	281	5.73	185
February	4.90	349	2.80	2	6.47	311	6.25	351
March	6.00	273	3.70	248	6.75	251	5.45	283
April	9.10	254	6.10	228	9.45	224	7.13	264
May	13.00	244	10.30	224	14.21	234	9.30	239
June	12.00	229	9.70	221	13.14	231	9.89	221
July	11.50	231	9.00	222	11.89	231	9.10	229
August	11.10	233	7.30	222	9.48	224	8.34	238
September	9.50	234	4.40	222	7.18	206	7.43	242
October	5.10	257	2.60	220	4.87	251	4.68	319
November	4.50	357	2.00	34	3.62	276	4.47	354
December	3.80	14	2.00	31	5.13	284	6.01	180

* The readings were taken at 5:00 pm

Exhibit 4.20: Wind Rose



[Signature]

Thar Energy Limited
Karachi

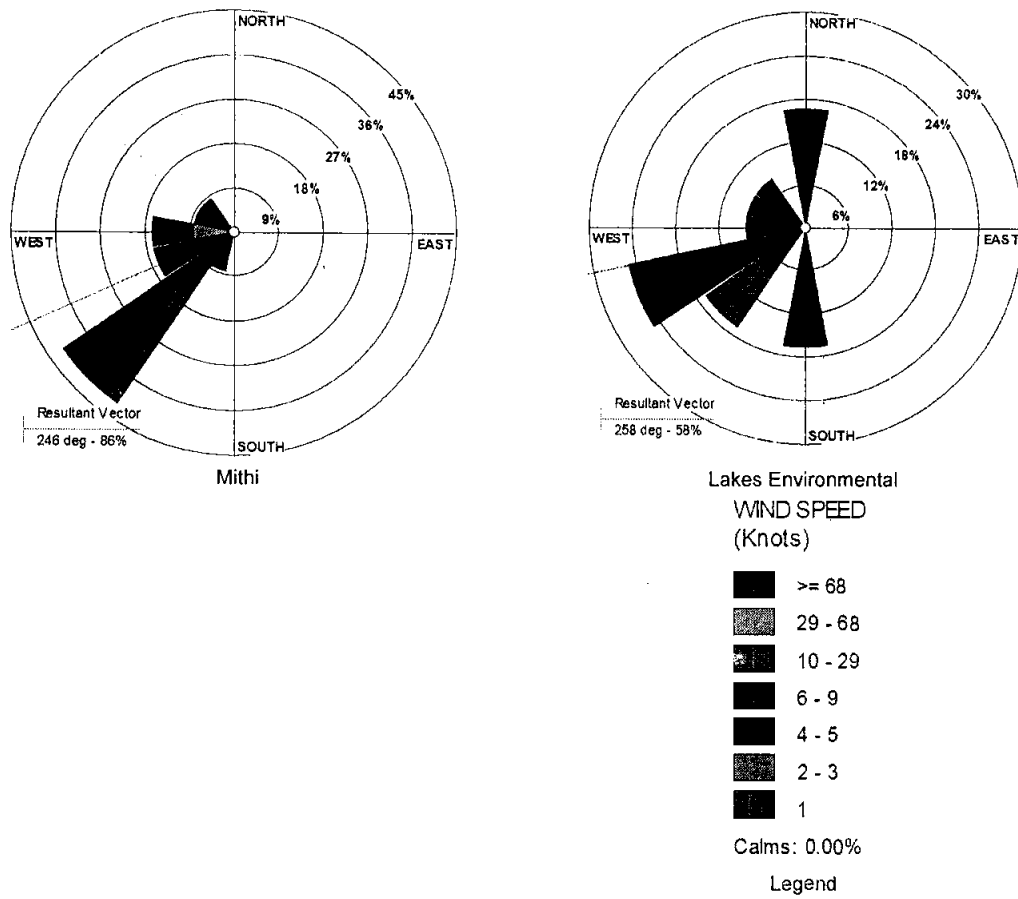


Exhibit 4.21: Mean Monthly Precipitation

Month	Badin	Chor	Mithi	Synthetic
January	1.0	0.6	1.3	0.0
February	3.6	2.0	2.5	3.5
March	2.3	4.5	2.2	4.3
April	2.5	3.5	3.0	13.7
May	0.7	3.0	1.8	24.7
June	10.8	19.7	22.1	78.3
July	70.5	79.0	58.6	45.7
August	89.9	74.5	162.0	64.3
September	34.4	22.9	129.5	98.7
October	3.7	2.1	14.0	10.7
November	1.7	3.6	3.0	1.7
December	1.1	0.9	1.0	0.0
Annually	222	216	398.5	345

Analysis

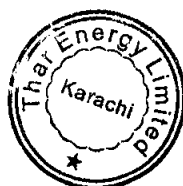
The calendar season's spring, summer, autumn and winter cannot be used to characterize the climate in the Study Area. This is because the Study Area has mild winters and there is consistency of temperatures between the rest of the seasons. Considering the climate data presented above, the seasons in the Study Area are classified as:

- ⑤ **Summer** (mid-March to mid-June): Characterized by high temperatures, moderate rainfalls with moderate atmospheric humidity and high speed-winds that blow from southwest towards northeast.
- ⑤ **Summer Monsoon** (mid-June to mid-September): The summer Monsoon, hereafter referred to as the Monsoon, is characterized by high temperatures (milder than summers), high rainfalls with high atmospheric humidity and moderate speed-winds.
- ⑤ **Post-Monsoon Summer** (mid-September to mid-November): Characterized by moderately high temperatures, low rainfalls and low speed-winds blowing from southwest towards northeast.
- ⑤ **Winter** (mid-November to mid-March): Characterized by moderate temperatures, dry conditions with low atmospheric humidity and a reduction in wind speeds blowing from northwest to southeast.

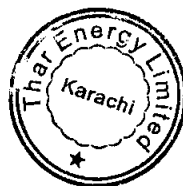
Season wise descriptions of the climate in the Study Area based on the data from the Mithi weather station are presented in **Exhibit 4.22**.

Exhibit 4.22: Summary Data for Study Area (based on Mithi Station)

Parameter Group	Statistic	Season	Value or Description
Temperature	Maximum	Summer	41°C
		Summer Monsoon	40°C
		Post-Monsoon Summer	38°C
		Winter	34°C
	Mean	Summer	31°C
		Summer Monsoon	31°C
		Post-Monsoon Summer	27°C
		Winter	20°C
	Minimum	Summer	16°C
		Summer Monsoon	24°C
		Post-Monsoon Summer	13°C
		Winter	6°C
Relative Humidity	5 am (Mean)	Summer	76 %
		Summer Monsoon	81 %
		Post-Monsoon Summer	76 %



Parameter Group	Statistic	Season	Value or Description
	5 pm (Mean)	Winter	70 %
		Summer	27%
		Summer Monsoon	49 %
		Post-Monsoon Summer	34 %
		Winter	25 %
Precipitation	Median (monthly)	Summer	3 mm
		Summer Monsoon	94 mm
		Post-Monsoon Summer	14 mm
		Winter	2 mm
Cloud Cover	Mean (monthly)	Summer	2 oktas
		Summer Monsoon	4 oktas
		Post-Monsoon Summer	2 oktas
		Winter	1 oktas
Wind Speed	Mean (monthly)	Summer	11 knots
		Summer Monsoon	10 knots
		Post-Monsoon Summer	6 knots
		Winter	5 knots
Wind Direction	Monthly Average	Summer	Southwest to northeast
		Summer Monsoon	Southwest to northeast
		Post-Monsoon Summer	Southwest to northeast
		Winter	Northwest to southeast
Extremes	Dry months in year	-	December and January
	Recent droughts	-	Recently declared drought years include 2013 and 2014. The associated annual rainfall at Mithi during these years was 190 mm and 207 mm respectively.
	Wettest month in year	-	August
	Recent high intensity rainfall and flooding.	-	High rainfall intensities in 2010, 2011 and 2015 were associated with flooding in the Thar region. The associated annual rainfall is also higher in these years. Flooding caused damage in the Study Area in 2015.



Weather Extremes

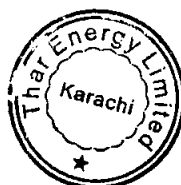
Extreme weather events at the Badin and Chor are given in **Exhibit 4.23** and **Exhibit 4.24**.

Exhibit 4.23: Extreme Temperature Events at Badin and Chor (°C)

	Highest Recorded				Lowest Recorded			
	Badin		Chor		Badin		Chor	
	Value	Date	Value	Date	Value	Date	Val	Date
January	36.1	15/1965	36	27/1932	-2	15/1935	-2.8	12/1967
February	40	26/1943	42	14/1934	1	8/1974	-2	5/1980
March	44	28/1945	43.5	31/1984	5	(4)/1979	-1.6	5/1984
April	46	18/1949	49	28/1983	11	2/1945	9	15/1955
May	49.4	22/1962	51	24/1932	17.5	5/1989	11.8	25/1989
June	49	15/1947	48.1	11/1988	21.1	20/1967	20	7/1976
July	44	2/1958	45.9	19/1989	22	31/1948	19.5	16/1987
August	44	5/1957	43	11/1981	22	13/1956	21	25/1932
September	44	30/1951	44	23/1981	20	10/1960	17.8	27/1972
October	43	4/1951	44	4/1941	9	30/1949	8.9	28/1964
November	40	2/1951	40	3/1977	4	29/1938	1.1	28/1966
December	35.6	1/1968	36	7/1934	2.5	14/1986	-1.7	11/1964

Exhibit 4.24: Extreme Precipitation Events at Badin and Chor (mm)

	Badin				Chor			
	1931-1960		1961-1990		1931-1960		1961-1990	
	Value	Date	Value	Date	Value	Date	Value	Date
January	21.8	8/1945	13.3	14/1976	7.6	29/1935	4.6	9/1968
February	23.6	2/1940	58	27/1990	17.5	2/1940	14.5	1/1961
March	37.8	10/1960	11.2	7/1970	15.5	24/1933	61	6/1970
April	33	7/1957	21	14/1983	6.6	19/1959	57.4	10/1961
May	50.5	1/1933	15.7	31/1985	20.3	19/1957	21.1	29/1977
June	47.5	26/1934	55.7	1/1985	41.7	26/1956	97.6	2/1985
July	249.4	1/1936	111.5	25/1967	114.3	23/1937	119.9	1/1983
August	105.9	12/1933	241	13/1979	61.7	1/1931	214.6	7/1990
September	115.6	7/1954	159.3	3/1990	76.2	6/1959	80	2/1990
October	8.9	14/1959	3.4	17/1963	26.7	2/1956	22.2	3/1975
November	25.1	16/1936	21.2	12/1978	22.6	15/1936	38.6	3/1981
December	17	30/1937	15	22/1980	12.9	6/1956	15	12/1967



4.3.6 Air Quality

The objective of the air quality baseline was to collect data on air quality in the airshed, particularly the area likely to be affected by the Project.

The air quality baseline specifically assess the concentration of pollutants in the ambient air without the Project. The Project is assumed to become operational in 3 to 4 years. Other developments, such as the Block II and Block VI mines, are planned around the Project and are also likely to affect air quality. Therefore, the concentration of pollutants in the ambient air in, say, 2020 when the Project comes in operation, is likely to be different from the concentration at present.

The air quality baseline was developed using measured concentration and modeled concentration. The modeled concentration shows the expected impact of the proposed developments around the Project. The concentrations were modeled using air emission modelling.

The pollutants selected for evaluation, based on the expected emissions from the planned operations and the level of risk to human health posed by these pollutants, are as follows:

- ☞ Sulfur dioxide (SO₂)
- ☞ Nitrogen dioxide (NO₂)
- ☞ Particulate matter (PM₁₀ and PM_{2.5})

Measured Baseline

The measured air quality baseline was developed using both primary and secondary data on ambient air quality in the Project area.

Primary Data

Air quality sampling was carried out at four different locations in the Study Area from May 24th to 31st, 2016. As the results from the literature indicate low concentrations of SO₂ and NO₂. This low concentration was expected, as there were no major sources of these pollutants in the area other than cook stoves in villages that use wood as a fuel. However, previous sampling also indicates high concentrations of particulate matter (PM₁₀ and PM_{2.5}). This was largely due to the desert environment of the area that results in naturally high dust concentrations. Therefore, sampling for this study focused only on sampling particulate matter.

A description of sampling locations and the rationale of selection is given in **Exhibit 4.25**.

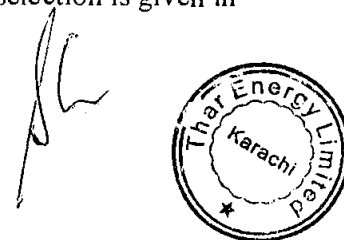


Exhibit 4.25: Air Quality Sampling Locations and Rationale of Selection

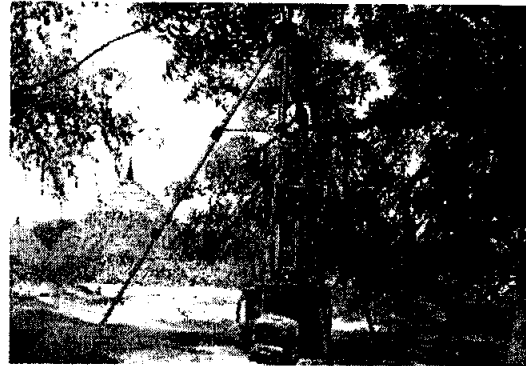
Sample ID	Coordinates	Location	Rationale
A1	24° 45' 55.3" N 70° 23' 08.8" E	Lale Je Dhani	Engro activities influenced zone
A2	24° 48' 42.3" N 70° 28' 00.2" E	Vakerio	Receptor (large village) downwind of site
A3	24° 49' 58.3" N 70° 24' 46.1" E	Jaman Samo	Receptor (village) downwind of site
A4	24° 45' 15.1" N 70° 21' 43.9" E	Thahriyo Halipota	Receptor (village) on transport route

At each location, PM₁₀ and PM_{2.5} were sampled using a low volume sampler for 24 hours. Lab analysis was performed at the HBP Laboratory in Islamabad. Photographs of the particulate matter sampling sites are shown in **Exhibit 4.26**.

Exhibit 4.26: Particulate Matter Sampling Site Photographs



Low Volume Samplers at A1



Low Volume Samplers at A2



Low Volume Samplers at A3



Low Volume Samplers at A4

Handwritten signature and circular stamp of Thar Energy Limited, Karachi.

Secondary Data

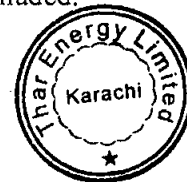
Additional data on ambient air quality in the Project area, available from previous EIAs conducted near the Study Area, is summarized in **Exhibit 4.27**. The current and previous sampling locations are shown in **Exhibit 4.28**.

Exhibit 4.27: Air Quality Sampling Locations in Literature

Sample ID	Coordinates	Dates of Survey	Description	Source
THMA1	24°44' 14.56" N 70°13' 14.32" E	May, June, July 2010	Mehari Bajeer	ESIA of Block II coal mine ²⁷
THMA2	24°51' 47.63" N 70°24' 54.39" E	May, June, July 2010	Salah Jhanjhi	
THMA3	24°46' 11.39" N 70°21' 23.94" E	May, June, July 2010	Pakistan Camp	
THMA4	24°45' 08.94" N 70°21' 25.76" E	May, June, July 2010	Thario Halepota	
TCOA1	24°49' 12.19" N 70°17' 08.83" E	May, June 2012	Ranjho Noon	ESIA of Block VI coal mine. (Oracle Coalfields Limited) ²⁸
TCOA2	24°53' 51.32" N 70°19' 04.57" E	May, June 2012	Meghay Jo Tar	
TCOA3	24°51' 21.78" N 70°24' 45.21" E	May, June 2012	Salah Jhanjhi	
SSRA1	24°39' 22.51" N 70°19' 01.10" E	November, 2011	Open Field Tilwai	ESIA of Block I coal mine) ²⁹
SSRA2	24°40' 48.48" N 70°17' 56.62" E	November, 2011	Open Field Varvai	
SSRA3	24°40' 11.39" N 70°22' 01.06" E	November, 2011	Open Field Khario Ghulam Shah	

Results and Analysis

The results of the current sampling along with the results from literature are tabulated in **Exhibit 4.29**. The results were compared against Sindh Environmental Quality Standards (SEQS) and IFC EHS guidelines. Results that exceed SEQS are shaded.



²⁷ Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project. Prepared for Sindh Engro Coal Mining Company

²⁸ Hagler Bailly Pakistan, April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

²⁹ Environmental Management Consultants (EMC), May 2012, Environmental Impact Assessment of Thar Coal Mining Project, Sinhar Vikian Varvai, Block 1 for Sino-Sindh Resources

Exhibit 4.28: Air Quality Sampling Locations

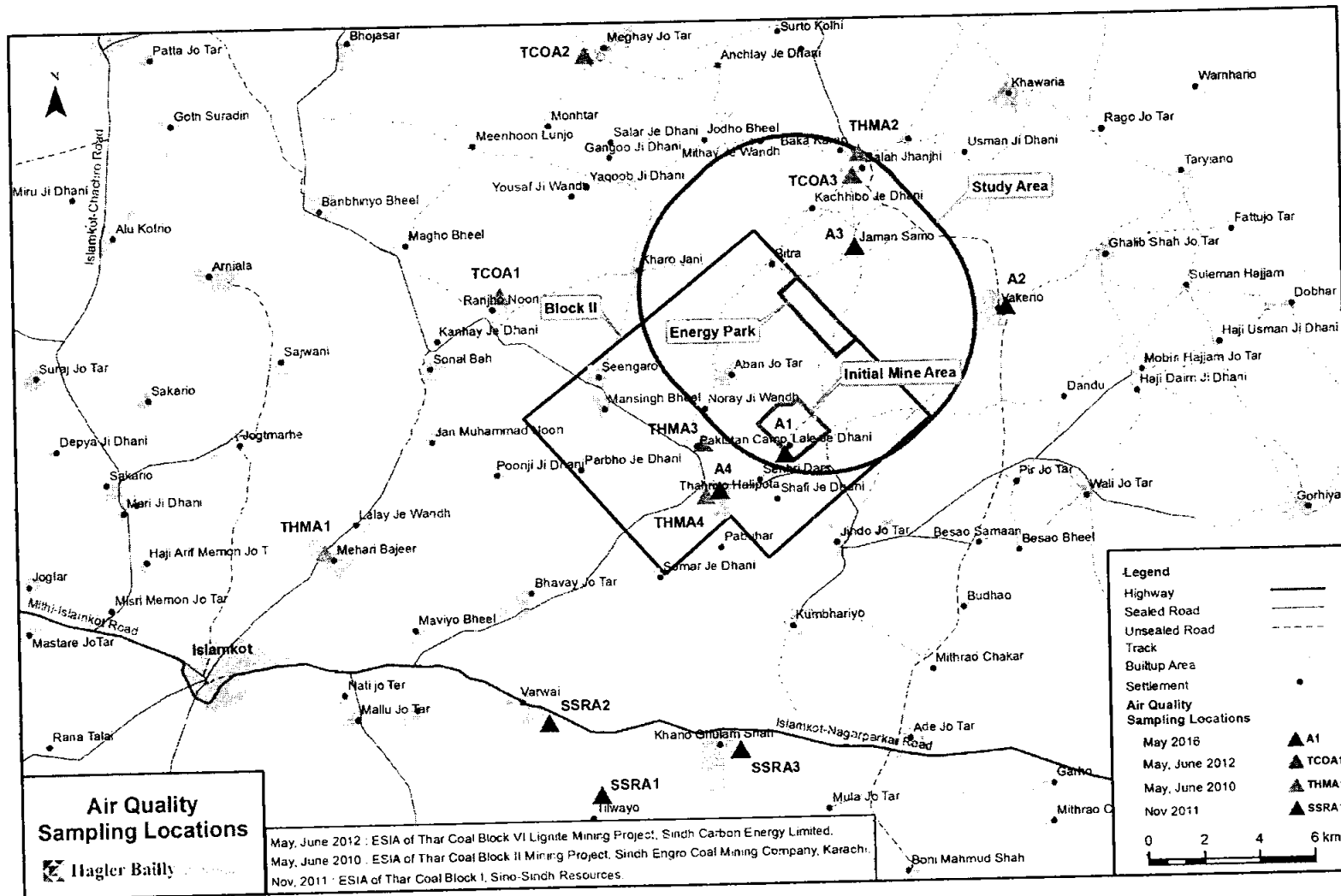


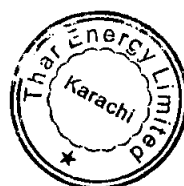
Exhibit 4.29: Results of Current and Previous Sampling ($\mu\text{g}/\text{m}^3$)

Sample ID	Date	NO ₂	SO ₂	PM ₁₀	PM _{2.5}
A1	May, 2016	—	—	114.3	63.5
A2		—	—	109.3	68.3
A3		—	—	104.7	52.4
A4		—	—	84.6	36.3
THMA1	May, 2011	6.98	12.40	—	—
THMA2		4.65	9.14	—	—
THMA3		2.39	4.49	—	—
THMA4		3.23	NA	—	—
THMA1	June, 2011	2.95	5.83	138.9	13.9
THMA2		3.36	8.39	180.7	27.8
THMA3		2.81	2.18	166.7	27.8
THMA4		2.22	3.37	222.2	55.6
TCOA1	June, 2012	—	3.2	333	112
TCOA2		—	2.1	776	129
TCOA3		—	9.0	406	98
THMA1	July, 2011	3.31	2.99	83.3	13.9
THMA2		4.56	6.77	97.2	13.9
THMA3		2.66	8.12	97.2	13.9
THMA4		2.88	1.6	111.1	27.8
SSRA1	Nov, 2011	16.1	27.0	140.6	20.8
SSRA2		5.8	10.1	228.0	34.2
SSRA3		6.7	11.2	205.6	30.8
Median Value		3.3	7.4	139.8	32.5
SEQS (annual)		40	80	120	40
SEQS (24-hour)		80	120	150	75
IFC EHS (annual)		40	—	70	35
IFC EHS (24-hour)		—	125	150	75

Note: — means the data was not available

From the measured values the following conclusions can be drawn:

- The median value of SO₂ concentration is 7.4 $\mu\text{g}/\text{m}^3$ which complies with SEQs (24 hour and annual) and is within IFC EHS guideline limits. The maximum recorded SO₂ in the area is 27.0 $\mu\text{g}/\text{m}^3$ which is also well below the SEQs and IFC EHS limits.
- The median value of NO₂ concentration is 3.3 $\mu\text{g}/\text{m}^3$ which complies with SEQs (24 hour and annual) and is within IFC EHS guideline limits. The maximum recorded NO₂ in the area is 16.1 $\mu\text{g}/\text{m}^3$ which is also well below the SEQs and IFC EHS limits.
- The median value of PM₁₀ and PM_{2.5} concentrations are 139.8 $\mu\text{g}/\text{m}^3$ and 32.5 $\mu\text{g}/\text{m}^3$ respectively. The PM_{2.5} concentration complies with SEQs (24 hour and annual) and is within IFC EHS guideline limits. The median value of PM₁₀ concentrations exceeds the annual limit but is within the 24-hour limits of the SEQs and the IFC EHS guideline values. PM₁₀ concentrations from previous



sampling exceeds the standards at 8 out of 14 locations. PM_{2.5} concentrations from previous sampling exceeds the standards at 3 out of 14 locations. PM₁₀ and PM_{2.5} concentrations from current sampling complies with the standards. Their concentrations are very high due to the natural background influence of the desert environment. Human sources of particulate matter (PM) include the use of wood as fuel and vehicular traffic on unpaved roads and dirt tracks. In this study the highest PM readings were recorded at A1 (Lale Je Dhani) and A2 (Vakerio).

Based on the above exercise, **Exhibit 4.30** presents the current pollutant levels of the Study Area that are established based on the rounded median of the measured results. These values are used for development of the modelled cumulative baseline. The error bars are of one standard deviation.

Exhibit 4.30: Baseline Ambient Air Quality in the Study Area ($\mu\text{g}/\text{m}^3$)

	NO ₂	SO ₂	PM ₁₀	PM _{2.5}
Baseline Levels	3 ± 3	7 ± 6	140 ± 93 ³⁰	30 ± 40
SEQS (annual)	40	80	120	40
SEQS (24-hour)	80	120	150	75
IFC EHS (annual)	40	-	70 ^a	35
IFC EHS (24-hour)	-	125	150	75

Even though the standard deviation of NO₂ and SO₂ is large the level of these pollutants are much lower than SEQs and IFC EHS limits. However, the PM readings are both high, but also have high variation, due the intense variation in background levels depending on the season.

Modeled Baseline

Expected activities near the Study Area, that may influence the air quality baseline of the Project are summarized in **Exhibit 4.31** and locations shown in **Exhibit 4.32**

Exhibit 4.31: Approved Developments near Study Area

Block No.	Coal Mine	Power Plant	Source
Block II	up to 22 mtpa	2x330 MW	ESIA of Block II Mining Project ³¹ ESIA of Block II Power Plant Project ³²
Block VI	2.5 mtpa	-	ESIA of Block VI Mining Project ³³

³⁰The reading of 780 $\mu\text{g}/\text{m}^3$ is removed as it was 5 times the median value and is likely a low occurring outlier.

³¹ Hagler Bailly Pakistan, February 2011, Environmental and Social Study of Thar Coal Block II Mining Project for Sindh Engro Coal Mining Company.

³² Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

³³ Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

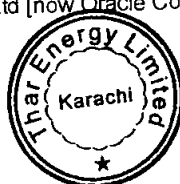
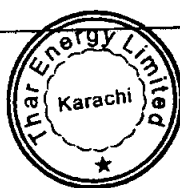
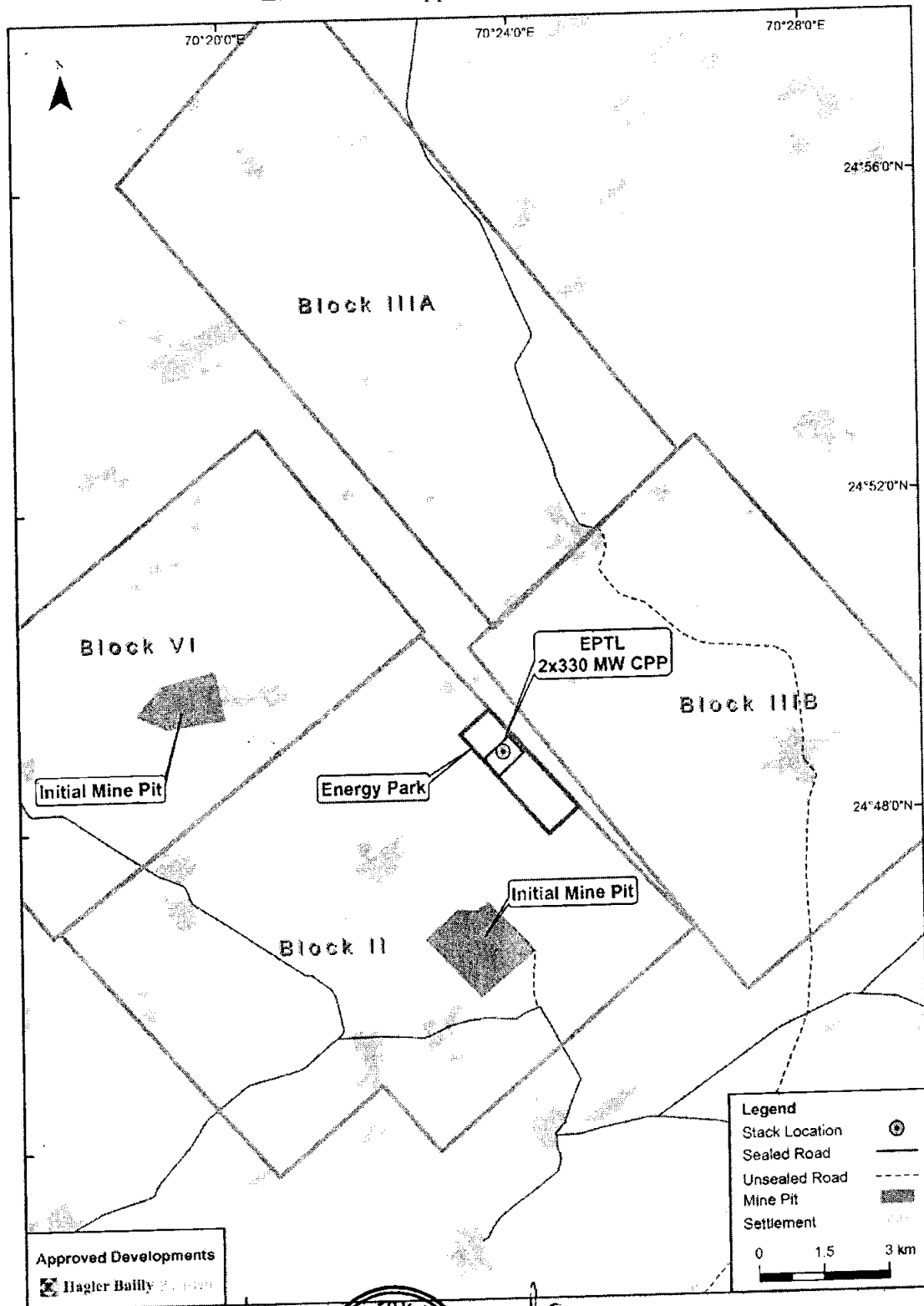


Exhibit 4.32: Approved Developments



Modelling Area

The modeling area was defined as circle of radius 15 km centered at the center of the Energy Park. The area was taken considering the distance of receptors and expected impact of the Project. As Block I is farther than 15 km it was not included in the modelling exercise.

Model Details

These activities were modeled using USEPA approved regulatory model AERMOD. AERMOD provides predicted pollutant concentrations for hourly, daily, monthly, and yearly averaging periods, and complies with the USEPA's guidelines on air quality models. Weather data from the Mithi weather station from 2012-2014 was used.

Modeling Approach

There is a large variability in the natural dust concentrations. This can be observed from the large standard deviation in the particulate matter readings. This could be due to the following reasons:

- Seasonal influence such as the monsoons, that result in large amounts of greenery in the Thar Desert which suppress dust emissions to dry and windy dust storms that result in large dust emissions.
- Location of measurement with reference to sand dunes, which can both shade receptors from the wind but are also a source of dust emissions depending on whether the receptor location is upwind or downwind of the dune.

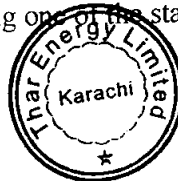
This natural spatial and temporal variability is not captured in the average value of $140 \mu\text{g}/\text{m}^3$ for PM_{10} and $30 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$.

Initial modelling using AP-42 methodology shows that under unmitigated mining operation, areas within 3 to 5 km of the active coal mine and waste dump will be dominated by the dust emissions from the mining activity. The mining activity is not included further in this assessment.

The EPTL power plant is modelled based on the parameters given in the ESIA of the project.

Combined Baseline

The measured baseline was added to the modelled results to uniformly elevate the current modelled concentrations. It should be noted that the existing pollutant concentrations are not uniform and this is a simplifying assumption. Contour maps for dispersion of SO_2 and NO_x are presented in **Exhibit 4.33** to **Exhibit 4.40**. The measured and modeled results are compiled in **Exhibit 4.41**. The results were compared against SEQS and IFC EHS limits and the values exceeding one of the standards are shaded.



A handwritten signature in black ink, appearing to be a stylized "K" or similar character.

Exhibit 4.33: Baseline SO₂ Concentration (Annual)

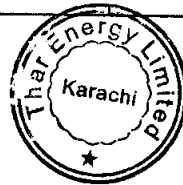
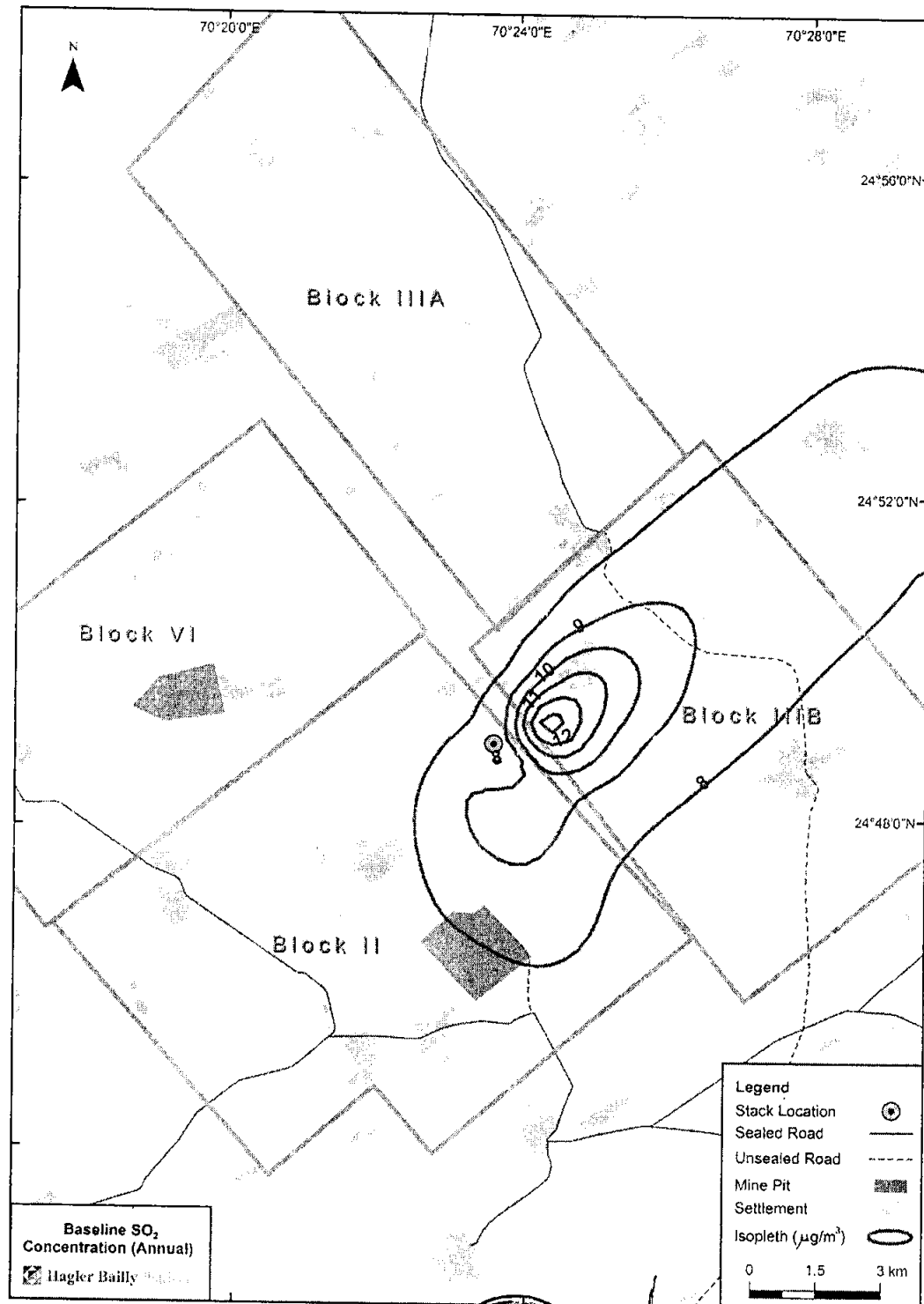


Exhibit 4.34: Baseline SO₂ Concentration (24 hour)

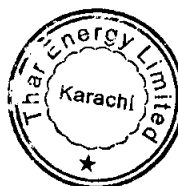
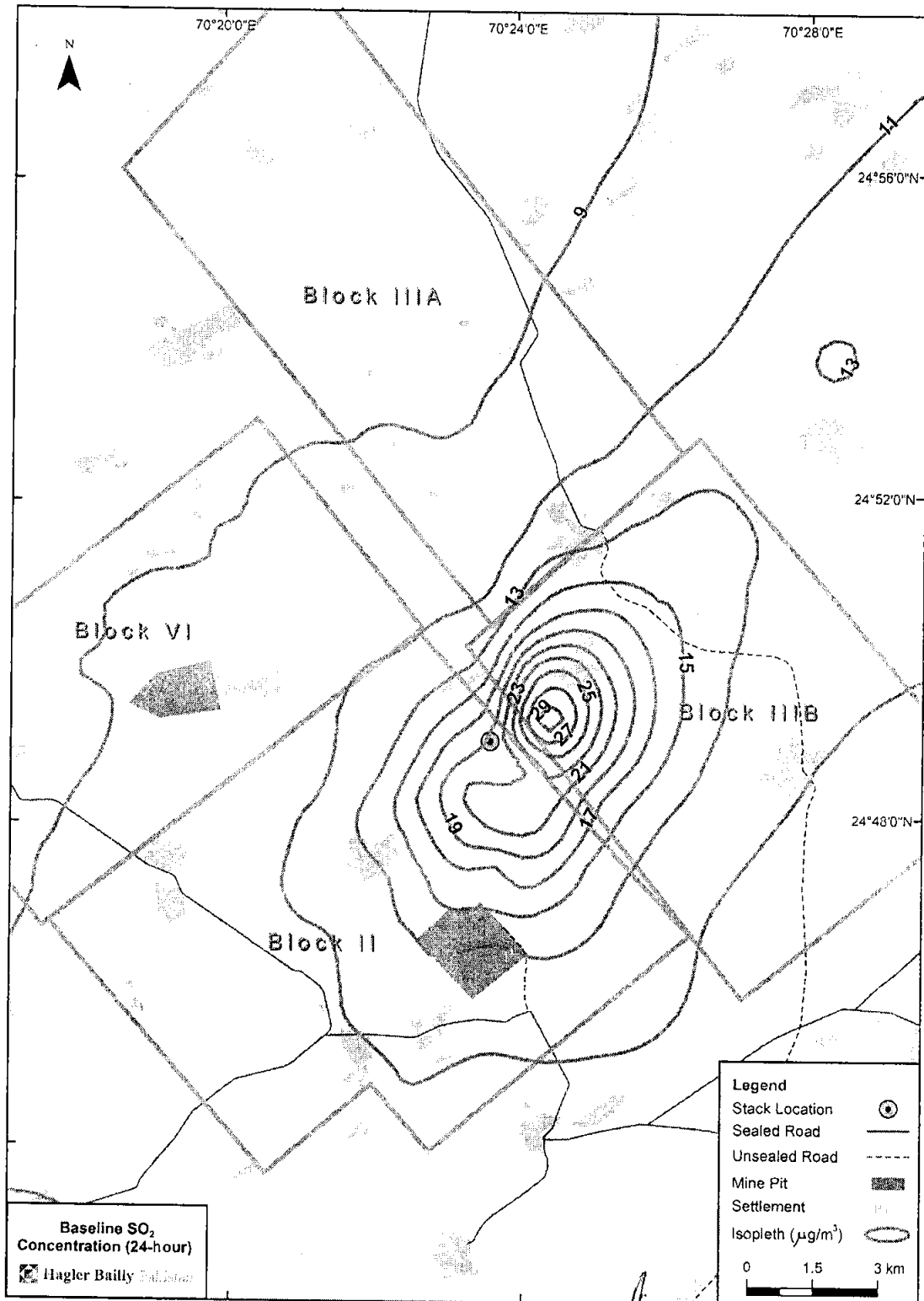


Exhibit 4.35: Baseline Concentration of NO₂ (Annual)

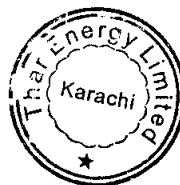
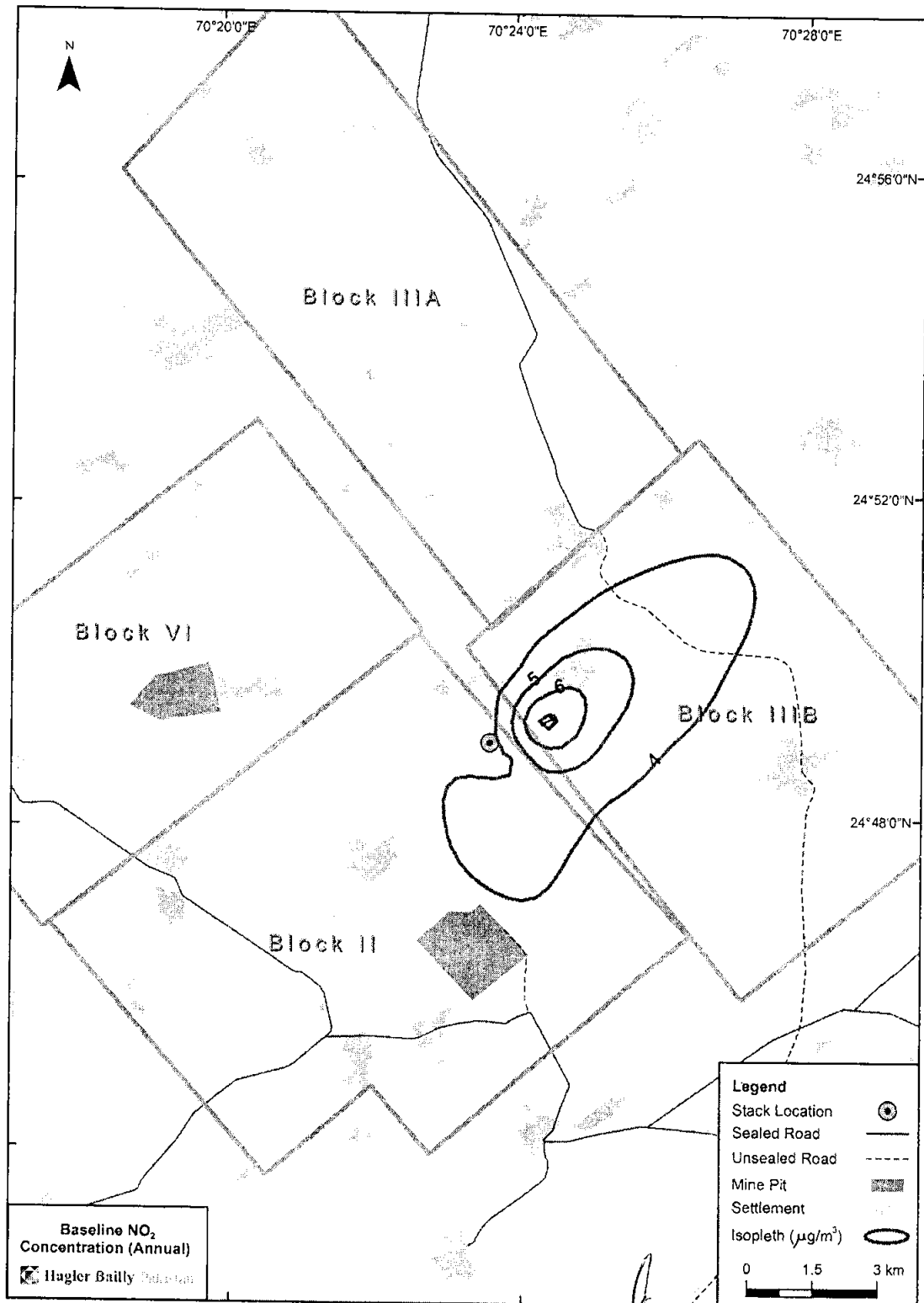


Exhibit 4.36: Baseline NO₂ Concentration (24 hour)

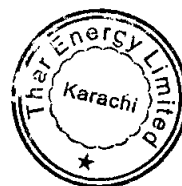
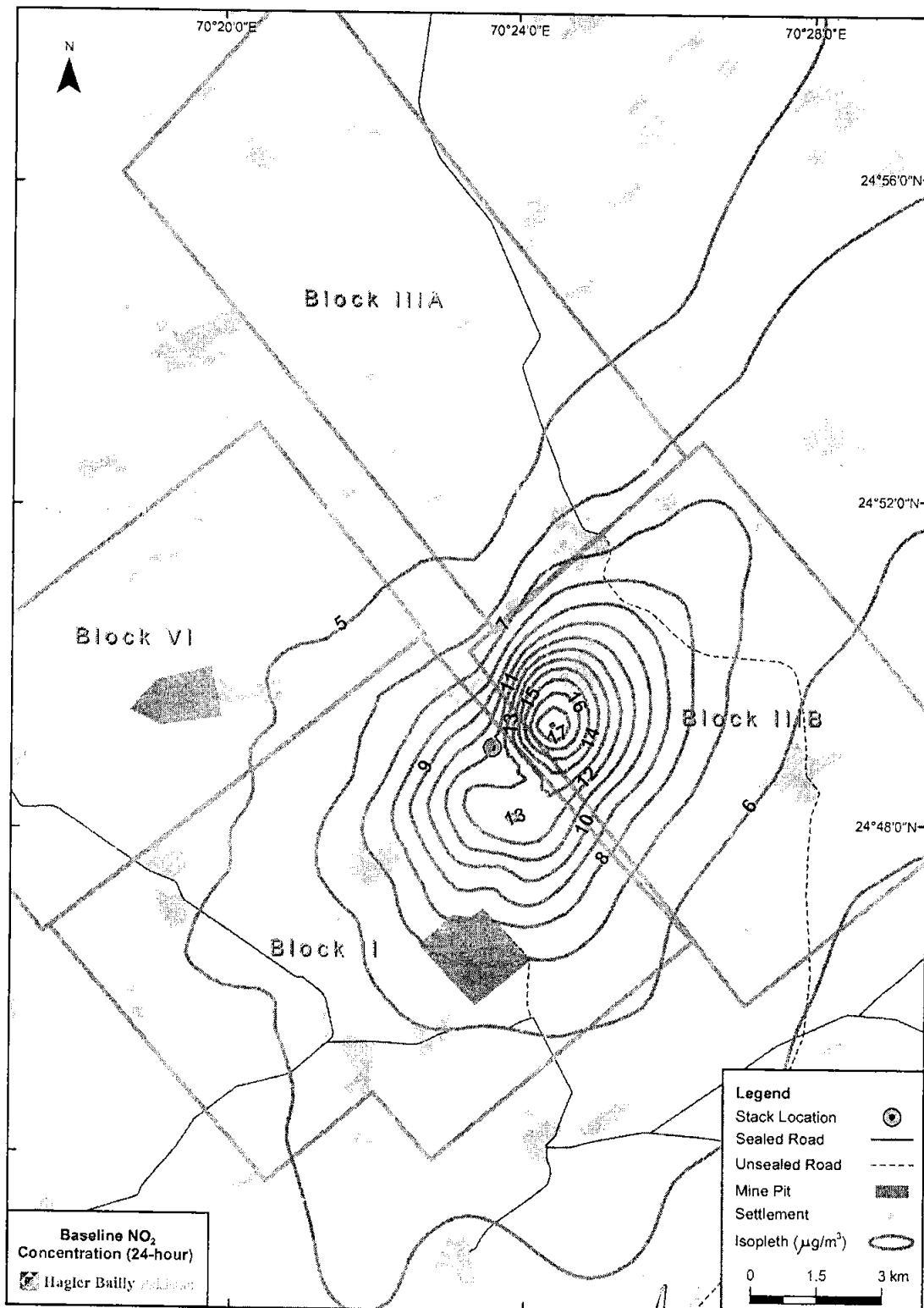


Exhibit 4.37: Baseline PM₁₀ Concentration (Annual)

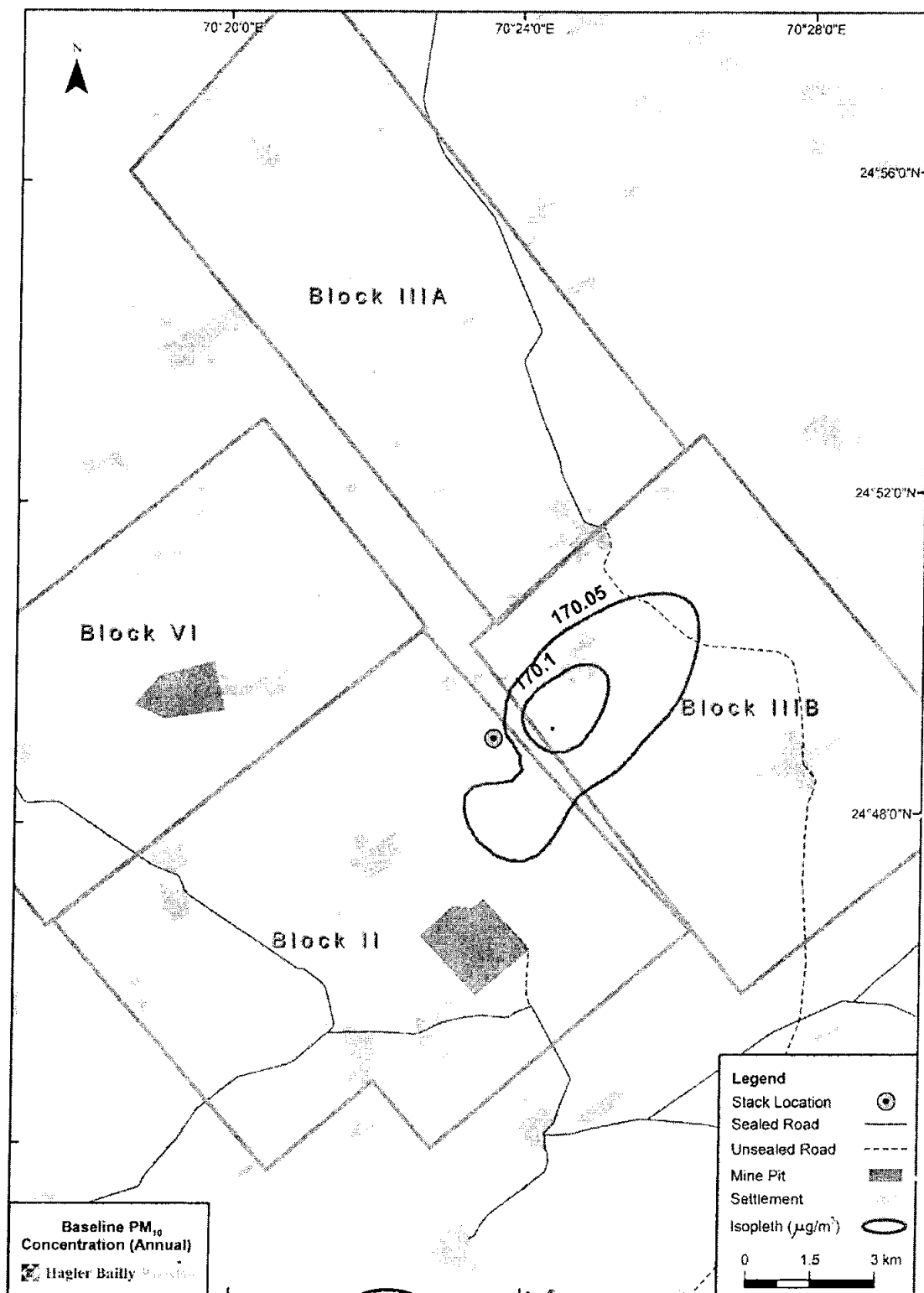


Exhibit 4.38: Baseline PM₁₀ Concentration (24-hour)

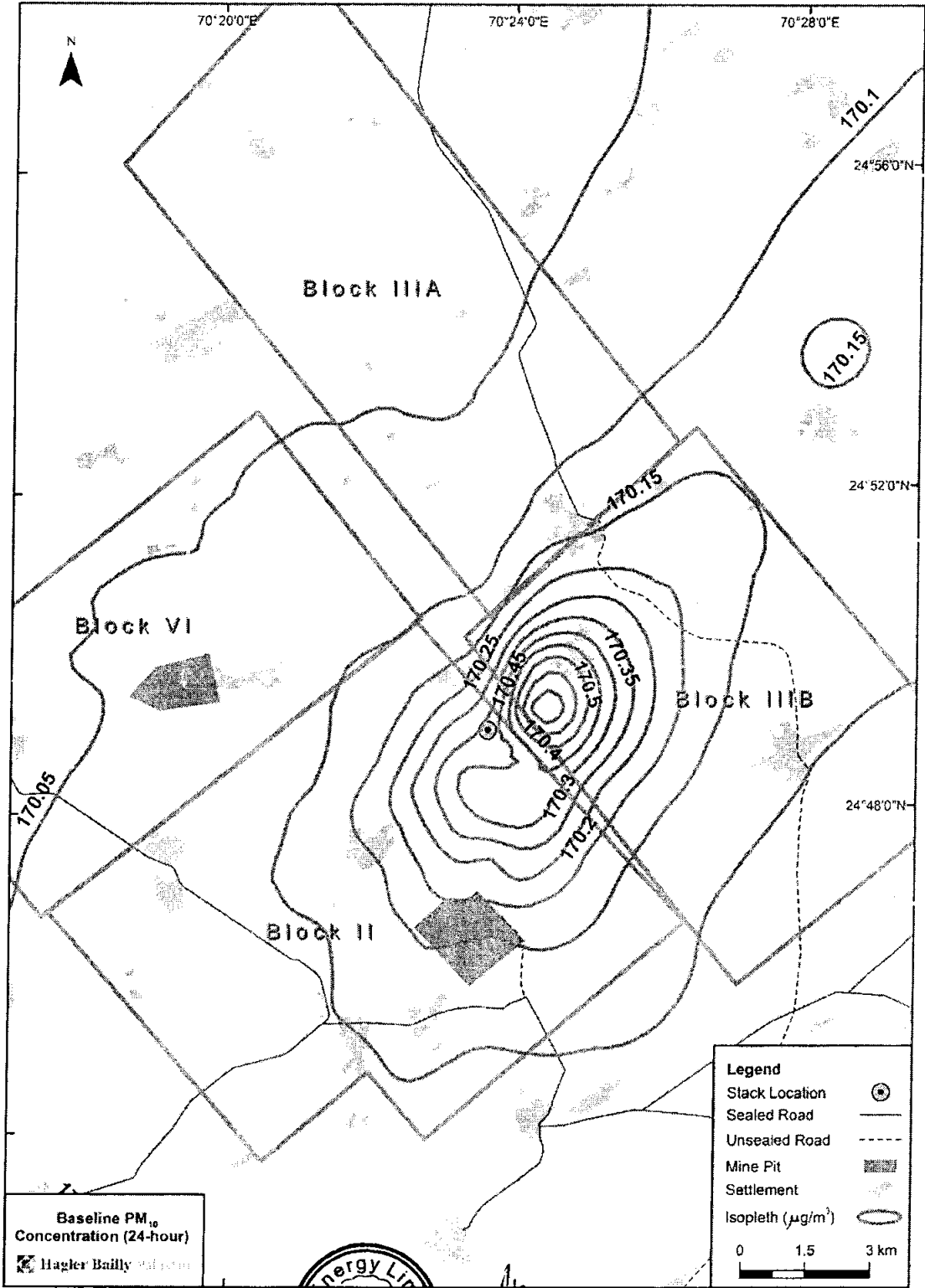


Exhibit 4.39: Baseline PM_{2.5} Concentration (Annual)

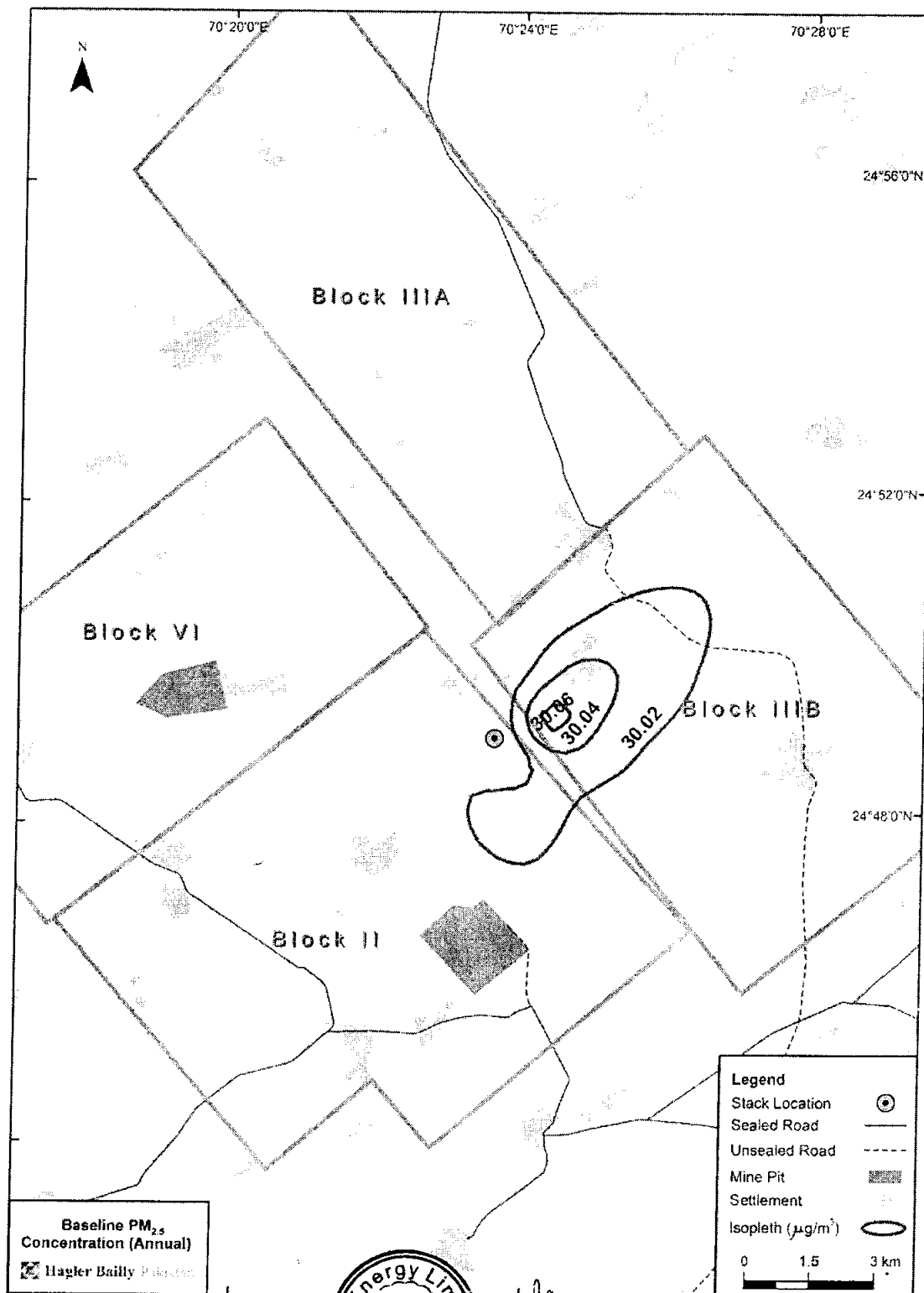


Exhibit 4.40: Baseline PM_{2.5} Concentration (24-hour)

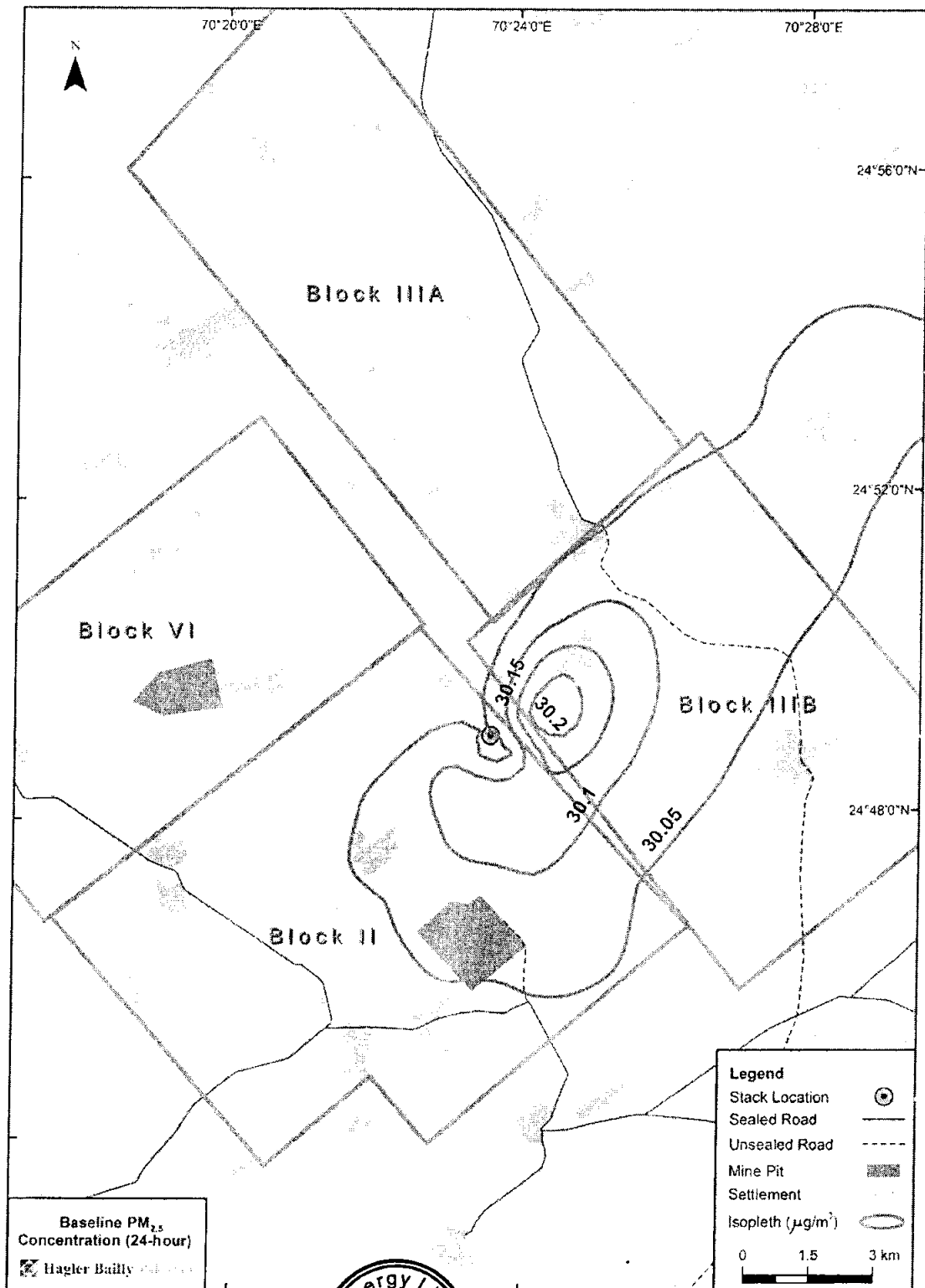


Exhibit 4.41: Combined Baseline Results ($\mu\text{g}/\text{m}^3$)

Pollutant	Averaging Period	Measured Baseline	Modeled Increment	Simulated Baseline	SEQS	IFC EHS limits
SO ₂	24-hour (98 th percentile)	7	23.8	30.8	120	125
	Annual Avg.		7.1	14.1	80	-
NO ₂	24-hour (98 th percentile)	3	15.5	18.5	80	-
	Annual Avg.		4.6	7.6	40	40
PM ₁₀	24-hour (98 th percentile)	140	0.6	140.6	150	150
	Annual Avg.		0.2	140.2	120	70
PM _{2.5}	24-hour (98 th percentile)	30	0.2	30.2	75	75
	Annual Avg.		0.1	30.1	40	35

The following conclusions can be drawn:

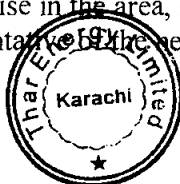
- ☞ The 24-hour and annual concentrations of SO₂ complies with both SEQs and IFC EHS limits.
- ☞ The 24-hour and annual concentrations of NO₂ complies with both SEQs and IFC EHS limits.
- ☞ The 24-hour concentrations of PM₁₀ complies with SEQs and IFC EHS limits.
- ☞ The annual PM₁₀ concentrations exceed the limits in the entire area as the measured baseline conditions exceed the standard. It must be noted that the measured baseline is established based on 18 measurements each at 24 hour and not the annual average. The modelled annual PM₁₀ concentrations due to the developments are not a significant cause for exceedance. The background levels of PM₁₀ are high due to naturally dusty desert environment.
- ☞ The 24-hour PM_{2.5} concentration complies with both SEQs and IFC EHS limits. The modeled 24-hour and annual concentrations complies with the standards.

4.3.7 Sound Levels

This section defines the baseline ambient sound levels in the Study Area in a manner that can be used for the assessment of the noise impact of the proposed Project.

Primary Data

To determine the baseline noise in the area, sound levels were measured at selected locations considered representative of the nearby receptors of possible noise pollution



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from the Project. These locations are given in **Exhibit 4.42**. The survey was conducted from the May 11 to 15, 2016. Per second measurements were taken for 24 hours at each location.

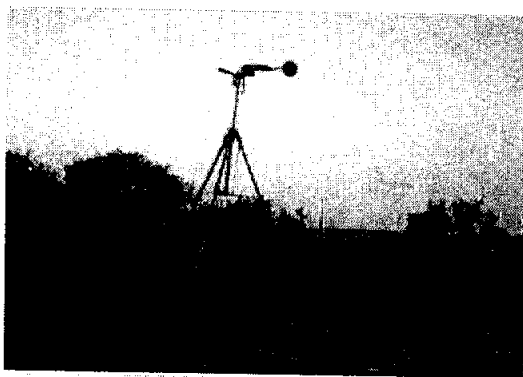
Exhibit 4.42: Description of Sampling Sites

ID	Location	Coordinates	Dates of Survey	Rationale
N1	Bitra	24° 49' 37.8" N 70° 22' 59.5" E	May 12, 2016	Nearest receptor (village)
N2	Jaman Samo	24° 49' 19.4" N 70° 24' 19.1" E	May 14, 2016	Background levels near the Project site
N3	South of Energy Park	24° 48' 12.2" N 70° 24' 24.8" E	May 15, 2016	Background levels near the Project site
N4	Thahriyo Halipota	24° 45' 15.6" N 70° 21' 38.9" E	May 11, 2016	Road sound levels

The survey was conducted with Cirrus Research plc.'s sound level meter, Model CR:1720. The instrument meets the International standards IEC 61672-1:2002, IEC 660651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986, and ANSI S1.43-1997 where applicable. The instruments have a resolution of 0.1 dB.

The instrument was mounted on a tripod, to avoid interference from reflecting surfaces within the immediate neighborhood, and a wind shield was used in all measurements. Photographs of the sampling equipment setup are provided in **Exhibit 4.43**. Day time hours are considered to be from 6 am to 10 pm and night time hours are taken to be from 10 pm to 6 am as per SEQS standards for noise.

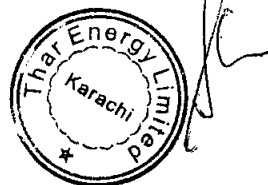
Exhibit 4.43: Sound Sampling Site Photographs

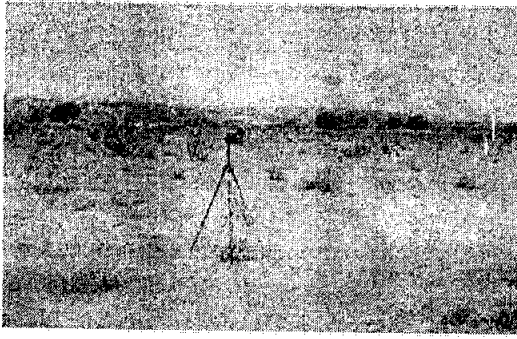


Sound meter at N1 (Bitra, village)

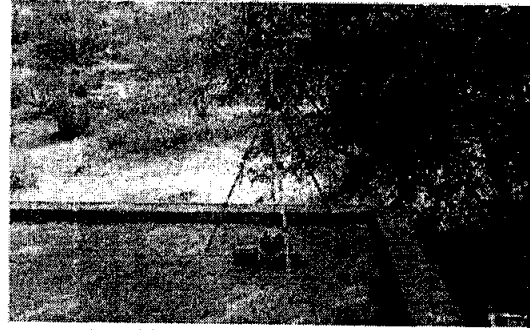


Sound meter at N2 (background levels)





Sound meter at N3 (background levels)



Sound meter at N4 (Thahriyo Halipota, village near road)

Secondary Data

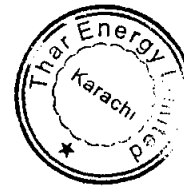
Additional data on sound levels in the Project area was available from previous ESIA³⁴. The previous sampling locations along with the description of each is given in **Exhibit 4.44**.

The current and previous sampling locations are shown in **Exhibit 4.45**.

Exhibit 4.44: Sound Level Sampling Locations in Literature

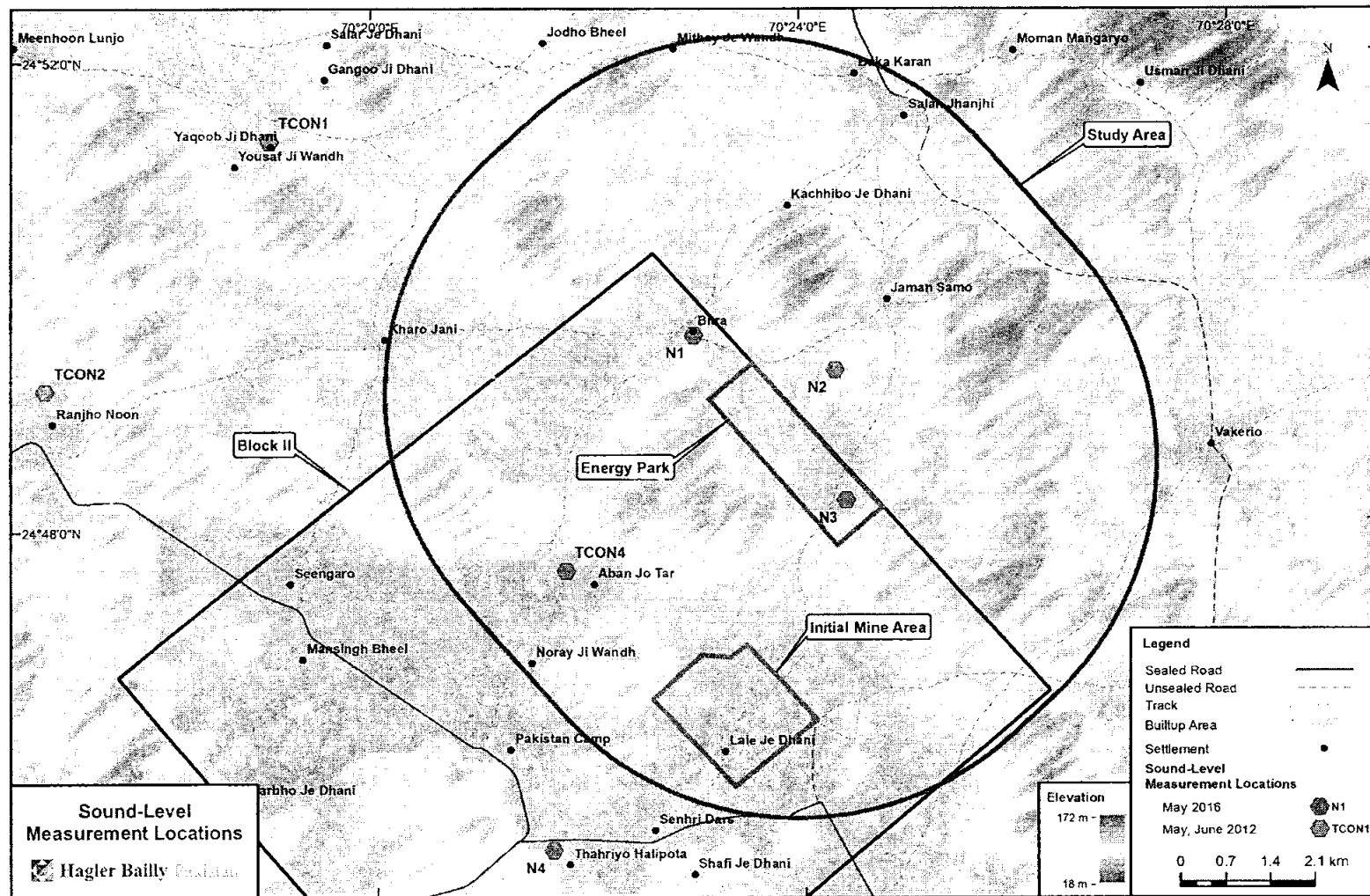
Sample ID	Coordinates	Dates of Survey	Description
TCON1	24° 51' 18.9" N 70° 19' 02.8" E	October 2012	Yaqoob Ji Dhani
TCON2	24° 49' 12.1" N 70° 16' 55.8" E	October 2012	Ranjho Noon
TCON4	24° 47' 37.5" N 70° 21' 47.3" E	October 2012	Aban jo Tar

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³⁴ Hagler Bailly Pakistan (HBP), April 2013, Environmental Impact Assessment of Block VI Lignite Mining Project for Sindh Carbon Energy Ltd [now Oracle Coalfields Limited].

Exhibit 4.45: Sound-Level Measurement Locations



Measurement Results and Analysis

A summary of the results and SEQS for noise are provided in **Exhibit 4.46**. Reported results include:

- ☞ L_{90} is the sound level exceeded 90% of the time. The L_{90} is representative of the background sound level.
- ☞ L_{10} is the sound level that is only exceeded 10% of the time (higher than L_{90}).
- ☞ L_{eq} is the average of the total sound level in decibels.

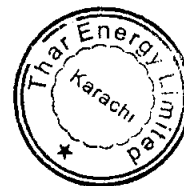
Reported sound levels are on the A scale, which covers the full audible range and is relatable to human hearing.

Exhibit 4.46: Summary of Sound Levels during the Survey and from Literature

Point	Description	24 hour (dBA)			Daytime Averages (dBA)	Nighttime Averages (dBA)
		L_{90}	L_{10}	L_{eq}	L_{eq}	L_{eq}
Current Study						
N1	Village (Bitra)	31.8	52.4	51	51.8	46.0
N2	Background, no human presence	35.8	46.8	45	46.2	43.0
N3	Background, no human presence	29.0	41.1	40	41.9	34.2
N4	Road + Village	36.0	50.2	50	49.8	50.1
Literature						
TCON1	Village	31.6	44.2	46.8	48.6	41.1
TCON2	Village	25.8	44.5	43.9	45.5	38.6
TCON4	Village + Road	34.0	55.5	52.4	53.7	46.2
SEQS					55.0	45.0

Conclusion

The sound levels of the primary and secondary data are averaged³⁵ to obtain the sound level baseline as presented in **Exhibit 4.47** and discussed below.

³⁵ dB cannot directly be averaged due to the log scale of the unit.

Exhibit 4.47: Sound Level Baseline of the Study Area

Location	Average L_{eq} (dBA)	
	Daytime	Nighttime
Desert Background	44.6	40.5
Village	49.4	43.0
Village & Road	52.2	48.6
SEQS	55	45
IFC Limits³⁶	55	45

The desert background, is very quiet and approximately 10 dBA below SEQS for both day and night time. Observed noise sources included passing livestock herds, braying donkeys, and birds.

Villages have slightly higher noise levels due to the limited village activities. These include a few vehicles that pass through the villages, livestock, and human activities.

Villages near major roads record the highest noise levels. This is because of the road traffic, which includes a large fraction of trucks, jeeps and busses. Moreover, villages near roads often have shops where passengers stop to rest. This has resulted in the exceedance of the nighttime SEQS.

4.3.8 Traffic

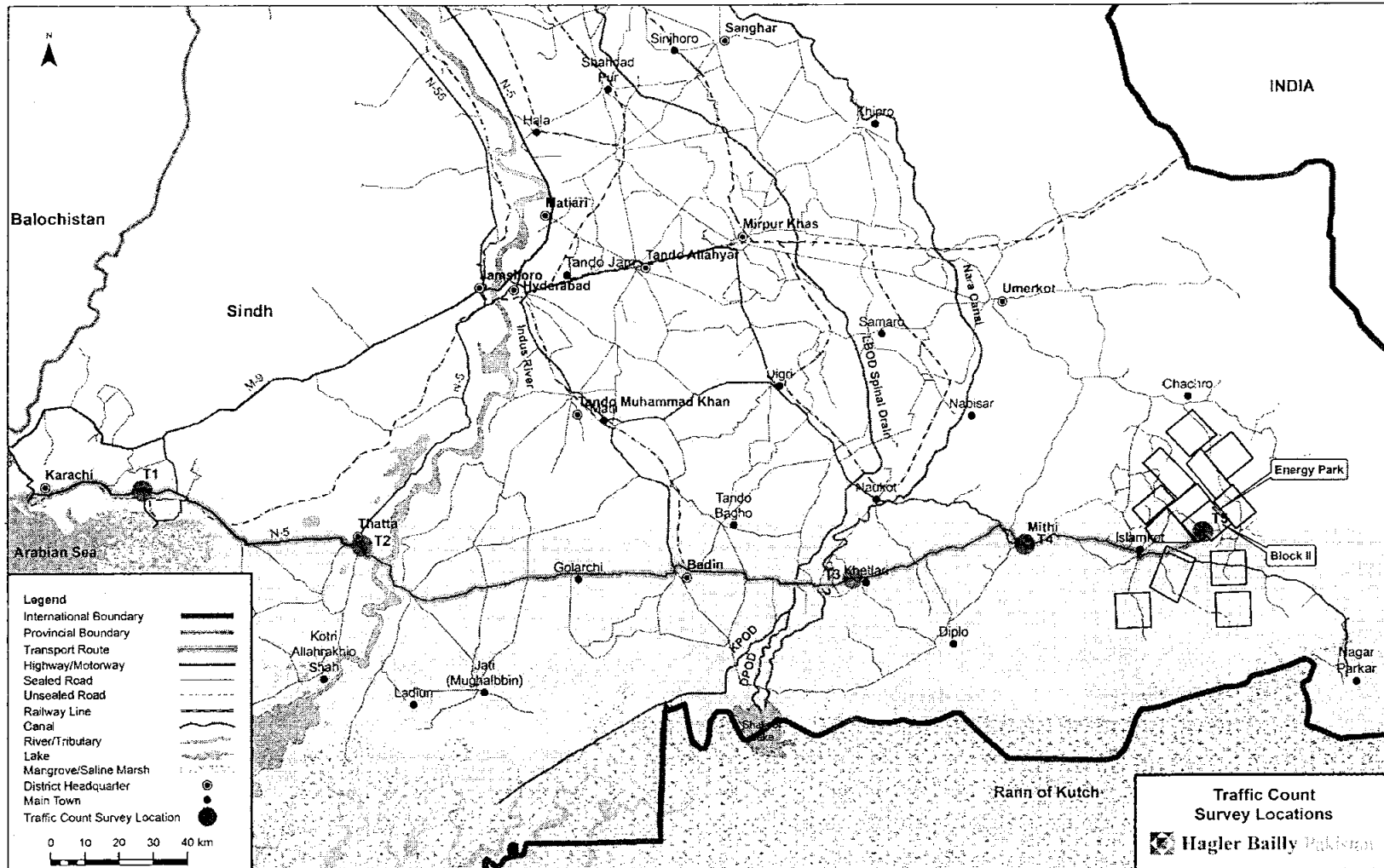
The traffic baseline was prepared to assess the current traffic conditions on the road route that could be used for Project related transportation of goods and services during construction and operation of the Project.

The selected transport route from Karachi to the Project site is shown in **Exhibit 4.48**. The route, is 366 km long and passes through the following towns:

Karachi (PQA)	Thatta	Badin	Mithi	Islamkot	Energy Park
National Highway N-5 75 km Two lane 7.3 m wide	Provincial Highway 105 km Two lane 6.1-6.7 m wide	Provincial Road 114 km Two/One lane 4-6 m wide	Provincial Road 44 km Two/One lane 4-6 m wide	Provincial Road 28 km Two/One lane 4-6 m wide	

³⁶ For IFC EHS limits, daytime is from 7 am to 10 pm, whereas for SEQS daytime is from 6 am to 10 pm. Values in this study were calculated based on SEQS daytime classification. Furthermore, IFC requires hourly L_{eq} to comply with the limit.

Exhibit 4.48: Transport Route and Traffic Count Survey Locations

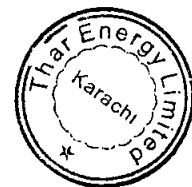


Traffic counts are reported at five points as shown in **Exhibit 4.48**. A photograph of the surveyors and site location is given in **Exhibit 4.49**.

The data for four points (T1, T2, T3, and T4) are based on previous surveys³⁷. The previous surveys were conducted between 2012 and 2014. To ascertain the present traffic condition, traffic counts from previous surveys were extrapolated using an annual growth rate of 2.58%³⁸. The results are shown separately for each direction in **Exhibit 4.50**.

A traffic count for T5 was conducted for this ESIA on May 12, 2016, on the newly constructed road that will provide access to the Project Site.

Exhibit 4.49: Traffic Survey Location



³⁷ Hagler Bailly Pakistan, August 21, 2015, "Environmental Impact Assessment of 660 MW Coal Fired Power Plant Construction Project at Lakhra in Islamic Republic of Pakistan", GENCO Holding Company Limited, Pakistan.

³⁸ Pakistan Sustainable Project, "Principle policy guidelines for Sindh urban transport policy", December, 2014.

Exhibit 4.50: Traffic on the Transport Route (Karachi to Nagar Parkar Road) in both directions

Sub-segments	Location ID	Survey Date	M-cycles	Cars	Pickups	Buses	Trucks ^a	Trailers/ Trolleys	Total	% of Light Traffic Vehicle	% of Heavy Traffic Vehicle
Karachi – Thatta	T1	Jul 2012	1,862	3,405	941	892	1,289	20	8,409	74	26
Thatta - Karachi			2,613	4,477	1,022	799	1,247	11	10,169	80	20
Thatta – Badin	T2	May 2013	1,503	1,582	383	78	1,033	NA	4,579	76	24
Badin - Thatta			1,721	1,734	468	130	1,121	NA	5,174	76	24
Badin – Mithi	T3	Mar 2014	107	91	112	8	133	3	454	68	32
Mithi - Badin			127	106	116	12	109	6	476	73	27
Mithi – Islamkot	T4	Mar 2014	177	80	124	47	108	2	538	71	29
Islamkot - Mithi			230	87	144	52	120	1	634	73	27
Islamkot – Project Site	T5	May 2016	74	77	55	4	27	3	240	87	13
Project Site – Islamkot			74	78	49	3	31	1	236	87	13

Note: NA means data not available

a includes all truck categories from 2 axle to 5 axle.



4.3.9 Soil

The soils in Thar are generally coarse-textured, well drained and calcareous in nature. At varying depths a thick accumulation of lime may also be encountered. The soils usually overblown with sand due to severe wind erosion. In general, these are infertile soils.

There are seven main groups of soils found in the Thar.³⁹ These are:

- ♦ Desert soils
- ♦ Red desertic soils
- ♦ Sierozems (rowinsh gray soils)
- ♦ Red and yellow spoils of the foothills
- ♦ The saline soil of the depressions
- ♦ Lithosols (shallow, weathered soils)
- ♦ Rigosols (soft loose soils) found in the hills

4.3.10 Groundwater

There are no major rivers within the Thar Desert. Rainwater flows (mostly as sheet flow) to the nearest topographic low, and either evaporates there or infiltrates⁴⁰. The inactive Nara River used to flow in the west of the Thar Desert. The old bed of the Nara River is now utilized as part of the Nara Canal.

Three main aquifers and two aquitards have been identified in the Thar region. These units comprise (from the surface downwards):

- ☞ upper aquifer (Top Aquifer), which is located in the base of the dune sands
- ☞ fine grained siltstone aquitard
- ☞ middle alluvial sand aquifer (Middle Aquifer) of sub-recent age
- ☞ claystone and lignite aquitard in the top part of the Bara Formation
- ☞ deep aquifer (Deep Aquifer or Bottom Aquifer) of marine sands belonging to the bottom part of the Bara Formation.

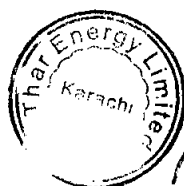
A groundwater census was carried out in the Study Area for a previous study⁴¹. The results are summarized below and the locations shown in **Exhibit 4.51**.

- ☞ The wells are open dug wells; no mechanically drilled boreholes were found in the Study Area. Most of the wells are brick-lined.

³⁹ Ihsan H. Nadiem: Thar, the Great Pakistan Desert: Land, History, People. Sang-e-Meel Publications, Lahore. 2001

⁴⁰ Bender, 1995, Geology of Pakistan

⁴¹ Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014



- ⑤ The minimum, maximum and average depths of the well with respect to ground are 48.0 m, 86.4 m, and 60.9 m, respectively; 90% of the wells are between 50 and 70 m in depth.
- ⑤ The minimum, maximum and average depths of the well with respect to mean sea level are -10.38 m, 31.43 m, and 19.26 m, respectively; 95% of the wells are between 10 and 30 m in depth.

Water quality samples were obtained from the 40 wells and were analyzed for common chemical parameters and heavy metals. The results indicate that in general the water is unfit for human consumption. Sodium, sulfate, chlorides, and hence the total dissolved solids (TDS), exceed the drinking water standards for almost all the wells. The results of these tests are presented in **Exhibit 4.52**.

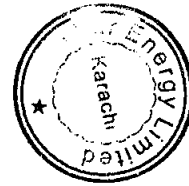
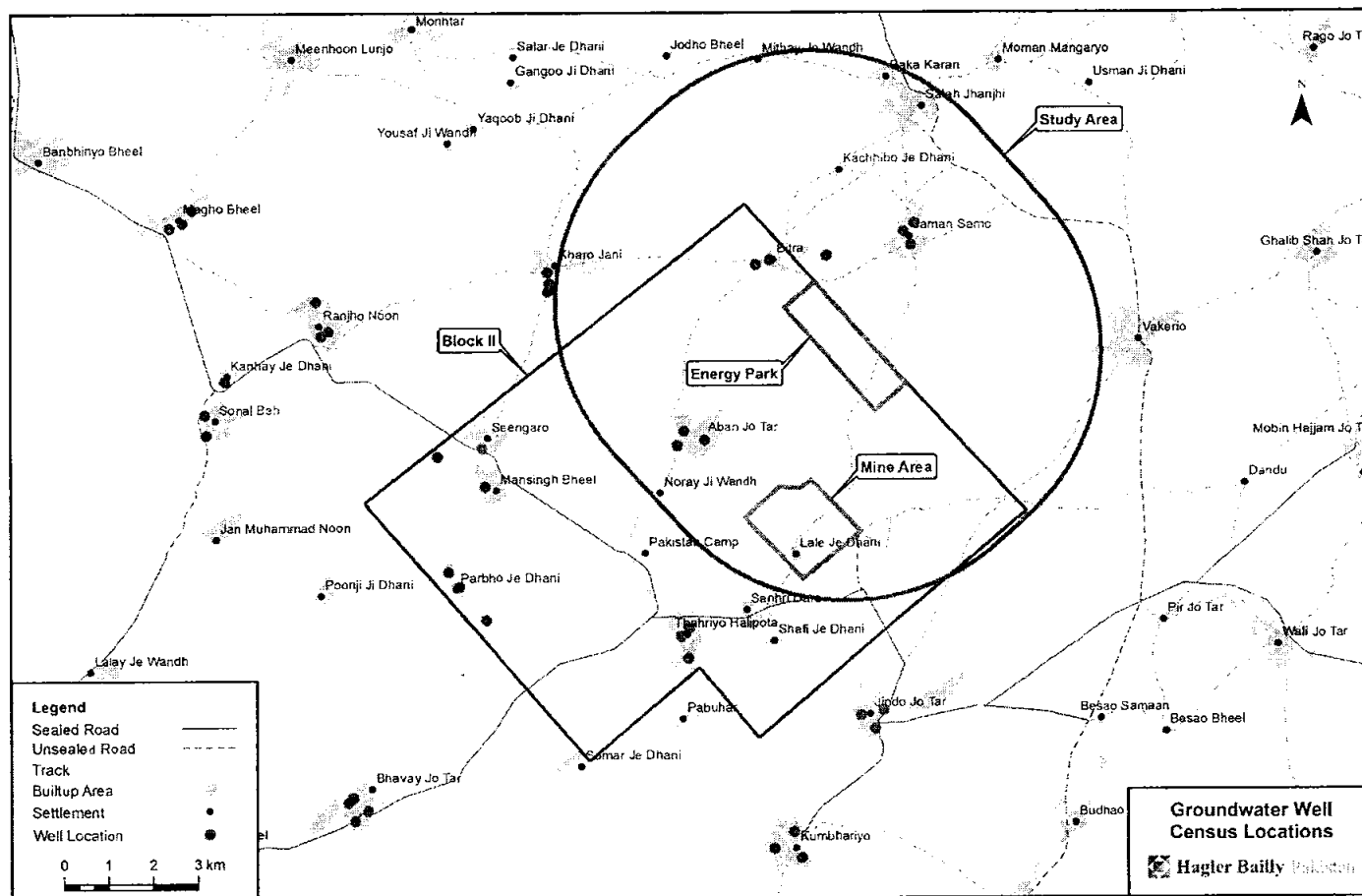


Exhibit 4.51: Groundwater Well Census Locations⁴²



⁴² Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

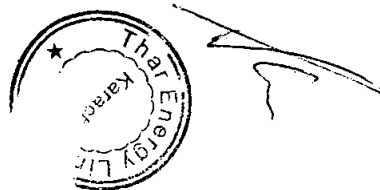
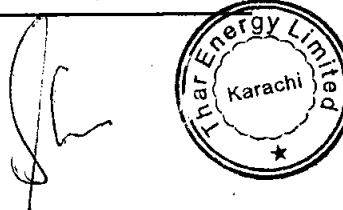


Exhibit 4.52: Water Quality in the Study Area⁴³

Parameters	Unit	Min ^a	Max ^b
pH	-	7.48	8.42
EC	μS/cm	3,280	14,500
Sodium	mg/l	500	2,460
Magnesium	mg/l	10	240
Calcium	mg/l	11	320
Potassium	mg/l	9	58
Sulfate	mg/l	150	712
Chloride	mg/l	975	5,599
Bicarbonate	mg/l	185	729
Silica Dioxide	mg/l	11.2	15.4
Hardness (as CaCO ₃)	mg/l	68	1,705
Sulfide	mg/l	<1.00	
Fluoride	mg/l	0.495	1.14
TDS	mg/l	1,996	9,584
Iron	mg/l	0.05	0.675
Aluminum	mg/l	0.075	0.28
Manganese	mg/l	0.025	0.08
Arsenic	mg/l	0.005	0.01
Copper	mg/l	0	0
Lead	mg/l	0.02	0.1
Zinc	mg/l	0.025	0.05
Cadmium	mg/l	0	0
Nickel	mg/l	0.025	0.25
Chromium	mg/l	0	0
Cobalt	mg/l	0	
Selenium	mg/l	0	0
Mercury	mg/l	0	0

a Minimum value among the 40 wells

b Maximum value among the 40 wells



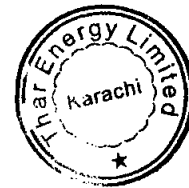
⁴³ Hagler Bailly Pakistan. Environmental and Social Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

4.4 Ecological Baseline

The Thar Desert is a large ecoregion lying to the west of the Aravalli Mountain Range in northwestern India. The relief in the Thar Desert varies between near sea level to more than 150 meters. The sand dunes defining the topography are mostly longitudinal forming a NE-SW trend and are stabilized by shrubs and grass. In the inter-dunal valleys, the alluvial soil brought by rainwater is deposited in the depressions. The vegetation in Thar Desert is desertic and semi-desertic.

4.4.1 Protected Areas in the Vicinity of the Study Area

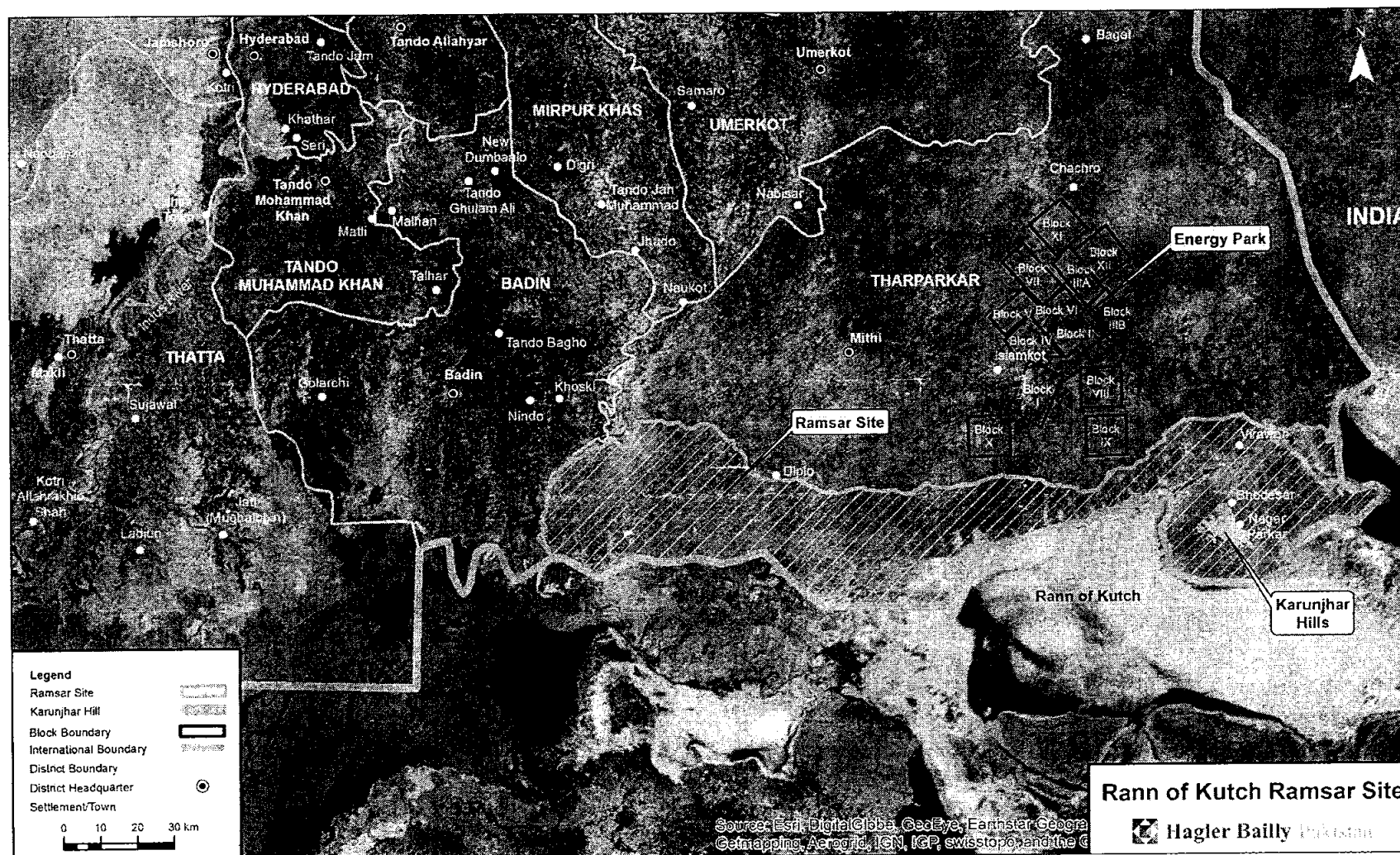
The Protected Area closest to the Study Area is the Rann of Kutch Wildlife Sanctuary. It is located 32 km from Study Area. The Rann of Kutch Ramsar Site is the only designated area of global conservation importance present in the vicinity of the Study Area, being a part of the 1.6 million hectares of wetlands of international importance stretching across the two countries of India and Pakistan.⁴⁴ The Rann of Kutch Ramsar Site information sheet provides a list of species present within the Ramsar Site which includes a total of 154 plant species, 26 mammal species, 14 reptile species (no amphibian species) and 107 bird species.⁴⁵ Based on these figures it can be concluded that the Rann of Kutch Ramsar Site is an area richer in biodiversity compared to the Study Area. The location of the Project relative to the Rann of Kutch Ramsar Site is shown in **Exhibit 4.53**.



⁴⁴ World Wildlife Fund (WWF). Desert wetlands, World Wildlife Fund Global, News and Stories (February 2003)

⁴⁵ Hussain Bux Bhaagat, Information Sheet Ramsar Wetlands, Sindh Wildlife Department, (September 2002). Available at <<http://www.ramsar.org/>>, accessed January 27, 2016

Exhibit 4.53: Rann of Kutch Ramsar Site and Project Location



4.4.2 Habitat Types in the Study Area

Habitats within the Study Area were classified relying primarily upon geomorphology and soil texture, with consideration of variations within habitat types. The Study Area was classified by geomorphological characteristics into Agricultural Fields, Sand Dunes with Agriculture, Sand Dunes, Plains and Settlements. The relative percentage of each habitat type has been provided in **Exhibit 4.54**.

A map showing the distribution of the different habitat types has been shown in **Exhibit 4.55**.

Exhibit 4.54: Table giving Habitat type Percentages

<i>Habitat Type</i>	<i>Percentage of Study Area (%)</i>
Agricultural Fields	46
Sand Dunes	24
Sand Dunes with Agriculture	15
Plain	13
Settlements	2

Agriculture Fields are the dominant habitat, constituting 46% of habitats of the Study Area. There is only one cropping season in the summer (called *kharif* season) in which a variety of summer crops are grown. Sand dunes are the second dominant habitat, constituting 24% of the total habitat. They vary in height, ranging from a few meters to over a hundred meters. Sand Dunes with Agriculture are the third most dominant type making up 15% of the Study Area with Plains constituting 13% and Settlements constituting 2%. An established tradition of preservation of trees contributes to maintaining the vegetation cover in the Thar Desert. Grazing pressure, however, is significant and the ground vegetation in terms of grasses, scrubs and bushes can be considered as uniformly degraded.

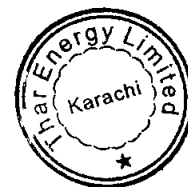
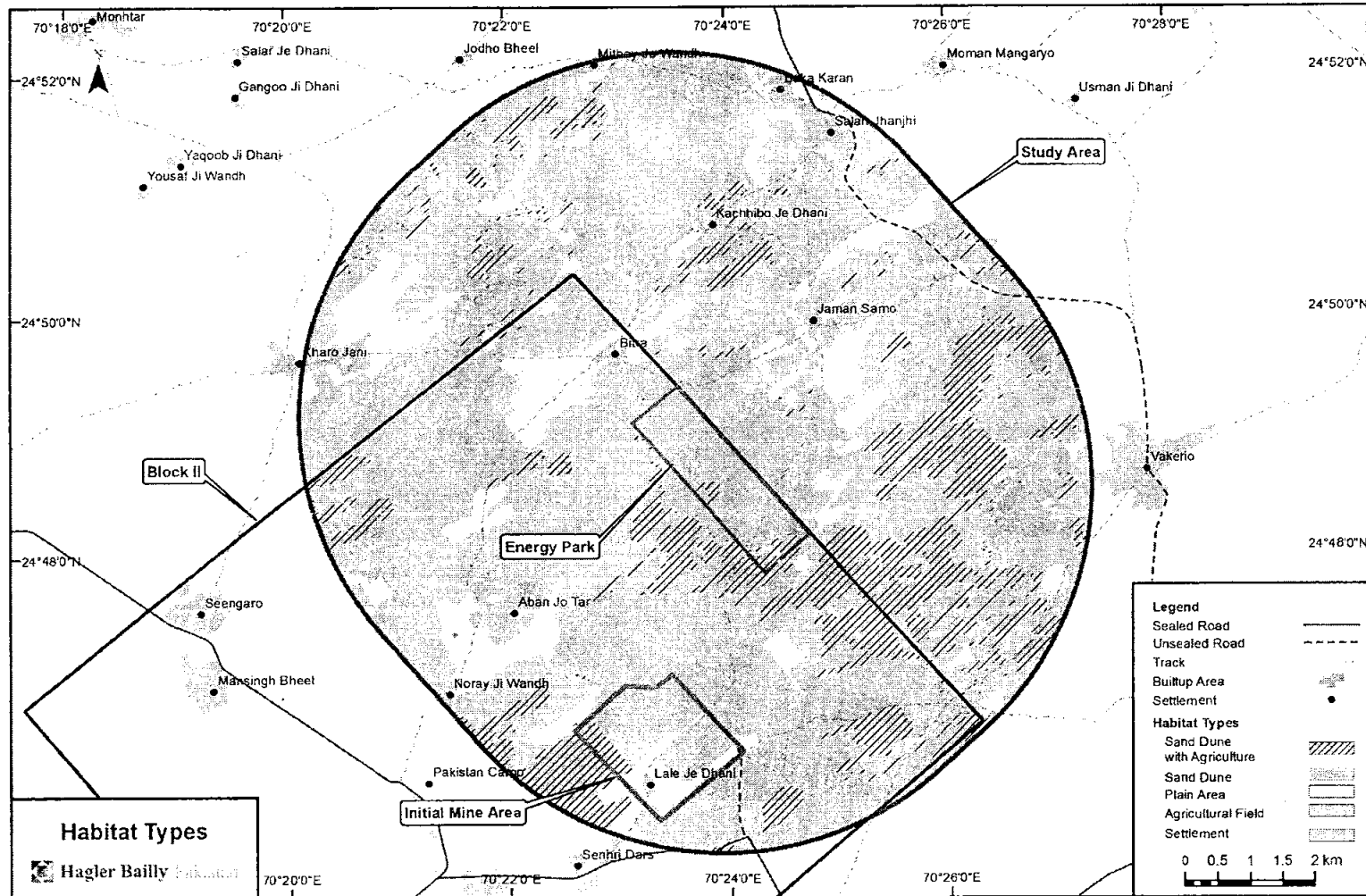


Exhibit 4.55: Habitat Types within the Study Area



4.4.3 Ecological Resources

Information about the ecological resources in the Study Area has been obtained from the surveys carried out as part of other studies done both within the Study Area as well as nearby areas. The following reports have been used to collect information about the flora and fauna present within the Study Area:

- ② Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Block VI Lignite Mining Project, Main Report for Sindh Carbon Energy Limited, April 2013
- ② Hagler Bailly Pakistan, Environmental and Social Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012
- ② Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, February 15, 2011

Vegetation

The vegetation of the Thar Desert can be classified as Tropical Thorn Forest.⁴⁶ It comprises mainly scattered trees and bushes.⁴⁷ These are mainly thorny, drought resistant species and grasses. Following rains, lush green grasses sprout providing a rich source of fodder.⁴⁸ The vegetation is typical of arid regions with adaptations to survive the extreme conditions of the desert environment.⁴⁹

A total of 137 plant species have been reported from the Tharparkar area. These plant species are the base for the animal and human life in the desert. The plants are used for a variety of purposes, including production of medicines, resins, dyes and fibers, and for construction, forage and fodder making. The habitat in the Thar Desert is influenced by the extreme climate. The vegetation consists of xerophilious grasslands of *Eragrostis sp.*, *Aristida adscensionis*, *Cenchrus biflorus*, *Cymbopogon sp.*, *Cyperus sp.*, *Eleusine sp.*, *Panicum turjidum*, *Lasiurus scindicus*, *Aeluropus lagopoides*, and *Sporobolus sp.* Scrub vegetation consists of low trees such as *Acacia nilotica*, *Prosopis cineraria*, *Prosopis juliflora*, *Tamrix aphylla*, *Zizyphus mauritiana*, *Capparis decidua*, and shrubs such as *Calligonum polygonoides*, *Calotropis sp.*, *Aerva sp.*, *Crotalaria sp.*, *Haloxylon salicornicum* and *Haloxylon recurvum* are also present. The region comprises 9.1% of the total flora of Pakistan, making it poor in terms of floristic diversity.⁵⁰

None of the plant species found during the survey is listed under either the IUCN Red List of Threatened Species or under the Pakistan legislation.

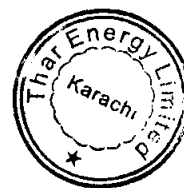
⁴⁶ Nisar Ahmad Khan. Deserts in Pakistan. Pakistan Geographic, <<http://pakistangeographic.com/deserts.html>>, accessed December 17, 2015

⁴⁷ Ibid

⁴⁸ Ibid

⁴⁹ Chapter 1: Biological Adaptations to Aridity. Global Deserts Outlook, United Nations Environment Programme. Available at, <<http://www.unep.org/geo/gdoutlook/028.asp>>, accessed December 17, 2015.

⁵⁰ Nasir, Yasin J., and Rubina A. Rafiq. "Wild flowers of Pakistan." Karachi: Oxford University Press xxxiii, 298p. 104p. of plates-illus., col. illus.. ISBN195775848 (1995).



The only plant species included in the CITES Species List is Leafless Milk Hedge (Thor) *Euphorbia caducifolia* that is included in Appendix II.⁵¹ It is a major species in rocky deserts of western and central India and Pakistan, occurring from sea level up to 600/800 meters.⁵²

The data for the vegetation survey carried out for the Thar Coal Block II Mining Project⁵³ has been provided in **Appendix G** along with information about their phytosociological attributes.

Mammals

Thirty-five (35) mammalian species have been reported from the Tharparkar area, which includes large mammals from the Family Canidae (dog family), Felidae (cat family), Hyaenidae (hyena family), Mustelidae (e.g. badgers, weasels etc.), Bovidae (ruminant mammals such as gazelle), Equidae (such as wild ass) and Suidae (artiodactyl mammals such as boars, pigs etc.). Small mammals reported from the Study Area include members from the Family, Erinaceidae (e.g. hedgehogs), Soricidae (e.g. shrews), Herpestidae (e.g. mongoose), Rhinopomatidae (insectivorous bats), Vespertilionidae (e.g. Common Bat), Manidae (pangolins), Leporidae (rabbits and hares), Sciuridae (squirrels), Hystricidae (porcupines) and Muridae (family of rodents).⁵⁴

The mammal species observed during the surveys carried out as part of the environmental and social impact assessment of the Thar Coal Block II Mining Project⁵⁵ included both small and large mammal species. The small mammal species, the Balochistan gerbil *Gerbillus nanus* was found to be the most abundant followed by *Tatera indica* and Indian desert jird *Meriones hurrianae*. Common medium sized mammals included the Long-eared Desert Hedgehog *Hemiechinus collaris* and Five-striped Palm Squirrel *Funambulus pennantii*. The large mammal species, Fox *Vulpes sp.*, Indian Hare *Lepus nigricollis* and Indian Hedgehog *Paraechinus micropus* are the abundant species in the Study Area while the rest of the species are comparatively less common. The Striped Hyena *Hyaena hyaena* is listed as Near Threatened in the IUCN Red List of Threatened Species. It was not sighted but signs (foot print) indicating its presence were seen during the April 2010 survey for the environmental and social impact assessment of the Thar Coal Block II Mining Project.⁵⁶ Dens of this species were not observed in the area. None of the mammalian species observed is exclusively found in the Study Area and the habitat of the species found is widespread across the Thar Desert.

⁵¹ UNEP-WCMC. SPECIES+ CITES database. < <http://www.speciesplus.net/species> > accessed November 20, 2015

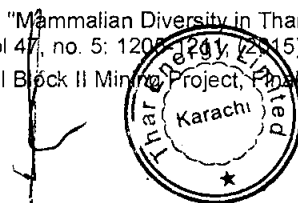
⁵² Llife, Encyclopedias of living forms, The Encyclopedia of Succulents, *Euphorbia caducifolia*, <http://www.llife.com/Encyclopedia/SUCCULENTS/Family/Euphorbiaceae/28041/Euphorbia_caducifolia>, accessed December 18, 2015

⁵³ Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

⁵⁴ Khan, Abdul Aziz, Waseem Ahmad Khan, and Abdul Aleem Chaudhry. "Mammalian Diversity in Thar Desert Habitat of Tharparkar District, Sindh, Pakistan." Pakistan J. Zool 47, no. 5: 1205-1215 (2015)

⁵⁵ Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

⁵⁶ Ibid



The data for the mammal survey carried out for the Thar Coal Block II Mining Project⁵⁷ has been provided in **Appendix E** with information about their conservation status based on National Status, the IUCN Red List of Threatened Species and the CITES Appendices.

Avifauna

There is no permanent wetland close to the Study Area; therefore avifauna of the area predominantly consists of terrestrial birds. During the surveys carried out for the environmental and social impact assessment of the Thar Coal Block II Mining Project⁵⁸ 50 bird species were observed of which 43 are classified as resident, five as passage migrants and irregular year round visitors, one as a summer breeder and one was an isolated or occasional breeder in the Study Area.

A total of seven nests of Egyptian Vultures *Neophron percnopterus* were identified in the Study Area during the surveys for the environmental and social impact assessment of the Thar Coal Block II Mining Project⁵⁹, of which five were empty and two were occupied. A further three empty nests were located on *Prosopis cineraria* trees, which are thought to be nests of either the White-backed Vulture *Gyps bengalensis* or the Egyptian Vulture *Neophron percnopterus*. One active nest of a Tawny Eagle *Aquila rapax*, one active nest of a Spotted Owlet *Athene brama* and a further 10 nests of unknown bird species were identified in the Study Area.

The subfamily *Aegypinae* contains 15 species of old world vultures, 8 of which are reported in Pakistan. Of the four belonging to the genus *Gyps*, three including Oriental White-backed Vulture *Gyps bengalensis*, are listed as Critically Endangered in the IUCN's Red List of Threatened Species. The Egyptian Vulture *Neophron percnopterus* is listed as Endangered (IUCN Red List of Threatened Species). The Greater Spotted Eagle *Clanga clanga* is listed as Vulnerable in the IUCN Red List of Threatened Species. It was seen in the Study Area in the April 2010 survey. The Laggar Falcon *Falco jugger* is listed as Near Threatened in the IUCN Red List of Threatened Species and was also seen in the Study Area during the April 2010 surveys.

The data for the avifauna survey carried out for the Thar Coal Block II Mining Project⁶⁰ has been provided in **Appendix G** along with information about their conservation status based on the IUCN Red List of Threatened Species and the CITES Appendices.

Herpetofauna

Of the 32 species of reptiles reported in the literature and likely to be found in the area, 17 were observed during the surveys conducted in the Study Area for the environmental and social impact assessment of the Thar Coal Block II Mining Project.⁶¹ Of these, common species were the Indian fringe-toed sand lizard *Acanthodactylus cantoris*, Three-toed snake skink *Ophiomorus tridactylus*, garden lizard *Calotes versicolor*, yellow-tailed

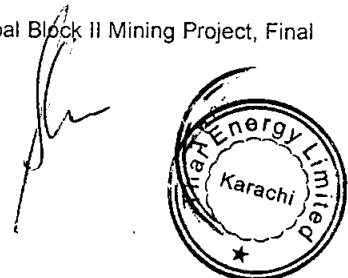
⁵⁷ Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, September 3, 2012

⁵⁸ Ibid

⁵⁹ Ibid

⁶⁰ Ibid

⁶¹ Ibid



sand gecko *Crossobamon orientalis* and brilliant ground agama *Trapelus agilis*. The species found were evenly distributed across three habitats in the Study Area, namely, Agricultural Fields (including Sand Dunes with Agricultural Fields), Sand Dunes and Plains during the surveys carried out for the Thar Coal Block II Mining Project.⁶²

The three species of amphibians known to occur in the Study Area include the Indus Valley toad *Duttaphrynus stomaticus*, the Common Skittering Frog *Euphlyctis cyanophlyctis* and the Indian Bullfrog *Hoplobatrachus tigerinus*.⁶³ None of these amphibian species are of conservation importance based on the IUCN Red List of Threatened Species,⁶⁴ however, the Indian Bullfrog is listed in Appendix II of the CITES Species List.⁶⁵

None of the species observed or reported in the area are on the IUCN Red List of Threatened Species. However, according to one reference⁶⁶, three species are endemic to Pakistan which include the Red-throated Ground Agama *Trapelus rubrigularis*, the Sindhi Krait *Bungarus sindanus* and the Cholistan Desert Lacerta *Eremias cholistanica*. However, according to the Reptile Database online resource only the Cholistan Desert Lacerta is endemic.⁶⁷

The data for the herpetofauna survey carried out for the Thar Coal Block II Mining Project⁶⁸ has been provided in **Appendix G** along with information about their conservation status based on Pakistani guidelines and CITES Appendices.

4.4.4 Conclusions

Vegetation – there are no plant species of conservation importance in the Study Area.

Mammals – none of the mammal species are of conservation importance based on the IUCN Red List of Threatened Species. However, according to Pakistan's National Red List, there are certain species which are of conservation importance, however, their distribution is widespread and not limited to the Study Area.

Herpetofauna – there is at least one endemic species and possibly three. However, their distribution is widespread and they are not restricted to any habitat type, therefore, there is no species of conservation importance in the Study Area amongst herpetofauna.

Birds – the main concern is with respect to vulture species and certain bird species such as the Laggar Falcon which are of conservation importance according to the IUCN Red List of Threatened Species.

⁶² Ibid

⁶³ Khan, Muhammad Sharif. Amphibians and reptiles of Pakistan. Krieger Publishing Company, 2006.

⁶⁴ IUCN 2015. *The IUCN Red List of Threatened Species. Version 2015-4*. <<http://www.iucnredlist.org>>. accessed December 14, 2015

⁶⁵ UNEP-WCMC. SPECIES+ CITES database. < <http://www.speciesplus.net/species> > accessed 19th November 2015

⁶⁶ Khan, Muhammad Sharif. Amphibians and reptiles of Pakistan. Krieger Publishing Company, 2006.

⁶⁷ Uetz, P. (editor), The Reptile Database, <http://www.reptile-database.org>, accessed May 9, 2016

⁶⁸ Hagler Bailly Pakistan, Environmental Impact Assessment of Thar Coal Block II Mining Project Final Report for Sindh Engro Coal Mining Company, September 3, 2012

The only protected area near the Study Area is the Rann of Kutch Wildlife Sanctuary. This is 32 km from the Study Area and will not be adversely affected by the Project.

4.5 Socioeconomic Baseline

The baseline was developed using a combination of secondary sources. The main data source was the ESIA Thar Coal Block II Power Plant Project, for which the Study Area covers the same villages as this study. Ground verification was performed during consultations with the villages in the Study Area.

Other key secondary sources of information for this baseline study include official statistics, such as maps, census reports and other available documentation on the history of the people and the area from a broad selection of recent and reliable sources, both published and unpublished. These sources of information include:

- ☞ Information collected from the Thardeep Rural Development Programme offices;
- ☞ Development Statistics of Sindh, 2006;
- ☞ Pakistan Social and Living Standards Measurement Survey (PSLM) 2006-07;
- ☞ District Census Reports, 1998, published by Population Census Organization, Government of Pakistan;
- ☞ Development statistics published by the Federal Bureau of Statistics, Government of Pakistan;
- ☞ Other published material from the private sector, including NGOs working in the Sindh province.

4.5.1 Governance and Administration

Thar Desert has been governed by various rulers of Sindh over the last millennium. In 1843, the British rulers merged it into the Kutch Political Agency. In 1882, the Thar Desert was upgraded to the Tharparkar District and made a part of the Hyderabad Collectorate. In December 1990, the district was bifurcated into two districts including Mirpurkhas, and Tharparkar with headquarters at Mithi.

The Study Area falls within the Tharparkar District of Sindh Province. The District lies between 24° 10' to 25°45' N latitudes and 69° 04' to 71°06' E longitudes. There is a single local government at the District level called the District Government. The District Government consists of an elected District (*zila*) Council Chairman. The District administration comprises District offices including sub-offices at UC and town level (includes municipal and town committees).

The District is bounded on the east by India (Jaisalmer District), whereas the northern and western peripheries are bounded by the Mirpurkhas and Badin districts respectively. In the south of Tharparkar, there is an extensive marsh, known as Rann, and the Indian district of Kutch.

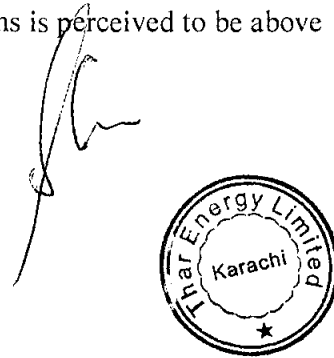
Tharparkar is administratively divided into six *talukas*, namely Mithi, Diplo, Nagarparkar and Chachro, Dhali and Islamkot. The taluka are further sub-divided into Union Councils, town committees and municipal committees. Each Union Council has villages (*dehs*) under its administration, while the municipal and town committees have municipal

or town subdivisions called *wards*. The Energy Park falls within the Islamkot *taluka* as shown in **Exhibit 4.55**.

Social Organizations

Civil society organizations have been active in Tharparkar District since the 1960s. Save the Children Fund, now transformed into Thardeep Rural Development Program (TRDP), is the largest NGO in Sindh. It has staff, offices and programs in all *talukas* of the Tharparkar district, and a field office in the town of Islamkot near Thar coal field. and Participatory Village Development Programme (PVDP) works mostly with the *Kolhi* and *Bheel* scheduled castes. Other NGOs working in Tharparkar include the Trust for Voluntary Organizations (TVO), Baanhn Beli (helping hands) organization and the Marooara Coordination Council. Civil society groups in the area include the Press Club Mithi, Press Club Islamkot and Sindhi Adabi Sungat among others.

The performance of these social and political organizations is perceived to be above average by the locals in the Study Area.



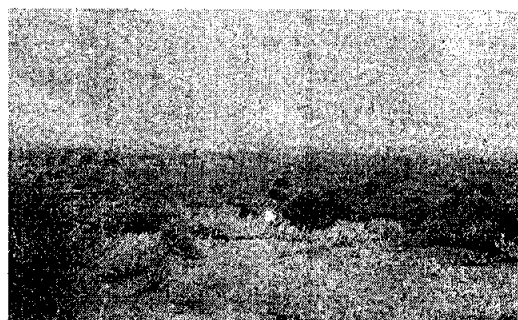
4.5.2 Land Cover and Land Use

The Study Area covers 111 square km of which of sand dunes cover 43 km² (38%) and plains cover 69 km² (62%)⁶⁹. Major land uses in the Study Area consists of settlements (2%), agricultural fields (61%) and grazing areas (37%). Sand dunes are permanent with significant vegetative cover and therefore are suitable for use as grazing lands. Once the crop is harvested livestock is also grazed on the agricultural fields. Photographs of different land uses are shown in **Exhibit 4.57**. The distribution of these uses is given in **Exhibit 4.58** and a land use map is shown in **Exhibit 4.59**.

Exhibit 4.57: Photographs of Different Land Uses in the Study Area



Sand Dunes are permanent with significant vegetation cover.



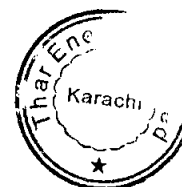
Uncultivated plains are used for grazing livestock.



A village on the plain, nestled between dunes



Agriculture field on the plains.



⁶⁹ As indicated by digitized Google Earth imagery dated April 10, 2013.

Exhibit 4.58: Land Cover and Land Use Distribution in the Study Area

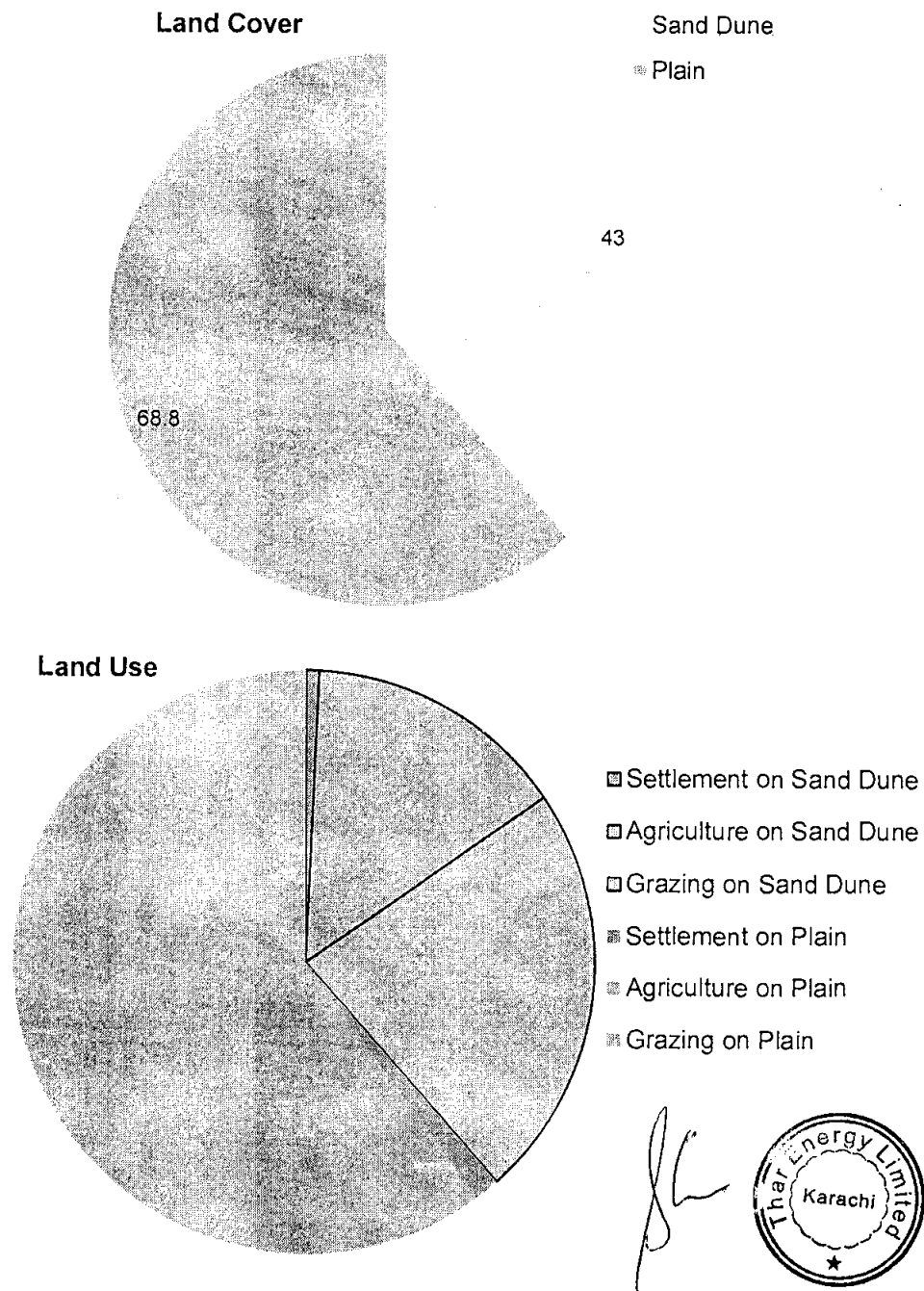
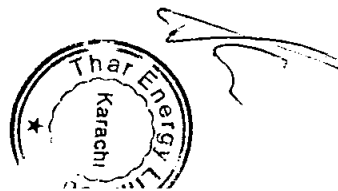
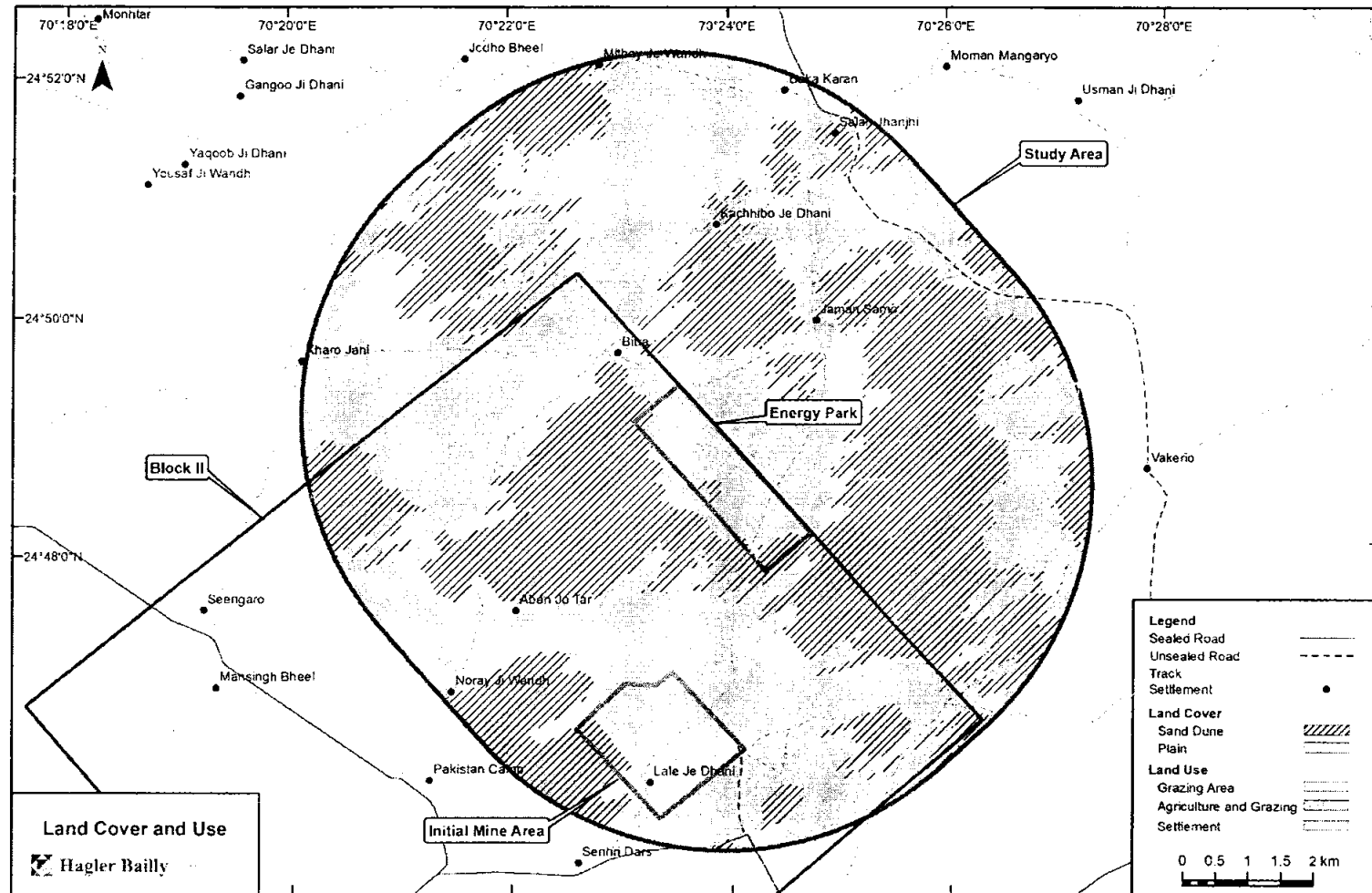


Exhibit 4.59: Land Cover and Land Use



4.5.3 Demography

The estimated population of the Tharparkar District ('District') as compared to Sindh and Pakistan is given in **Exhibit 4.60**. Although the Thar Desert is considered as one of the most densely populated deserts in the world, the population of Tharparkar District represents less than one percent of the country's population and three percent of Sindh's population. The population density of the District is low at 47 persons per square kilometer, nearly 6.7 times lower than the provincial average of 326 persons per square kilometer. However, the density is on the rise since 1998.

Exhibit 4.60: Population and Growth⁷⁰

	Population, 000'				Land Area		Density (persons per sq. km)	
	1998	%	2015*	%	sq. km	%	1998	2015*
Study Area	NA	NA	6.2**71		112	0.01%	NA	55
Tharparkar (District)	914*	0.7%	1,273	0.7%	19,638	2.5%	47	65
Sindh	30,440	23.0%	45,988	24.0%	140,914	17.7%	216	326
Pakistan	132,352	100.0%	191,708	100.0%	796,096	100.0%	166	241

Note: * 2010 for Tharparkar

** 2014 for Study Area

The Study Area, as with the majority of Tharparkar is rural, and contains ten villages with an average of approximately 600 persons per settlement. The distribution of the population by settlement is given in **Exhibit 4.61**.

Exhibit 4.61: Population of Settlements in the Study Area⁷²

No	Village	Population
1	Baka Karan	500
2	Salah Jhanjhi	1,500
3	Kachhibo Je Dhani	210
4	Jaman Samo	900
5	Bitra	600
6	Mithay Je Wandh	120
7	Kharo Jani	1,200
8	Aban Jo Tar	1,100

⁷⁰ Ministry of Finance, Government of Pakistan, Statistical Appendices of Chapter 12, Population, Labour Force and Employment, Pakistan Economic Survey 2014-2015, (Government of Pakistan, 2015)

⁷¹ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

⁷² Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

No	Village	Population
9	Lale Je Dhani	30
10	Noray Ji Wandh	60
	Total	6231

Size of Settlements and Households

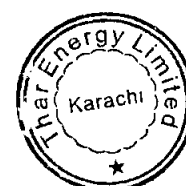
A comparison of village and household sizes as recorded in the Study Area with those recorded by the 1998 district statistics for Tharparkar is presented in **Exhibit 4.62** and **Exhibit 4.63** respectively. The population density map in **Exhibit 4.64**, shows the population of each village in the Study Area. Village sizes, in terms of population in the Study Area, range from 60 to 1,500 for the smallest and largest settlements respectively.

Exhibit 4.62: Average Population per Settlement in Tharparkar and Study Area⁷³

	Number of Settlements	Total Population	Average Population per Settlement
Study Area	10	6231	623
Tharparkar (1998)	2000	914,291	4,57

Exhibit 4.63: Average Household Size

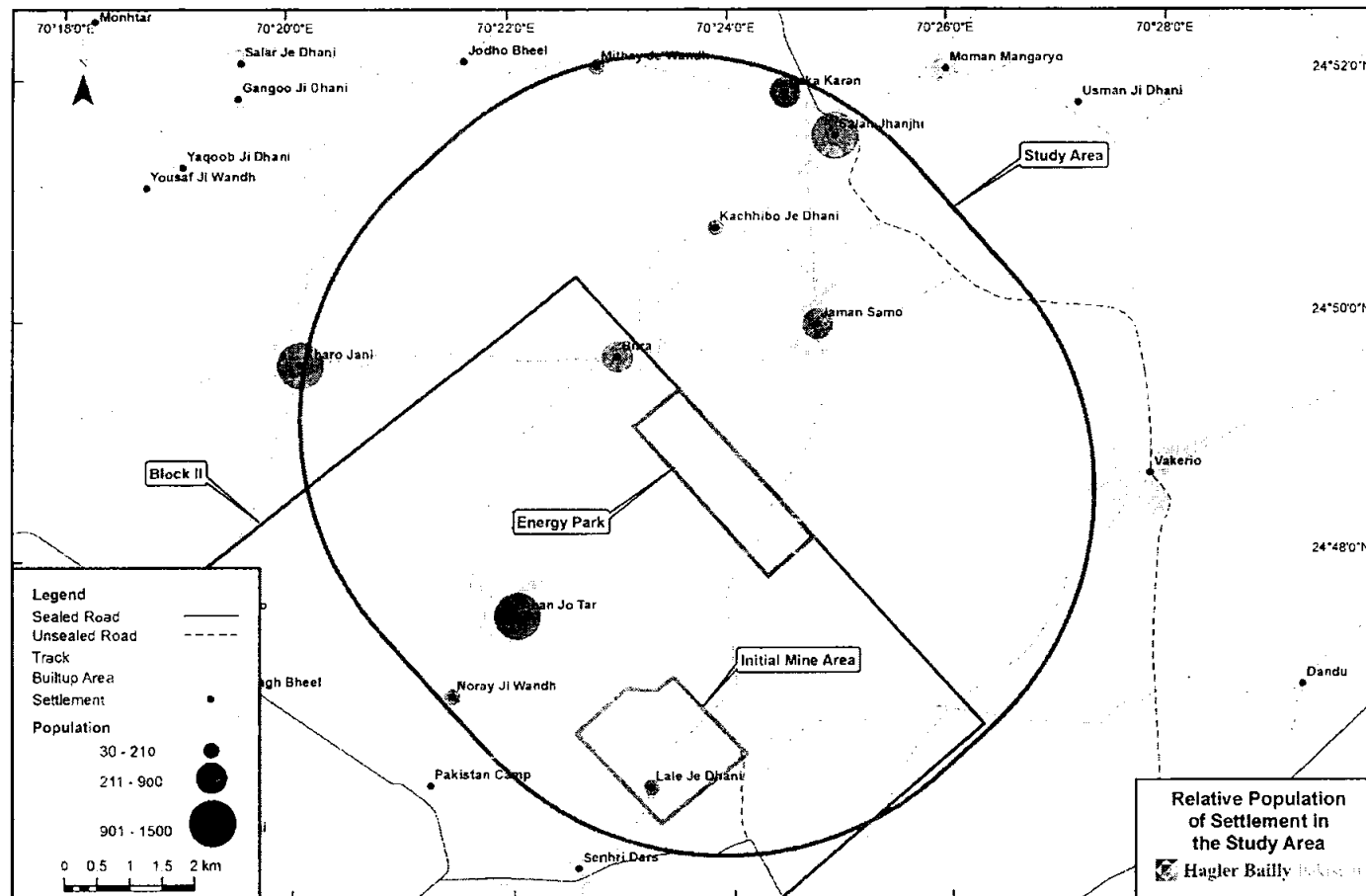
	Sample Size	Average Household Size
Previous Study ⁷⁴	81	6.2
Rural Tharparkar (1998)	156,591	5.6
Save the Children	383	8.3



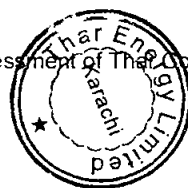
⁷³ Ibid

⁷⁴ Hagler Bailly Pakistan. Environmental and Social Study of Thar Coal Block II Mining Project. Pakistan, February 2011

Exhibit 4.64: Population Distribution in the Study Area⁷⁵



⁷⁵ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014



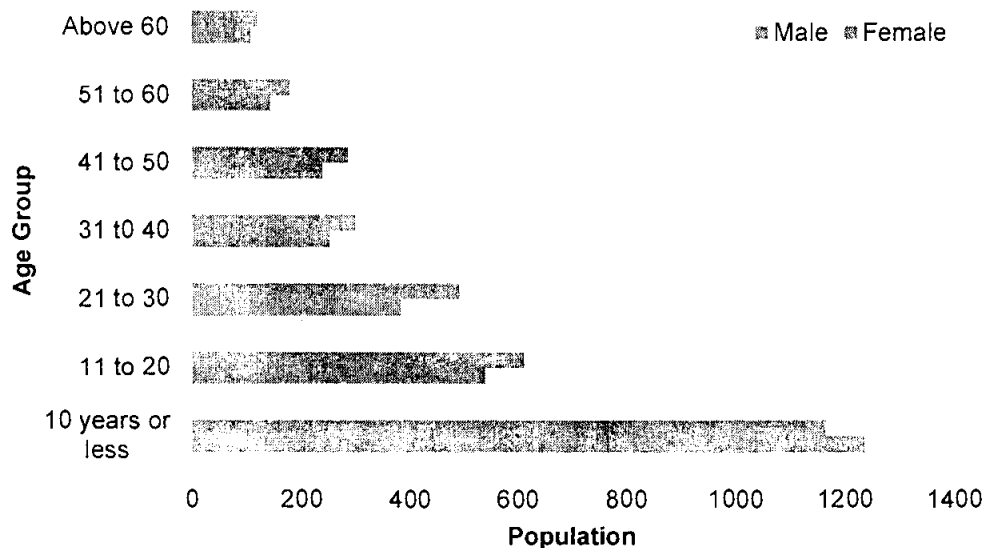
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Gender and Age Profile.

The population pyramid of the Study Area is shown in **Exhibit 4.65**. The population pyramid has a broad base with a relatively large number (40%) of children (10 years of age or less), which indicates high birth rates. The sharp decline of the pyramid signifies a low life expectancy amongst the population of the Study Area, as those above 60 years of age account for only 4% of the population. The structure also shows that more than half (around 60%) of the population is 20 years of age or younger.

While there are more female than male children 10 years or younger, this trend reverses for the other age brackets. This indicates a possible higher death rate for female children which could indicate a disparity in care or facilities available to the different sexes.

Exhibit 4.65: Age and Sex Composition of Study Area⁷⁶



4.5.4 Ethnology and Religion

The inhabitants of the Study Area, as those of the larger Thar Desert, belong to different religions, sects and castes which gives the area a rich multifaceted culture.

Religion

Hindus and Muslims form the two ethnic groups of the Study Area and are further split into multiple castes. **Exhibit 4.66** provides the percentage distribution of population by main religious groups in Tharparkar District. Muslims are in the majority, forming 59.4% of the District's population. However, the ESIA of the Block II coal mine, which

⁷⁶ Based on Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

surveyed a larger but overlapping Study Area than this study, noted that the area has a Hindu majority (55.6.% Hindus as compared to 44.4% Muslims).⁷⁷

Exhibit 4.66: Percentage of Tharparkar District Population by Religion, 1998

Religion	District wide	Rural	Urban	Study Area
Muslim	59.4%	60.8%	29.5%	44.4%
Hindu	40.5%	39.1%	69.6%	55.6%
Others	0.1%	0.1%	0.9%	0.0

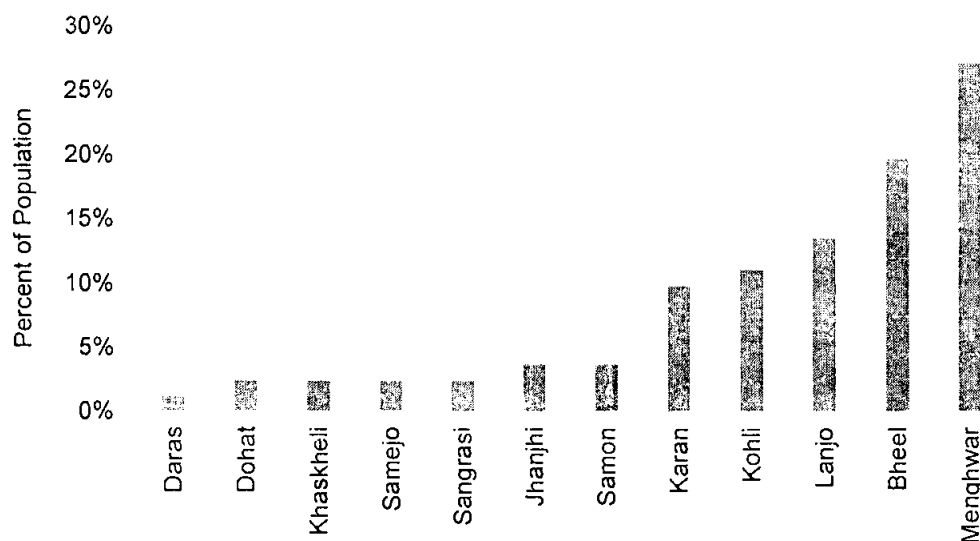
Source: District Census Report of Tharparkar, 1998, Population Census Organization, Statistics Division, Government of Pakistan

Castes

A caste is a social class separated from others by distinctions of hereditary rank, profession, or wealth. In this study, the term caste has not been used in its strict definitional sense. It carries a different meaning for the Hindus and Muslims. Therefore, for the two ethnic groups, the term caste should be understood in light of the explanation provided in the statements to follow. The Hindu castes were established under the Hindu religion and not only on social grounds. On the other hand, the Muslim castes are not recognized by the religion, but are differentiated on religious, social or hereditary basis.

The distribution of the households in the Study Area by Hindu and Muslim castes is provided in **Exhibit 4.67**.

Exhibit 4.67: Distribution of Population in the Study Area by Castes⁷⁸



⁷⁷ Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report for Sindh Engro Coal Mining Company, February 15, 2011

⁷⁸ Hagler Bailly Pakistan, Environmental and Social Study of Thar Coal Block II Mining Project, Final Report, February 2011

Language

The main languages spoken in the Tharparkar District are Sindhi and Dhatki. In the Study Area, Muslims typically speak Sindhi and/or Dhatki as their primary language while Hindus primarily speak Dhatki only

4.5.5 Family Structure

The division of labor in the villages of Tharparkar is gender based and clearly demarcated, as is the case with most traditional communities. A household usually contains two gender-based positions of authority: the first is the position of the head of the household. This position belongs to the oldest, able-bodied male member of a household. The second, which is subordinate to that of the household head, is the position of the senior woman.

Exhibit 4.68: People of the Study Area



Village elders



Indigenous women

4.5.6 Livelihoods and the Local Economy

Types of Occupations

The majority (77%) of the employed population of the District was engaged in primary occupations such as agriculture and livestock according to the 1998 population census. Other occupations in the district include woodwork, wool-weaving, leather work, jewelry-making, cloth-dyeing, embroidery, and snake-charming. The number of artisans has increased over the last decade to meet the demand for handicrafts.

The Thar Desert is considered to be one of the greenest deserts in the world. The alluvial silt-mixed sands, relatively flat ground surface and summer monsoon rain (see **Section 4.1.6**) encourage agriculture and recharge groundwater for natural scrub vegetation thereon. There is only one cropping season in the summer (called *kharif* season) in which a variety of summer crops are grown. About 27,000 hectares (60,000 acres) within the district are irrigated through the Thar Minor of Jamrao canal. Crops grown using irrigation include cotton, wheat, sugarcane, rice, chilies, fodder and vegetables. Crops grown in rain-fed lands include sorghum (*jowar*), millet (*bajra*), sesame, guar, moth beans, mung beans and sesame.⁷⁹

⁷⁹ Development Statistics of Sindh, 2006

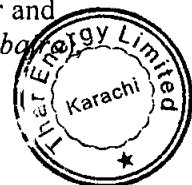


Exhibit 4.69: Average Annual Yield, Usage and Average Income from Crops Grown⁸⁰⁸¹

Type of Crop	Average Annual Yield kg/Acre	Consumed (%)	Sold (%)	Average Income (Rs/kg)
Millet	377	86%	14%	20
Guar	444	14%	86%	36
Mung Beans	150	10%	90%	49
Moth Beans	182	8%	92%	37

The natural scrub vegetation and harvested agricultural lands serve as grazing grounds for the large animal herds for most of the year. Dug wells are the major source of water for livestock. **Exhibit 4.70** shows images of livestock in the area. Due to recent droughts, which reduced ground water levels substantially, large numbers of livestock herds have moved from the desert to the canal fed lands to the west. An estimate of the population levels of livestock in Tharparkar is given in **Exhibit 4.71** and average livestock held by each household in **Exhibit 4.72**.

Exhibit 4.70: Typical images of Livestock



Camels



Livestock use roads to access grazing areas.

Exhibit 4.71: Livestock Population in Study Area

Type of Livestock	Livestock Population in Study Area ⁸²	Livestock Population in Tharparkar (2000) ⁸³
Total Population	10,559	3,806,000
Goats and Sheep	77%	79%

⁸⁰ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

⁸¹ Average income (Rs/kg) taken from Resettlement Study Sample Household Survey

⁸² Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

⁸³ Development Statistics of Sindh, 2006



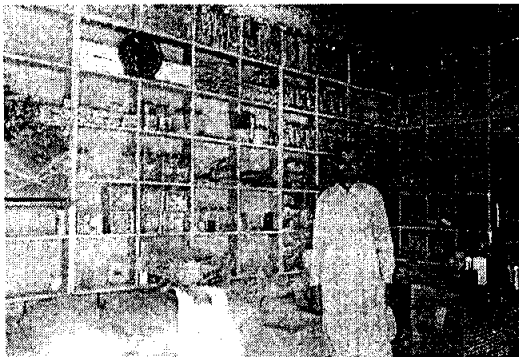
Type of Livestock	Livestock Population in Study Area ⁸²	Livestock Population in Tharparkar (2000) ⁸³
Camels	6%	3%
Cows/Oxen	13%	14%
Donkeys	4%	4%
Horses	0.03%	0.26%

Exhibit 4.72: Average Livestock Population and Average Price of Livestock⁸⁴

Type of Livestock	Average Number/Household	Average Price (Rs/Animal)
Goats and Sheep	23	6,000
Camels	1	120,000
Cows/Oxen	2	43,333
Donkeys	2	4,000

Small businesses within the Study Area, shown in **Exhibit 4.73**, include shops that are located in larger settlements or on the roadsides.

Exhibit 4.73: Small Businesses within the Study Area



A village store



A roadside tea stall

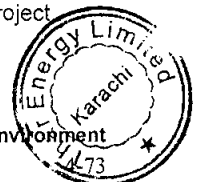


An oil and air pump for bikes



A wheat mill and granary

⁸⁴ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project Pakistan, January 2014



Income, Expenditure and Poverty

Tharparkar has been consistently ranked as one of the most deprived districts provincially and nationally. The Annual Report on Poverty 2001 by the Social Policy Development Center (SPDC) ranked Tharparkar as the most deprived district in Sindh and 84th out of 98 districts in Pakistan in terms of deprivation. A more recent analysis by SPDC in 2005 showed that the provincial ranking for Tharparkar improved marginally, with the district being ranked 15th out of 16 districts in Sindh⁸⁵. National rankings for 2005 were unavailable. The same report by SPDC gives the predicted percentage of population below the poverty line at 30% for Tharparkar in 2005; 44% in urban areas and 24% in rural areas.

The estimated annual income per household in the Study Area, as reported in the literature is about Rs. 142,000⁸⁶. For an average household of 6.2 this amounts to Rs. 1700 per person per month. The poverty line of Pakistan is based on a consumption of 2,350 calories per adult equivalent per day. The latest estimate of the inflation-adjusted poverty line for 2006 as reported in the FY 2008 Economic Survey of Pakistan⁸⁷ was Rs 944 per adult equivalent per month. Inflating this number for inflation estimates of 2007, 2008, 2009, 2010 and 2011, the poverty line of Pakistan in FY2011 has been calculated as Rs 1,755. Based on this estimate, the average household is just below the national poverty line.

Average annual household expenditure in the surveyed population was around Rs 119,000. Thus, on the average, the average annual income per household is around 19% above the average annual expenditure per household. Food expenditures contribute the most (over 50%) to the overall household expenditures. This is in line with the Pakistan Household Integrated Economic Survey 2010-11,⁸⁸ which indicates that food items contribute around 55% to total household expenditures in rural areas of the country. After food, farm related expenditures have the largest share in the overall household budget.⁸⁹

The ratio of indebtedness in Tharparkar is reported as very high (more than 80%) due to droughts and poverty. Though borrowing from relatives is a preferred source of credit for many families, more than half of the loans are advanced by money lenders and shopkeepers. Because options are so limited, local money lenders tend to trap poor families in loans with interests ranging as high as 40% to 120%⁹⁰. In recent years, microfinance loans by the TRDP and other Pakistan Poverty Alleviation Fund (PPAF) partners have been introduced as a way to reduce poverty.

⁸⁵ Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Center, Karachi

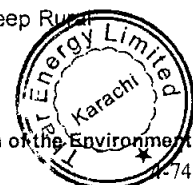
⁸⁶ Ibid

⁸⁷ Government of Pakistan, Economic Survey 2007-2008, Finance Division, Pakistan

⁸⁸ Government of Pakistan, Pakistan Household Integrated Economic Survey 2010-11, Federal Bureau of Statistics, Islamabad.

⁸⁹ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

⁹⁰ Reaching Out from Thar to Other Arid Zones of Sindh, Annual Report 2004-05; Thardeep Rural Development Programme (TRDP)



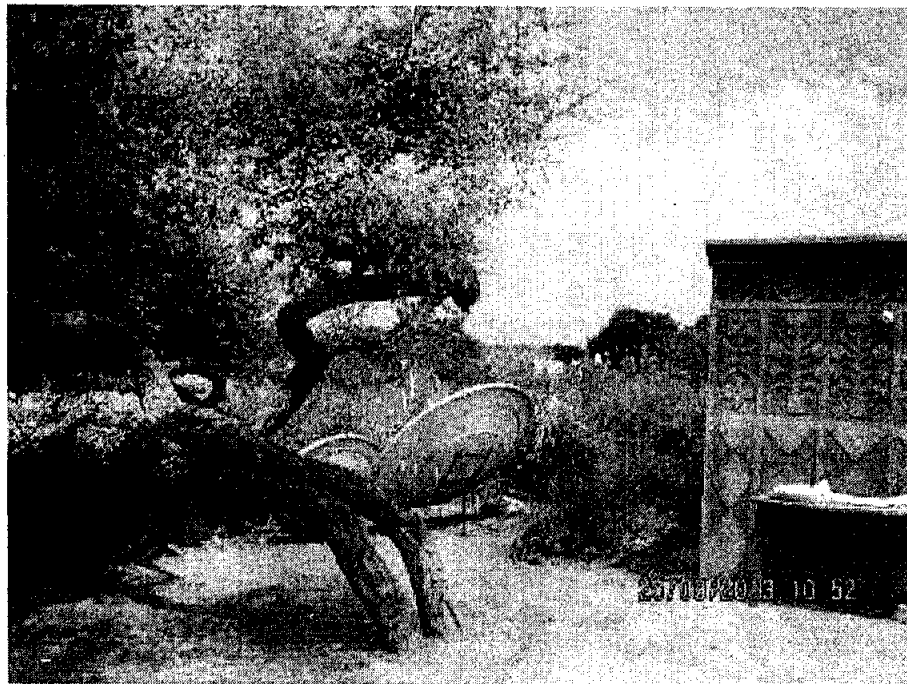
4.5.7 Physical Infrastructure and Services

The area has a weak infrastructure when compared to other districts provincially and nationally. It is discussed in this section.

Roads and Communication

The 1998 census reported that Tharparkar had 11 telephone exchanges. Cellular phones are the main mode of communication in the Study Area. Some homes, in larger villages connected to the electricity grid, receive television channels through satellite dish connections as shown in **Exhibit 4.74**.

Exhibit 4.74: Satellite Dish Connections⁹¹

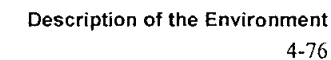


According to a 2006 report the District has a total of 737 km of roads, 529 km of which are of low quality⁹². Regular transport facilities to nearby towns in the form of private jeeps and buses is available at most villages. Road connectivity in the Study Area is mapped in **Exhibit 4.75**.



⁹¹ Source: HBP Library

⁹² Development Statistics of Sindh 2006



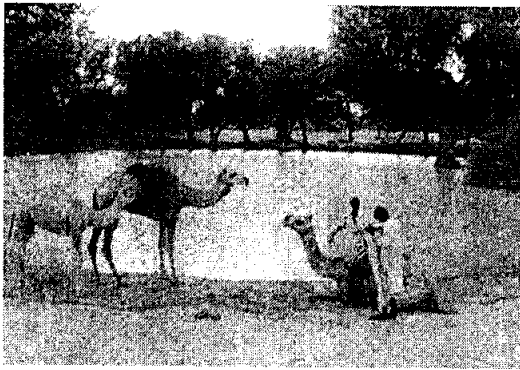
Community Water Supply and Quality

Water supply is a major problem faced by villages in Tharparkar. Most underground water is brackish and saline, there are no rivers and perineal springs are rare. Rainwater is collected in large open channels called *tarais*, and small underground tanks called *tankas*. There are also wells in lower lying areas that collect rainwater.

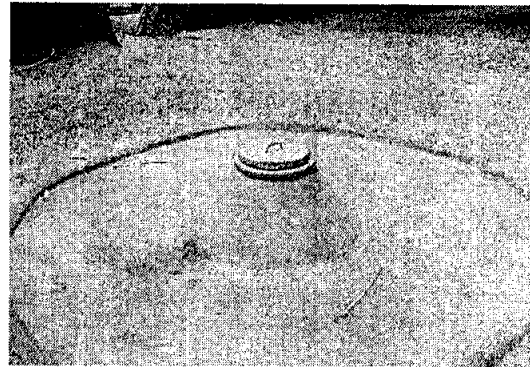
The main sources of drinking water for humans and livestock is from dug wells, which is supplemented by rainwater for a few months after the rainy season. Water is extracted from dug wells, through ropes attached to pulleys pulled by a pair of donkeys or a camel. It is tedious two person job, where one person leads the animal and the other unloads the large container once it has been pulled up. The water from wells is emptied into ponds for use of livestock. Wells are mostly communal and villagers take turns extracting water.

Recently, solar powered reverse osmosis systems have been installed in larger villages. Types of water sources in the Study Area are illustrated in **Exhibit 4.76**.

Exhibit 4.76: Water Sources in the Study Area



*Tarai*⁹³



Tanka



Dug Well



Collecting water in a pond for the livestock

⁹³ Hagler Bailly Pakistan. ESIA of Lignite Mining Project. Oracle Coalfields. Pakistan. April 30th 2013

Sanitation and Waste Disposal

Pakistan Social and Living Standards Measurement Survey 2010-11 (PSLM 2010-11) reported that 43% of the households in rural Tharparkar had no toilet, while 53% had a non-flush toilet. Only 4% of the households in rural Tharparkar had a flush toilet.

Sewerage or storm water drainage systems were not reported in any of the villages in the Study Area, and only open air pit latrines were available which were mostly constructed to facilitate women. Villagers reporting that waste is normally disposed of into open spaces at some distance from houses due to the absence of any solid waste management system.⁹⁴

Housing

The main mode of construction in rural Tharparkar consists of huts called *chaunras* with pointed thatched roofs of shrubs and grasses they are built on mud plastered platforms. The 1998 population census reported that 85% of all housing units in rural Tharparkar were of *kacha* or adobe construction, while a mere 5% were of *pakka* or masonry construction. Examples of houses within the Study Area are shown in Exhibit 4.77.

Exhibit 4.77: Housing Structures in the Study Area⁹⁵



A masonry or *pakka* house adjacent to the left of an adobe *chaunra*

Power and Fuel Supply

The 1998 census reported that only 6.75% of the housing units were using electricity in Tharparkar. Electricity usage in the urban areas was much higher at 68.38% of housing units, compared to only 4% in rural areas. An improvement in this number was seen with 44% of rural houses in Tharparkar using electricity in 2011.⁹⁶

⁹⁴ Hagler Bailly Pakistan. Environmental Impact Assessment of Thar Coal Block II Power Plant Project. Pakistan, January 2014

⁹⁵ Source: HBP Library

⁹⁶ Pakistan Social and Living Standards Measurement Survey 2010-11

Locals do not cut trees for fuelwood, rather harvest fast growing shrubs and bushes for cooking. There is no natural gas supply in the Study Area and most villages do not use of liquefied petroleum gas (LPG), kerosene or diesel to meet domestic fuel requirements.

4.5.8 Social Infrastructure

An overview of the health and education facilities that are available in the Tharparkar District are discussed.

Health

A high maternal mortality rate of 800 deaths per 100,000 live births in 1992, and a high infant mortality rate (IMR) of the district in 1992 at 150 (deaths per 1,000 live births) indicates a lack of health facilities in the area. These figures can be compared to the 8 times lower national IMR rate of 100 and that for Sindh at 98⁹⁷.

Health services are mainly provided through basic health units (BHUs), rural health centers (RHCs) and district head quarter hospitals that are equipped for primary health care services and to some extent comprehensive emergency obstetric care services⁹⁸.

Exhibit 4.78 shows a comparison of the number of government health facilities present in Tharparkar in 1998 with the number of facilities present in 2005⁹⁹. Rural health centers and basic health units have increased whereas other facilities have either declined in number or stayed constant. The number of private local clinics has, however, increased over the past decade.

Exhibit 4.78: Health Facilities in Tharparkar District

Health Facility	1998	2005
Hospitals	3	3
Rural Health Centers	3	10
Basic Health Units	21	32
Dispensaries	38	31
Maternity and Child Welfare Centers	2	1

As reported in a study conducted by Thardeep Rural Development Programme (TRDP)¹⁰⁰, the Thar coalfield area had just one BHU and four government dispensaries in 2003. The villagers mostly travel to the nearby towns of Mithi and Islamkot for health

⁹⁷ Thardeep Rural Development Programme (TRDP); Pakistan Economic Survey, Finance Division, Government of Pakistan; Social Development in Pakistan, Annual Review 2006-07, Social Policy and Development Centre

⁹⁸ Emergency obstetric care (EmOC) refers to the care of women and newborns during pregnancy, delivery and the time after delivery

⁹⁹ 1998 District Census Report of Tharparkar; Development Statistics of Sindh, 2006.

¹⁰⁰ Thardeep Rural Development Programme (TRDP), 'Socioeconomic and Environmental Aspects of Coal Mining in Tharparkar District' (2003)



facilities. Islamkot has a rural health center (RHC), while Mithi has a district hospital facility.

Education

Literacy¹⁰¹ in Tharparkar district is low and shows high gender disparity. The 1998 population census reported the literacy rate of Tharparkar district at 18.32%; 28.3% for males and 6.9% for females. In rural areas, the literacy rate was 25.72% for males and a mere 4.8% for females.

There has, however, been a distinct upward trend of literacy in the district, as shown by literacy rates of rural localities in 2010-11 reported in the PSLM. Both male and female literacy have increased significantly in rural Tharparkar since 1998 and are now at par with the literacy rates in rural Sindh and rural Pakistan, although the overall literacy rate of Tharparkar (46%) remains below the overall literacy rates of Sindh (59%) and Pakistan (58%).

Adult literacy¹⁰² was recorded at 57% for males and 13% for females in rural Tharparkar in 2011¹⁰³.

Tharparkar fares better nationally and provincially in terms of net primary enrollment rate, with PMDG 2006 ranking Tharparkar 51st out of 98 national districts, and 7th out of 16 provincial districts. A comparison of the net primary enrollment rate for 2010-11 for rural localities shows that Tharparkar now fares better than Sindh (**Exhibit 4.79**). The gender disparity in enrollment at the primary level, though present, is less pronounced.

Exhibit 4.79: Net Primary Enrollment Rate in Rural Localities, 2010-2011¹⁰⁴

	Male	Female	Total
Tharparkar	70%	54%	63%
Sindh	63%	43%	54%
Pakistan	68%	56%	62%

Considering the gender imbalance in enrollment in educational institutions, community support programs should give attention to improving access to education for girls.

4.5.9 Cultural Heritage

There are a large number of religious, archeological and cultural sites of significance in the Thar area. These include temples, forts, and tombs.

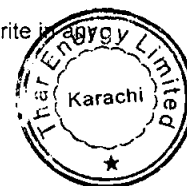
The site closest to the Study Area is the Gad of Mirs (Talpuars) in Block II. It is located in the south of Seengaro Village about 10 km southeast of the Energy Park. The Gad of

¹⁰¹ Literacy is defined as "all those persons ten years of age and above who could read and write in any language with understanding, as percentage of the population ten years and above."

¹⁰² Literacy in population aged 15 years and above

¹⁰³ Pakistan Social and Living Standards Measurement Survey 2010-11

¹⁰⁴ Pakistan Social and Living Standards Measurement Survey 2010-11



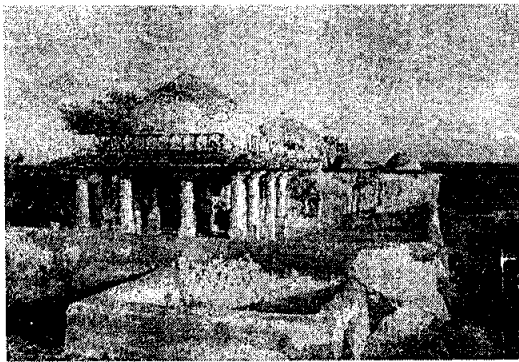
Mirs (Talpur), which belongs to the Talpur period (1784 to 1843),^{105,106} had a square plan. It had four bastions with a main gate opening to the east and a well in the center of the fortress. Close to the northern ramparts there were a few buildings used as residence. The condition of the fortress is poor due to lack of proper maintenance.

The Gorri temple is said to be built around 1376 AD, in the golden era of the Sodhas. Images of the temple are shown in **Exhibit 4.80**. Other important cultural sites that are close to the Study Area are mapped in **Exhibit 4.81**.

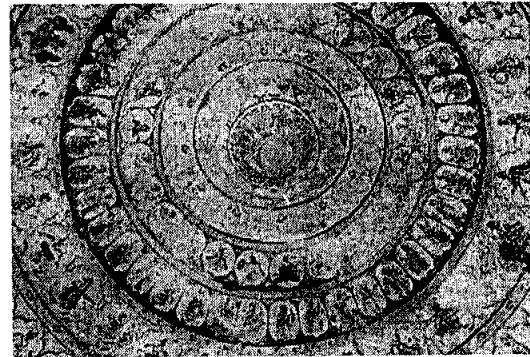
Cemeteries exist in almost every village. Muslims and Hindus bury their dead in their respective cemeteries. The Thakurs first cremate their dead and the ashes are buried.

Mosques and shrines are places of Muslim worship. Hindu places of worship include temples and shrines. Temples are located in almost every village.

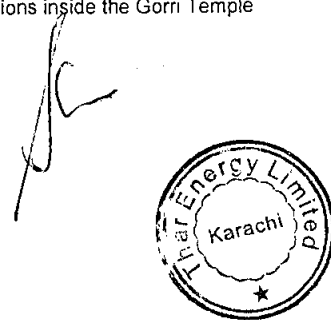
Exhibit 4.80: Gorri Temple¹⁰⁷



View of the Gorri Temple



View of roof inscriptions inside the Gorri Temple



¹⁰⁵ Ursani, M.I., *Ser Registan (Travels into desert)* 2nd edition, Jamshoro, Sindhi Adabi Board (1995)

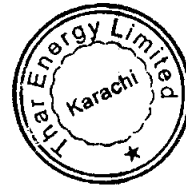
¹⁰⁶ Baloch, N.A., *Sindh: Studies Historical*, Jamshoro, University of Sindh (2003)

¹⁰⁷ Source: HBP Library

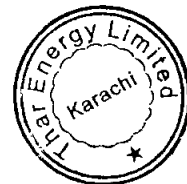
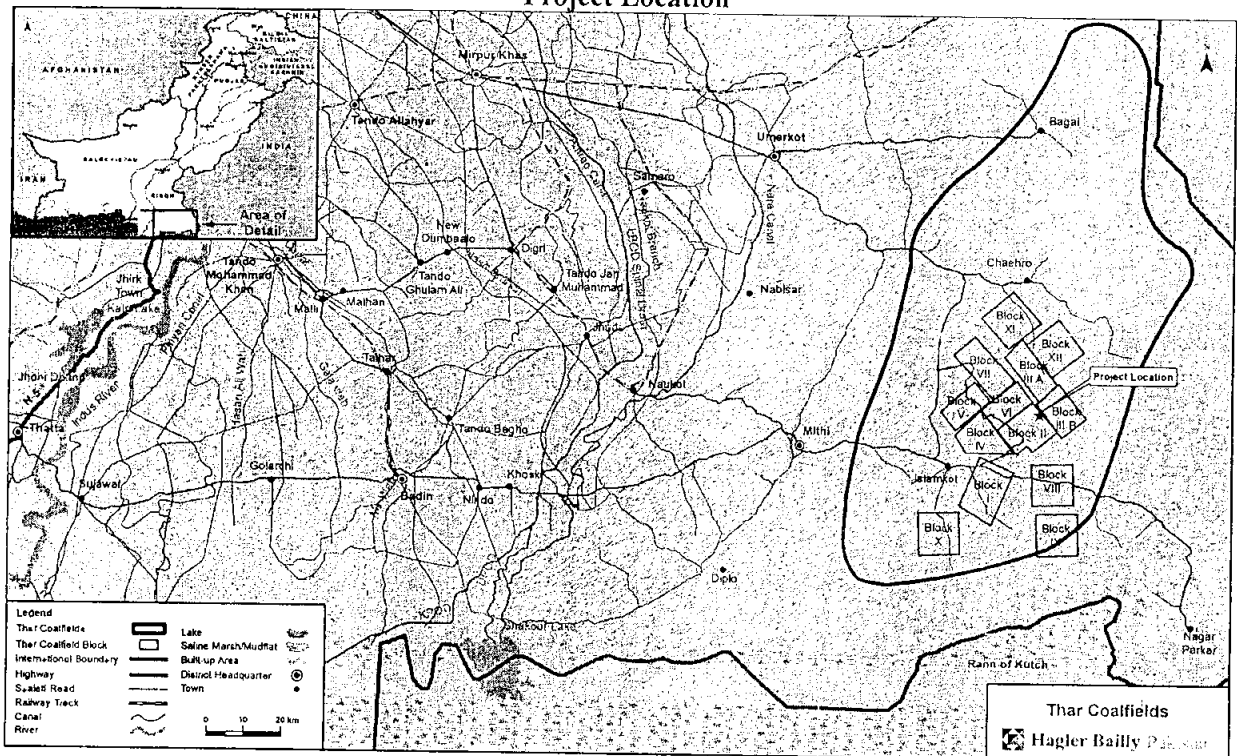
S

Information
for
SCHEDULE I

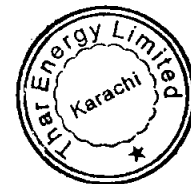
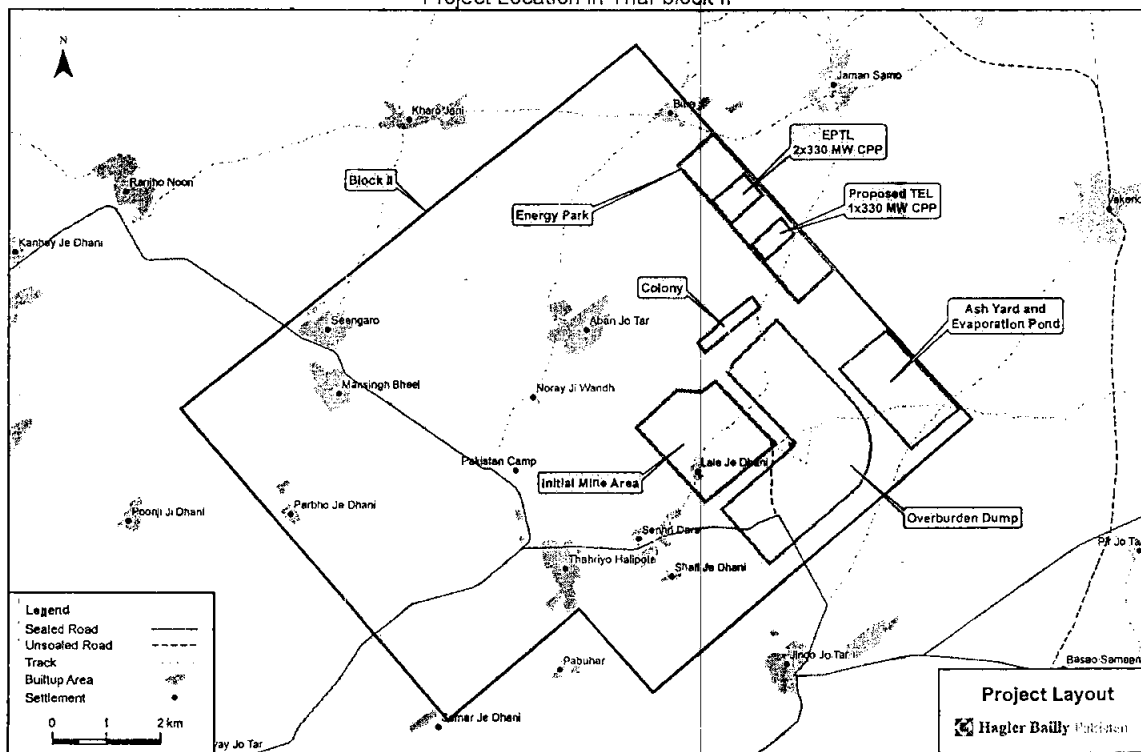
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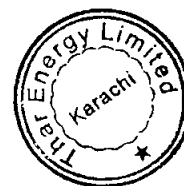
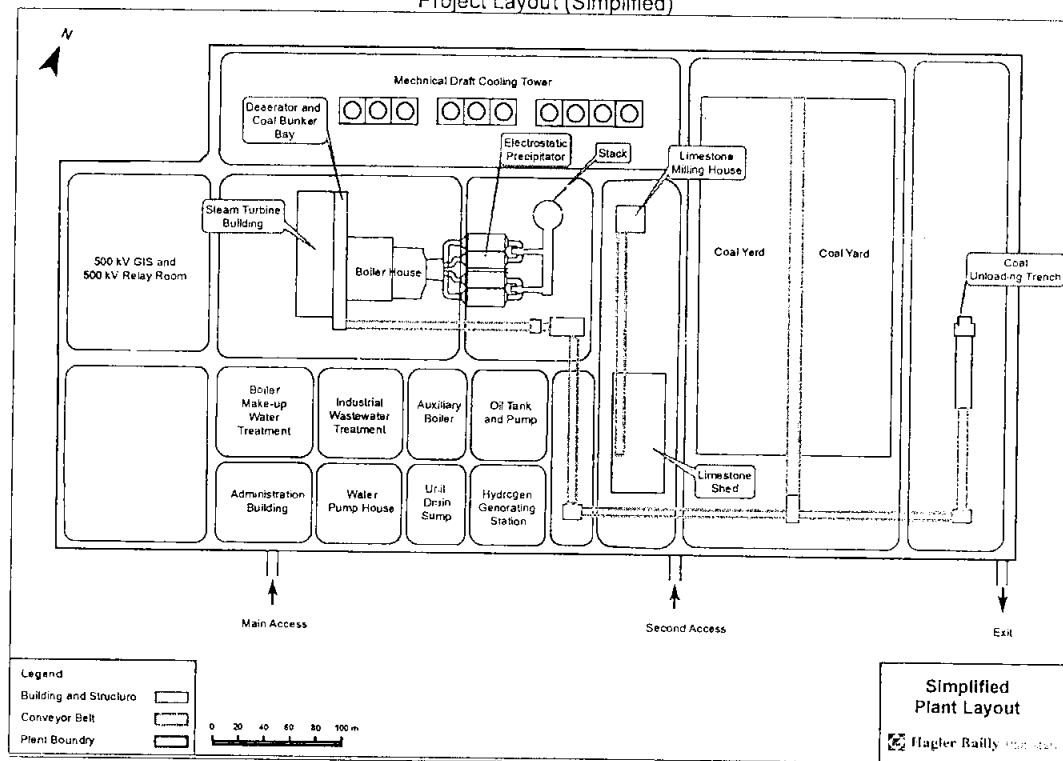
Project Location



Project Location in Thar block II



Project Layout (Simplified)



**Interconnection Facilities/
Transmission Arrangements for Dispersal of Power from
the Generation Facility**

The electric power from the Coal based generation facility will be dispersed to the National Grid.

The Interconnection Facilities (IF)/Transmission Arrangements (TA) for transporting power to national grid consists of 500 kV transmission lines for Thar Energy Power Plant will be constructed by National Transmission and Dispatch Company (NTDC). These lines are planned to be eventually connected to Matiari grid, 230 km away, from where the power will be transported to the load center of Pakistan in Punjab through HVDC transmission network.

Any change in the above mentioned IF/TA for dispersal of electric power as agreed by the Licensee and the Power Purchaser shall be communicated to the Authority in due course of time.

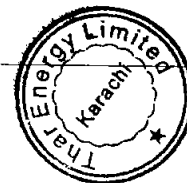
**Detail of
Generation Facility/
Power Plant**

(A). General Information

(i).	Name of Company/Licensee	Thar Energy Limited (TEL)
(ii).	Registered /Business Office	11 th Floor, Ocean Tower, G-3, Block-9, Main Clifton Road, P.O. Box No. 13841, Karachi – 75600
(iii).	Plant Location	Thar, Sindh
(iv).	Type of Generation Facility	Sub-critical, CFB technology, 1x330MW Thermal Coal Fired Power Plant based on indigenous (lignite) Coal of Thar Block II

(B). Plant Configuration

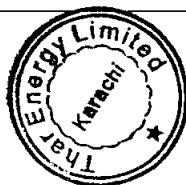
(i).	Plant Size Installed Capacity	330 MW
(ii).	Type of Technology	Sub-critical CFB technology 1x330MW Coal Fired Power Plant
(iii).	Number of Units/Size (MW)	1 x 330 MW
(iv).	Unit Make/Model/Type & Year of Manufacture Etc.	To be provided once the EPC is finalized



(v).	Commissioning/ Commercial Operation Date of the Generation Facility	Expected COD in July, 2020
(vi).	Expected Useful Life of the Generation Facility from Commercial Operation/ Commissioning Date	30 years

(C). Fuel/Raw Material Details

(i).	Primary Fuel	Indigenous Coal from Thar Block II Coal fields		
(ii).	Alternative Fuel	Imported lignite Coal from Indonesia		
(iii).	Start-up fuel	HSD		
(iv).	Fuel Source for each of the above (i.e. Imported/ Indigenous)	Indigenous / Imported (lignite)		
(v).	Fuel Supplier for each of the above	Primary Fuel	Alternative Fuel	Start-Up Fuel
		SECMC (Thar Block-II)	Trafigura / Anglo American / Mercuria	PSO / Shell / Bakri Trading Company Ltd
(vi).	Supply Arrangement for each of the above	Primary Fuel	Alternative Fuel	Start-Up Fuel
		Trucking (Mine mouth Plant)	Marine shipment/Truck ing/Railways	Oil tankers
(vii).	No of Storage Bunkers/Tanks/ Open Yard	Primary Fuel	Alternative Fuel	Start-Up Fuel
		1 Open Yard	1 Open Yard	2 Tanks



(viii).	Storage Capacity of each Bunkers/Tanks/Open Yard	Primary Fuel	Alternative Fuel	Start-Up Fuel
		19.5 x 10 ⁴ t	19.5 x 10 ⁴ t	2 x 500 m ³
(ix).	Gross Storage	Primary Fuel	Alternative Fuel	Start-Up Fuel
		19.5 x 10 ⁴ t	19.5 x 10 ⁴ t	1,000 m ³

(D). **Emission Values**

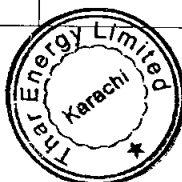
		Primary Fuel	Alternative Fuel	Start-Up Fuel
(i).	SO _x (mg/Nm ³)	< 850 mg/Nm ³	< 850 mg/Nm ³	N/A
(ii).	NO _x (mg/Nm ³)	< 510 mg/Nm ³	< 510 mg/Nm ³	N/A
(iii).	CO ₂ %	To be provided later	To be provided later	N/A

(E). **Cooling System**

(i).	Cooling Water Source/Cycle	LBOD water in closed cooling water circuit (cooling waters based)

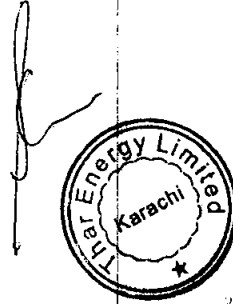
(F). **Plant Characteristics**

(i).	Generation Voltage	20 ~ 26 kV
(ii).	Frequency	50 Hz
(iii).	Power Factor	0.85
(iv).	Automatic Generation Control (AGC) (MW control is the general practice)	To be provided later
(v).	Ramping Rate (MW/min)	To be provided later
(vi).	Time required to Synchronize to Grid (Hrs.)	To be provided later



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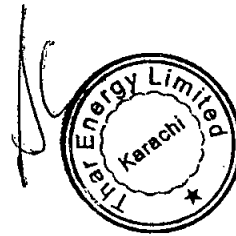
Note: The data provided above by the Licensee is tentative and may be subject to change. It will be finalized in design phase.



T

Information
for
SCHEDULE-II

The Installed/ISO Capacity (MW), De-Rated Capacity At Mean Site Conditions (MW), Auxiliary Consumption (MW) and the Net Capacity At Mean Site Conditions (MW) of the Generation Facilities of Licensee is given in this Schedule

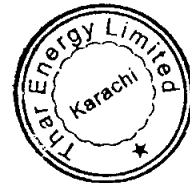


SCHEDULE-II

(1).	Total Gross Installed Capacity of the Generation Facility	330 MW
(2).	De-rated Capacity of Generation Facility at Reference Site Conditions	330 MW
(3).	Auxiliary Consumption of the Generation Facility	30 MW
(4).	Total Installed Net Capacity of Generation Facility at Reference Site Condition	300 MW

Note

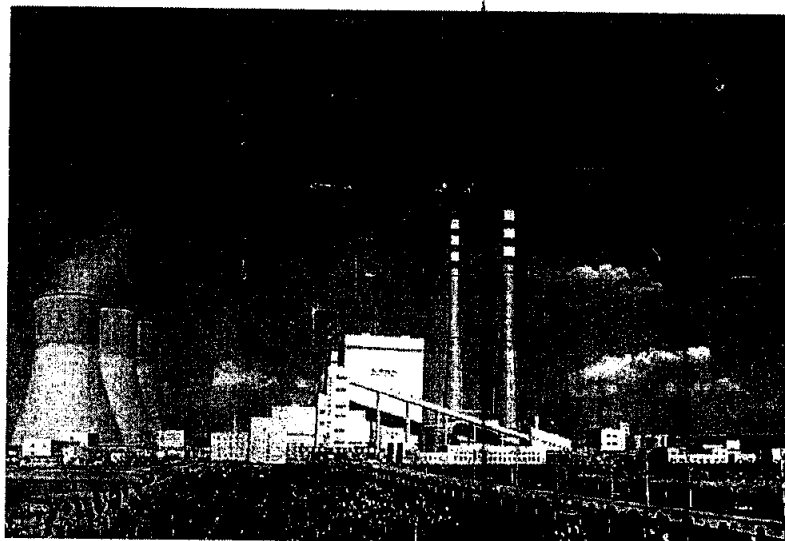
All the above figures are indicative as provided by the Licensee. The Net Capacity available to Power Purchaser for dispatch will be determined through procedure(s) contained in the Power Purchase Agreement or any other applicable document(s).





LOAD FLOW STUDY REPORT

For
**330 MW HUBCO Coal Fired Power Plant
at Thar, Sindh**



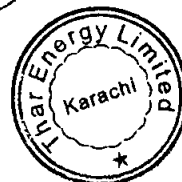
*Draft Report
(July 2016)*

POWER PLANNERS INTERNATIONAL

UK Office:
3-Sylvester Road,
Sudbury Town, Middlesex,
HA0 3AQ, UK
Phone & Fax: +44-(0)208-9223219

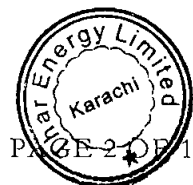
Pakistan Office:
64-F/1, Wapda Town,
Lahore, Pakistan
Phone: +92-42-35968118;
Fax: + 92-42-35183166

Email: info@powerplannersint.com
www.powerplannersint.com



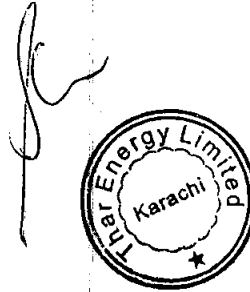
Executive Summary

- ❖ The Draft Load Flow Report of interconnection of the 330 MW Hubco Coal Fired Power Plant with NTDC grid system is submitted herewith. The installed capacity of the plant would comprise of one coal fired unit of 330 MW which would deliver maximum net power of 300.3 MW to the grid.
- ❖ The study objective, approach and methodology have been described and the plant's data received from the Client is validated. The network of Hubco Power Plant has been modeled at 500 kV.
- ❖ The system data of NTDC has been used as per permission granted by NTDC vide their letter no. GMPP/CEMP/TRP/274/2667-78 dated 20-06-2016 attached in Appendix-A.
- ❖ The nearest grid facility is Matiari 500 kV Converter Station as shown in Sketch-1 in Appendix-B.
- ❖ Taking the location of Hubco Power Plant in consideration, the most feasible Interconnection scheme would be looping in-out 500 kV circuit between Thal Nova Coal Fired Power Plant and Matiari Converter Station. The up-coming chapters discuss in detail the location and interconnection of the proposed Power Plant. A few approximate sketches are shown in Appendix-B.
- ❖ The two breaker bays of 500 kV at Hubco CFPP to connect with the 500 kV circuits each from Thal Nova CFPP and Matiari-CS respectively will be required.
- ❖ In view of planned COD of the Hubco Power Plant in August 2020, the base case of studies has been assumed as of September 2020 with the maximum load in the system. Therefore the above proposed interconnection have been tested for steady state conditions through detailed load flow studies for peak high water conditions of September 2020. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- ❖ In addition, low water condition of January 2021 because maximum power flow occurs on Southern grids of NTDC due to concentration of thermal power plants in the South. Beside, off peak condition with the minimum load in the system has also been a study.
- ❖ Steady state analysis by load flow for September 2020, peak and off-peak load of January 2021 reveals that the proposed scheme is adequate to evacuate the



maximum net power of 300.3 MW of the Plant under normal as well as contingency conditions.

- ❖ The complete Interconnection Study comprising of Loads Flow Analysis, Short Circuit Analysis and Stability Analysis will be submitted to NTDC shortly.
- ❖ The proposed scheme of interconnection has no technical constraints or problems under steady state load flow and contingency load flow conditions, and is therefore recommended to be adopted.



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8. Conclusions

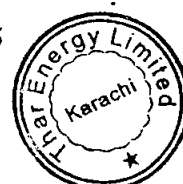
Appendices

Appendix –A:

- NTDC Generation Program
- Transmission Expansion Plan
- NTDC Load Forecast

Appendix –B: Sketches for Chapter-4

Appendix –C: Plotted Results of Load Flow for Chapter – 5



1. Introduction

1.1 Background

Hubco Power Plant is a coal fired power project which is located in Thar, Distance of about 5 km from the proposed location of Thal Nova CFPP 500 kV Power Station of NTDC.

The electricity generated from this project would be supplied to the grid system of NTDC through 500 kV grids available in the vicinity of this project. The nearest grid facility is Matiari 500 kV Converter Station as shown in Sketch-1 in Appendix-B

1.2 Objectives

The overall objective of the Study is to evolve an interconnection scheme between Hubco Power Plant and NTDC network, for stable and reliable evacuation of the electrical power generated from this plant, fulfilling N-1 reliability criteria. The specific objectives of this report are:

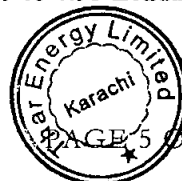
1. To develop scheme of interconnections at 500 kV for which right of way (ROW) and space at the terminal substations would be available.
2. To determine the performance of interconnection scheme during steady state conditions of system, normal and N-1 contingency, through load-flow analysis.

1.3 Planning Criteria

The planning criteria required to be fulfilled by the proposed interconnection is as follows:

Steady State:

Voltage	$\pm 5 \%$, Normal Operating Condition (+ 8 % is permitted for 500 kV only) $\pm 10 \%$, Contingency Conditions
Frequency	50 Hz Nominal 49.8 Hz to 50.2 Hz variation in steady state 49.4 - 50.5 Hz, Min/Max Contingency Freq.
Band	
Power Factor	0.8 to 0.85 Lagging; 0.9 to 0.95 Leading



2. Assumptions of Data

The number of generating units at Hubco Power Plant is one. As per the data provided by the Client the following parameters have been used in the simulations:

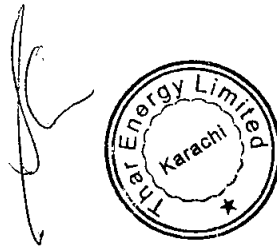
2.1 Hubco Power Plant data

Generator data:

Installed capacity of power plant	= 330 MW
Net Generation to be Delivered to the Grid	= 300.3 MW
Power factor	= 0.8 lagging, 0.95 leading
Lump sum MVA capacity	= 412.5 MVA
Generating Voltage	= 20 kV
Generator Step Up Transformer	= 420 MVA

2.2 Network data

The 500 kV network in the area near Hubco Power Plant is as shown in Sketches in Appendix-B. The system data of NTDC has been used as attached in Appendix-A as per permission granted by NTDC vide their letter no. GMPP/CEMP/TRP/274/2667-78 dated 20-06-2016.



3. Study Approach and Methodology

3.1 Understanding of the Problem

Hubco Power Plant is a coal fired power project which is located in Thar, Distance of about 5 km from the proposed location of Thal Nova CFPP 500 kV Power Station of NTDC.

Due to the location of Hubco Power Plant, the following scheme is proposed for the interconnection of the said plant with the 500 kV network of NTDC.

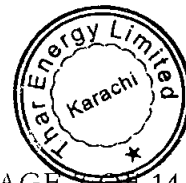
- Hubco Power Plant to be Looped In out of Thal Nova CFPP to Matiari-CS 500 kV circuit using 500 kV Greeley Conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be about 5 km.

The adequacy of NTDC network of 500 kV in and around the proposed site of Hubco Power Plant has been investigated in this study for absorbing and transmitting this power fulfilling the reliability criteria.

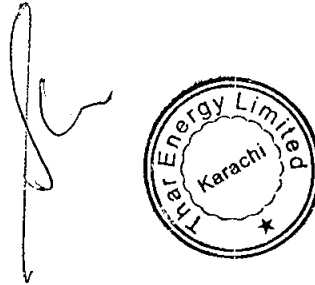
3.2 Approach to the problem

The consultant has applied the following approaches to the problem:

- A base case network model has been prepared for September 2020 after the commissioning of Hubco Power Plant by August 2020, comprising all 500 kV, 220 kV and 132 kV system, envisaging the load forecast, the generation additions and transmission expansions for that year.
- Month of September 2020 has been selected for the study because it represents the maximum loading conditions after the COD of Hubco Power Plant.
- In addition to Peak conditions of September 2020, system conditions have also been tested for peak and off-peak conditions of January 2021.
- Interconnection scheme without any physical constraints, like right of way or availability of space in the terminal substations, have been identified.
- Perform technical system studies for peak load conditions to confirm technical feasibility of the interconnections. The scheme will be subjected to standard load flow analysis to check the adequacy of transmission network for the proposed interconnection scheme under normal and disturbed conditions.



- Determine the relevant equipment for the proposed technically feasible scheme.
- Recommend the technically most feasible scheme of interconnection.

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4. Development of Scheme of Interconnection

4.1 The Existing and Ongoing Network

The existing 500 kV network available around Hubco Power Plant is shown in Sketch-1 in Appendix-B. Many thermal Power Plants are being installed in the Southern part of the country. The plants which will be in the system by January 2021 are:

- Port Qasim CFPP
- Engro CFPP
- Thal Nova CFPP
- Shanghai Electric CFPP
- HUBCO CFPP
- K-2/K/3 Unit-1

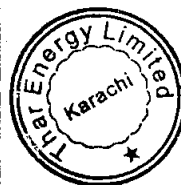
Power from all these power plants will be collected at Matiari-CS and Port Qasim-CS and will be transmitted to Lahore-CS and Faisalabad West-CS respectively via $\pm$ 600 kV Bi-pole HVDC Transmission Lines.

4.2 The Scheme of Interconnection of Hubco Power Plant

Keeping in view of the above mentioned 500 kV network available in the vicinity of the site of the Hubco Power Plant, the proposed interconnection of the said plant with the 500 kV network of NTDC has been shown in Appendix B.

Due to the location of Hubco Power Plant, the following scheme is proposed for the interconnection of the said plant with the 500 kV network of NTDC.

- Hubco Power Plant to be Looped In out of Thal Nova CFPP to Matiari-CS 500 kV circuit using 500 kV Greeley Conductor. The distance from the power plant to the looping point (immediately after the line take-off from the Grid Station) would be about 5 km.



5. Detailed Load Flow Studies

5.1 Base Case Load Flow September Peak 2020, Without Hubco Power Plant

A base case has been developed for the peak load of September 2020 using the network data of NTDC, after updating with latest load forecast and expansion plan of NTDC. Demand forecast obtained from NTDC have been incorporated into the base case.

The results of load flow for this base case are plotted in Exhibit 0.0 of Appendix-C. The system plotted in this Exhibit comprises of 500 kV network around the proposed power plant including 500 kV Grid Stations of Matiari-CS, Lahore-CS, Jamshoro, Guddu-New, Moro, Dadu, Muzaffargarh and Multan etc.

The load flow results show that the power flows on all the circuits are within their normal rating. The voltage profile of these surrounding substations is also within normal limits.

For N-1 contingency conditions we have performed the simulation cases with results plotted as follows:

- Exhibit 0.1 Thal Nova CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 0.2 Engro CFPP to Thal Nova CFPP 500kV Single Circuit Out
- Exhibit 0.3 Engro CFPP to SECL CFPP 500kV Single Circuit Out
- Exhibit 0.4 SECL CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 0.5 Jamshoro to Matiari-CS 500kV Single Circuit Out
- Exhibit 0.6 Matiari-CS to Lahore South-CS HVDC Single Circuit Out
- Exhibit 0.7 Matiari-CS to Dadu 500kV Single Circuit Out
- Exhibit 0.8 Matiari-CS to Moro 500kV Single Circuit Out

We see that in all the cases the power flows on all circuits remain within their rated limits. Also the bus voltages are within the acceptable operating range.

5.2 Load Flow Peak September 2020 with Hubco Power Plant

Load flow studies have been carried out for September 2020 because it represents the maximum loading conditions in the grids after the COD of Hubco Power Plant in August 2020. The results of Normal case of Peak September 2020 are plotted in

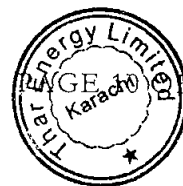


Exhibit 1.0 shown in Appendix-C. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of $\pm 8/-5$ % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

- Exhibit 1.1 HUB CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 1.2 Thal Nova CFPP to HUB CFPP 500kV Single Circuit Out
- Exhibit 1.3 Engro CFPP to Thal Nova CFPP 500kV Single Circuit Out
- Exhibit 1.4 Engro CFPP to SECL CFPP 500kV Single Circuit Out
- Exhibit 1.5 SECL CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 1.6 Jamshoro to Matiari-CS 500kV Single Circuit Out
- Exhibit 1.7 Matiari-CS to Lahore South-CS HVDC Single Circuit Out
- Exhibit 1.8 Matiari-CS to Dadu 500kV Single Circuit Out
- Exhibit 1.9 Matiari-CS to Moro 500kV Single Circuit Out

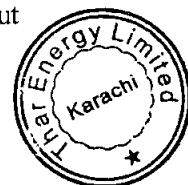
5.3 Load Flow Peak January 2021 with Hubco Power Plant

The results of Normal case of Peak January 2021 are plotted in Exhibit 2.0. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of $\pm 8/-5$ % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

- Exhibit 2.1 HUB CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 2.2 Thal Nova CFPP to HUB CFPP 500kV Single Circuit Out
- Exhibit 2.3 Engro CFPP to Thal Nova CFPP 500kV Single Circuit Out
- Exhibit 2.4 Engro CFPP to SECL CFPP 500kV Single Circuit Out



- Exhibit 2.5 SECL CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 2.6 Jamshoro to Matiari-CS 500kV Single Circuit Out
- Exhibit 2.7 Matiari-CS to Lahore South-CS HVDC Single Circuit Out
- Exhibit 2.8 Matiari-CS to Dadu 500kV Single Circuit Out
- Exhibit 2.9 Matiari-CS to Moro 500kV Single Circuit Out
- Exhibit 2.10 Port-Qasim-CS to Matiari-CS 500kV Single Circuit Out
- Exhibit 2.11 K-2/K-3 to Matiari-CS 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.4 Load Flow Off Peak January 2021 with Hubco Power Plant

The results of Normal case of Off Peak January 2021 are plotted in Exhibit 3.0. We find no capacity constraints on 500 kV circuits under normal conditions i.e. without any outages of circuits.

The power flows on the circuits are seen well within the rated capacities and the voltages on the bus bars are also within the permissible operating range of +8/-5 % off the nominal.

N-1 contingency analysis has been carried out and the plotted results are attached in Appendix – C as follows;

- Exhibit 3.1 HUB CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 3.2 Thal Nova CFPP to HUB CFPP 500kV Single Circuit Out
- Exhibit 3.3 Engro CFPP to Thal Nova CFPP 500kV Single Circuit Out
- Exhibit 3.4 Engro CFPP to SECL CFPP 500kV Single Circuit Out
- Exhibit 3.5 SECL CFPP to Matiari-CS 500kV Single Circuit Out
- Exhibit 3.6 Jamshoro to Matiari-CS 500kV Single Circuit Out
- Exhibit 3.7 Matiari-CS to Lahore South-CS HVDC Single Circuit Out
- Exhibit 3.8 Matiari-CS to Dadu 500kV Single Circuit Out
- Exhibit 3.9 Matiari-CS to Moro 500kV Single Circuit Out
- Exhibit 3.10 Port-Qasim-CS to Matiari-CS 500kV Single Circuit Out

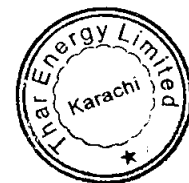


Exhibit 3.11 K-2/K-3 to Matiari-CS 500kV Single Circuit Out

We see that in all the contingency cases, in the event of outage of any circuit, the intact circuits remain within the rated capacity.

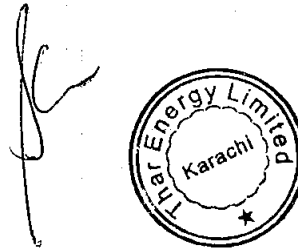
Also the bus bar voltages are well within the permissible limits in all the contingency events.

5.5 Conclusion of Load Flow Analysis

The proposed scheme for the interconnection of Hubco Power Plant has been tested under normal and contingency conditions for peak load conditions of September 2020. In all the normal and contingency cases, we find that the loading on the circuits remain within the rated capacity. Also the bus bar voltages are well within the permissible limits in all the normal and contingency events.

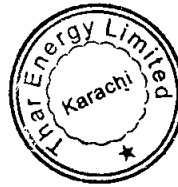
The proposed scheme has been further tested for peak and off-peak conditions of January 2021. It is found that the loading on the circuits remain within the rated capacity and the bus bar voltages are well within the permissible limits in all the normal and contingency events.

The proposed scheme fulfils all the required criteria under normal and contingency conditions and recommended to be adopted.

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8. Conclusions

- ❖ The proposed plant is going to be connected to the nearest grid facility of NTDC which is Matiari 500 kV Converter Station.
- ❖ Taking the location of Hubco Power Plant in consideration, the most feasible Interconnection scheme would be looping in-out 500 kV circuit between Thal Nova Coal Fired Power Plant and Matiari Converter Station. The up-coming chapters discuss in detail the location and interconnection of the proposed Power Plant. A few approximate sketches are shown in Appendix-B.
- ❖ The two breaker bays of 500 kV at Hubco CFPP to connect with the 500 kV circuits each from Thal Nova CFPP and Matiari-CS respectively will be required.
- ❖ In view of planned COD of the Hubco Power Plant in August 2020, the base case of studies has been assumed as of September 2020 with the maximum load in the system. Therefore the above proposed interconnection have been tested for steady state conditions through detailed load flow studies for peak high water conditions of September 2020. The system conditions of normal and N-1 contingency have been studied to meet the reliability criteria of NEPRA Grid Code.
- ❖ In addition, low water condition of January 2021 because maximum power flow occurs on Southern grids of NTDC due to concentration of thermal power plants in the South. Beside, off peak condition with the minimum load in the system has also been a study.
- ❖ Steady state analysis by load flow for September 2020, peak and off-peak load of January 2021 reveals that the proposed scheme is adequate to evacuate the maximum net power of 300.3 MW of the Plant under normal as well as contingency conditions.
- ❖ The complete Interconnection Study comprising of Loads Flow Analysis, Short Circuit Analysis and Stability Analysis will be submitted to NTDC shortly.
- ❖ The proposed scheme of interconnection has no technical constraints or problems under steady state load flow and contingency load flow conditions, and is therefore recommended to be adopted.



NATIONAL TRANSMISSION & DESPATCH CO. LTD

General Manager Planning Power, NTDC

No. GMPP/CEMP/TRP/274/2677-7B

Dated: 20-06-2016

Chief Executive Officer (CPPA-G)
6th Floor Shaheed-e-Millat Secretariat,
Jinnah Avenue Blue Area, Islamabad.
Fax #: 051-9213617

Attention: General Manager (WPFO)

Subject: Grid Interconnection Study of 330 MW Coal Fired Power Plant of M/s HUBCO at Thar Block-II

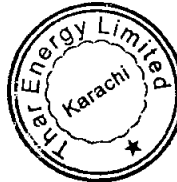
Ref: GM WPPO letter No. GM (WPPO)/CPPA-G/HUB-144/6189-92 dated 14-06-2016.

With reference to the above letter, the reply from this office is as under:

- i) M/s Power Planners International (PPI), the project consultant, is allowed to use the latest system model available with them for the subject study. However, the system model should be updated according to the latest generation and transmission expansion plans which will be provided shortly as the same is being updated to latest.
M/s PPI is advised not to use the system data/information for any other study nor should it be provided to any other company including the sponsor of the above mentioned power plant without the prior permission of Planning (Power) NTDC.
- ii) M/s PPI has the latest load projections of NTDC.
- iii) The study scenarios in the subject report should include peak and off-peak load conditions in the year when the subject coal-fired project is expected and also for future scenarios.
- iv) The short circuit rating of substation equipment at 500 & 220 kV substations needs to be obtained from GSO department of NTDC.
- v) It is intimated that the generator and transformer technical data of the subject coal-fired project, for use in the interconnection studies, should be obtained from the equipment supplier/EPC contractor. Moreover, the timeline of subject coal-fired project should be endorsed by PPIB.

For any further information/clarification deem required during execution of the study, be communicated to this office.

CC:
- P.S. to MD (NTDCL)
- Master File (MP)

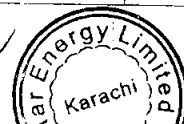


(Rehman Maqbool)
General Manager Planning (Power) NTDC

20/6/2016

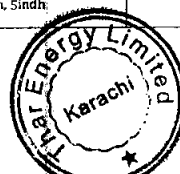
List of Underconstruction/Planned Generation Projects

Sr. #	Fiscal Year	Name of Project	Agency	Fuel	Location	Installed Capacity (MW)	Commissioning Date	Total Installed Capacity (MW)
		Existing capacity						22441
1		M/s Hamza Sugar Mills Ltd.	AEDB	Baggase	Khanpur, Punjab	15	May. 2016	
2		CHASNUPP-III	PAEC	Nucl	Chashma, Punjab	340	May. 2016	
3		Zonergy-II	PPDB	Solar	Lal Sohna (Cholistan), Punjab	100	May. 2016	
4		M/s Yunus Energy Ltd.	AEDB	Wind	Jhimpir, Sindh	50	Jun. 2016	
5		M/s Metro Power Co. Ltd.	AEDB	Wind	Jhimpir, Sindh	50	Jun. 2016	
6		M/s Gul Ahmed Energy Limited	AEDB	Wind	Jhimpir, Sindh	50	Jun. 2016	
7		M/s Tapal Wind Energy (Pvt) Limited	AEDB	Wind	Jhimpir, Sindh	30	Jun. 2016	
		Total Generation Addition in 2015-16				635		23076
8	2016-17	Zonergy-III, IV & V	PPDB	Solar	Lal Sohna (Cholistan), Punjab	300	Jul. 2016	
9		M/s Tenaga Generasi Limited	AEDB	Wind	Gharo/Bhambore/Kuttikun, Sindh	49.5	Sep. 2016	
10		M/s Master Wind Energy Limited	AEDB	Wind	Jhimpir, Sindh	49.5	Sep. 2016	
11		M/s HydroChina Dawood Power Ltd.	AEDB	Wind	Gharo, Sindh	49.5	Sep. 2016	
12		M/s United Energy Pakistan Limited	AEDB	Wind	Jhimpir, Sindh	99	Sep. 2016	
13		M/s Tenaga Generasi Limited	AEDB	Wind	Gharo, Sindh	49.5	Sep. 2016	
14		M/s Layyah Sugar Mills Ltd.	AEDB	Baggase	Layyah, Punjab	41	Dec. 2016	
15		CHASNUPP-IV	PAEC	Nucl	Chashma, Punjab	340	Dec. 2016	
16		Zonergy-VI	PPDB	Solar	Lal Sohna (Cholistan), Punjab	100	Dec. 2016	
17		Zonergy-VII	PPDB	Solar	Lal Sohna (Cholistan), Punjab	100	Jan. 2017	
18		Zonergy-VIII & IX	PPDB	Solar	Lal Sohna (Cholistan), Punjab	200	Feb. 2017	
19		LNG Based Plants (2*GT)	PPDB	LNG	Bhikki, Punjab	800	Mar. 2017	
20		Patind HPP	PPIB	Hydel	Kunhar River, KPK/AJK	147	Mar. 2017	
21		LNG Based Plants (2*GT)	PPDB	LNG	Haveli Bahadur Shah (Jhang), Punjab	800	Apr. 2017	
22		Gas Based Power Plants	PPIB	LNG	Existing Plant Sites	1000	Apr. 2017	
23		LNG Based Plants (2*GT)	PPDB	LNG	Baloki, Punjab	800	May. 2017	
24		M/s Alliance Sugar Mills Ltd.	AEDB	Baggase	Ghotki, Sindh	19	Feb. 2017	
25		M/s Chanar Sugar Mills Ltd.	AEDB	Baggase	Tandlianwala, Punjab	22	Jun. 2017	
26		M/s Sachal Energy Development (Pvt.) Limited	AEDB	Wind	Jhimpir, Sindh	49.5	Jun. 2017	
27		Tarbela 4th Ext. Project	WAPDA	Hydel	Tarbela, KPK	1410	Jun. 2017	
		Total Generation Addition in 2016-17				6425.5		29501.5
28		Neelum Jhelum Hydel	WAPDA	Hydel	Nauseri/Muzaffarabad, AJK	969	Aug. 2017	
29		M/s Ethiad Power Generation Ltd.	AEDB	Baggase	Rahim Yar Khan, Punjab	67	Feb. 2017	
30		M/s Almoiz Industries Ltd.	AEDB	Baggase	Mianwali, Punjab	36	Oct. 2017	
31		M/s Safina Sugar Mills	AEDB	Baggase	Lalian, Sagodha	20	Dec. 2017	
32		M/s Shahtaj Sugar Mills Ltd.	AEDB	Baggase	Mandi Bahauddin, Punjab	32	Dec. 2017	



List of Underconstruction/Planned Generation Projects

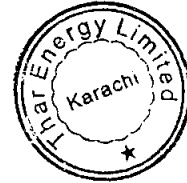
Sr. #	Fiscal Year	Name of Project	Agency	Fuel	Location	Installed Capacity (MW)	Commissioning Date	Total Installed Capacity (MW)
33	2017-18	M/s RYK Energy Ltd.	AEDB	Baggase	Rahim Yar Khan, Punjab	32	Dec. 2017	
34		M/s SSJD Bioenergy	AEDB	Baggase	Mirpurkhas, Sindh	12	Dec. 2017	
35		M/s Lumen Energia Pvt Ltd	AEDB	Baggase	Jhang, Punjab	12	Dec. 2017	
36		Shandong Imported Coal Based Power Project	PPIB	Coal	Sahiwal, Punjab	1320	Dec. 2017	
37		LNG Based Plants (1*ST)	PPDB	LNG	Bhikki, Punjab	400	Dec. 2017	
38		LNG Based Plants (1*ST)	PPDB	LNG	Baiki, Punjab	400	Dec. 2017	
39		LNG Based Plants (1*ST)	PPDB	LNG	Haveli Bahadur Shah (Jhang), Punjab	400	Dec. 2017	
40		M/s Jhampir Wind Power (Pvt.) Limited	AEDB	Wind	Jhampir, Sindh	50	Feb. 2018	
41		M/s Hawa Energy (Pvt.) Limited	AEDB	Wind	Jhampir, Sindh	50	Mar. 2018	
42		M/s Hartford Alternative Energy (Pvt.) Limited	AEDB	Wind	Jhampir, Sindh	50	Apr. 2018	
43		M/s Tricon Boston Consulting Corporation (Pvt.) Limited (A)	AEDB	Wind	Jhampir, Sindh	50	Apr. 2018	
44		M/s Tricon Boston Consulting Corporation (Pvt.) Limited (B)	AEDB	Wind	Jhampir, Sindh	50	May. 2018	
45		M/s Tricon Boston Consulting Corporation (Pvt.) Limited (C)	AEDB	Wind	Jhampir, Sindh	50	May. 2018	
46		M/s Three Gorges Second Wind Farm Pakistan Ltd (Wind Eagle Limited)	AEDB	Wind	Jhampir, Sindh	49.5	Jun. 2018	
47		M/s Three Gorges Second Wind Farm Pakistan Ltd (Wind Eagle Limited)	AEDB	Wind	Jhampir, Sindh	49.5	Jun. 2018	
48		Port Qasim Power Project	PPIB	Coal	Port Qasim Karachi, Sindh	1320	Jun. 2018	
		Total Generation Addition in 2017-18				5419		34920.5
49	2018-19	Golen Gol HPP	WAPDA	Hydel	Chitral, KPK	106	Jul. 2018	
50		Gulpur Poonch river	PPIB	Hydel	Poonch River/Gulpur, AJK	102	Oct. 2018	
51		M/s Zephyr Power Pvt. Ltd.	AEDB	Wind	Charo, Sindh	50	Nov. 2018	
52		Grange Holding	PPIB	Coal	Arifwala, Punjab	163	Jan. 2019	
		Total Generation Addition in 2018-19				421		35341.5
53	2019-20	TPS Jamshoro (Phase-1)	GENCOs	Coal	Jamshoro, Sindh	660	Jun. 2019	
54		Engro Powergen Project	PPIB	Coal	Thar, Sindh	660	Jun. 2019	
55		CASA	GoP	Import	Cross Border Interconnection	1000	Jul. 2019	
56		Coal Plant at Muzaffargarh	PPDB	Coal	Muzaffargarh, Punjab	600	Sep. 2019	
57		TPS Jamshoro (Phase-2)	GENCOs	Coal	Jamshoro, Sindh	660	Dec. 2019	
58		HUB Power Project, Thar Block-II	PPIB	Coal	Thar, Sindh	330	Jan. 2020	
59		Thal NOVA Power Project, Thar Block-II	PPIB	Coal	Thar, Sindh	330	Jan. 2020	
60		Keyal Khwar	WAPDA	Hydel	Dasu District, KPK	128	Jan. 2020	
61		Dther Wind Power Plants	AEDB	Wind	Sindh	524	Feb. 2020	
62		HUB Power Company Ltd.	PPIB	Coal	HUB, Baluchistan	1320	Mar. 2020	
		Total Generation Addition in 2019-20				6212		41553.5
63		Shanghai Electric Power Project	PPIB	Coal	Thar, Sindh	1320	Aug. 2020	
64		Siddiqsons Limited	PPIB	Coal	Port Qasim, Sindh	350	Oct. 2020	



List of Underconstruction/Planned Generation Projects

2019-2020 Planned Generation Projects								
Sr. #	Fiscal Year	Name of Project	Agency	Fuel	Location	Installed Capacity (MW)	Comissioning Date	Total Installed Capacity (MW)
65	2020-21	Karachi Coastal Power Plant (unit-1)	PAEC	Nud	Karachi	1100	Nov. 2020	
66		Lucky Electric Power Company Ltd.	PPIB	Coal	Port Qasim, Sindh	660	Dec. 2020	
67		Dasu HPP (Phase-1)	WAPDA	Hydel	7km upstream of Dasu Village on Indus River, KPK	2160	Feb. 2021	
68		Karot HPP	PPIB	Hydel	Jehlum River, Distt. Rawalpindi, Punjab	720	Jun. 2021	
69		Tarbela 5th Ext. Project	WAPDA	Hydel	Tarbela, KPK	1410	Jun. 2021	
		Total Genertion Addition in 2020-21					7720	
70	2021-22	Suki Kinari HPP	PPIB	Hydel	Kunhar River/Mansehra, KPK	870	Jul. 2021	
71		Karachi Coastal Power Plant (unit-2)	PAEC	Nucl	Karachi	1100	Oct. 2021	
72		Kotli	AJKHEB	Hydel	Poonch River/Kotli, A/JK	100	Jun. 2022	
73		Coal Plant at Lakhra	GENCOs	Coal	Lakhra, Sindh	660	Jun. 2022	
		Total Genertion Addition in 2021-22					2730	
Total Generation Addition upto 2021-22						29562.5		

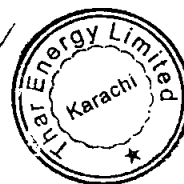
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NTDC TRANSMISSION EXPANSION PLAN

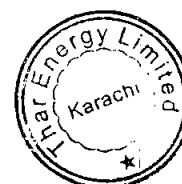
500 kV TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	500 kV Transmission Line/ 500/220 kV Transformer Description	No. of S/C Lines	Length of each Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
Ongoing Projects						
1	R.Y. Khan	Guddu – Multan 3rd Circuit In/Out at R.Y. Khan	2	30	2 x 600	G/S has been commissioned in 2015-16. T/L to be commissioned till Aug 2017
2	Shikarpur New	Guddu – Dadu 1st circuit In/Out at Shikarpur New	2	20	2 x 600	2015-16
3		Guddu – Dadu 2nd circuit In/Out at Shikarpur New	2	22		2015-16
4		Augmentation of 1x450 MVA T/F with 1x750 MVA capacity at Rewat 500 kV G/S			1 x 750	2015-16
5	Lahore New (South)	Sahiwal – Lahore single circuit In/Out at Lahore New	2	15	2 x 750	2016-17
6		Gujranwala – Lahore single circuit In/Out at Lahore New	2	50		2016-17



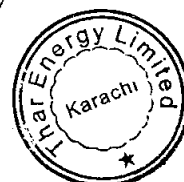
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	500 kV Transmission Line/ 500/220 kV Transformer Description	No. of S/C Lines	Length of each Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
Ready For Implementation Projects						
7		Jamshoro – Moro	1	200		2016-17
8		Dadu – Moro	1	55		2016-17
9		Moro – R.Y. Khan	1	335		2016-17
10		Ext. at Jamshoro, 3rd 500/220 kV T/F			1 x 450	2016-17
11		Guddu New Power Plant – M. Garh	1	256		2016-17
12		D.G. Khan – Multan S/C In/Out at M. Garh	2	10		2016-17
13		Neelum Jhelum HPP - Gakkhar (Gujranwala)	2	270		2017-18
14		Lahore South – Sahiwal S/C In/Out at Sahiwal Coal Power Plant	2	0.5		2017-18
15		Ext. at Sahiwal, 3rd 500/220 kV T/F			1 x 600	2017-18
Future Development Projects						
16		Lahore Old – Gatti S/C In/Out at 1200 MW Bhikki	2	5		2016-17
17		Lahore South – 1200 MW Balloki	2	40		2016-17
18		Ext. at Lahore South, 3rd 500/220 kV T/F			1 x 750	2016-17
19		Gatti – M.Garh S/C In/Out at 1200 MW Haveli Bahadur Shah	2	5		2016-17
20		Gatti – Multan S/C In/Out at 1200 MW Haveli Bahadur Shah	2	15		2016-17



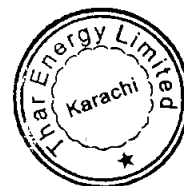
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	31New Substation	500 kV Transmission Line/ 500/220 kV Transformer Description	No. of S/C Lines	Length of each Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
21		Augmentation of 3x237 MVA T/Fs with 3x450 MVA capacity at Tarbela 500 kV G/S			3x 450	2016-17
22	Matari Switching Station	Port Qasim Coal Power Plant – Matari	2	180		2017-18
23		In/out of existing 500 kV Jamshoro – Dadu S/C at Matari Switching/ Converter Station	2	30		2017-18
24		Engro Thar CFPP – Matari	2	250		2018-19
25	Faisalabad West	M. Garh – Gatti circuit In/Out at Faisalabad West	2	2	2 x 750	2018-19
26		Multan – Gatti circuit In/Out at Faisalabad West	2	30		2018-19
27	Extension of 500/220 kV Transformers	Addition of 1x450 MVA T/F at 550/220 kV Sheikh Muhammadi			1x450	2018-19
		Addition of 1x600 MVA T/F at 550/220 kV Nokhar			1x600	2018-19
28	HVDC Converter Station at Matari	± 660 kV HVDC Bi-pole from Matari Converter Station - Lahore South Converter station		878		2019-20
29		Hubco Coal Power Plant– Matari Switching/ Converter Station	2	220		2019-20
30	Lahore HVDC Converter Station (CS)	In/Out of Lahore New (South) – Lahore D/C at Lahore HVDC CS	4	4+25		2019-20
31	Islamabad West	Ghazi Brotha – Rewat S/C In/Out at Islamabad West	2	7.4	2x750	2019-20



NTDC TRANSMISSION EXPANSION PLAN

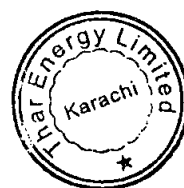
Sr. No.	New Substation	500 kV Transmission Line/ 500/220 kV Transformer Description	No. of S/C Lines	Length of each Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
32	Lahore North	Lahore North – Lahore South	2	60	2 x 750	2019-20
33		Lahore North – Gujranwala (Gakkhar)	2	50		2019-20
34		In/out of 500 kV Muzaffar Garh – HB Shah S/C at Muzaffar Garh CFPP	2	15		2019-20
35		Tarbela-Rawat In/Out S/C at Islamabad West	2	10.1		2019-20
36	Chakwal New	In/Out of Ghazi Barotha – Gatti D/C at Chakwal New	4	30	3x250	2019-20
37	± 500kV HVDC Converter Station at Peshawar New	± 500 kV HVDC Bipole to Peshawar New (CASA-1000)				2019-20
38	Peshawar New	In/out of existing 500 kV Tarbela – Peshawar S/C at Peshawar New	2	15	2 x 750	2019-20
39	Ludewala	Ludewala – Faisalabad West	2	100	2 x 600	2019-20
40		Ludewala – Peshawar New	2	325		2019-20
41		Tarbela 5 th Ext. switchyard - Islamabad West	2	52.4		2020-21
42		Engro Thar CFPP– Matiari S/C in/Out at Shanghai Electric CFPP with 40% series compensation on both 500 kV circuits (Engro CFPP – Matiari S/C & Shanghai Electric CFPP - Matiari S/C).	2	15		2020--21



NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	500 kV Transmission Line/ 500/220 kV Transformer Description	No. of S/C Lines	Length of each Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
43	Port Qasim Switching/ Converter Station	± 660 kV HVDC Bi-pole from 500kV Port Qasim Switching /Converter station – FSD WEST		1050		2020-21
44		Siddiqsons CFPP – 500kV Port Qasim Switching/ Converter Station	2	35		2020-21
45		Siddiqsons CFPP – 500kV Port Qasim Switching/ Converter Station S/C In/Out at Lucky	2	3		2020-21
46		Port Qasim Coal Power Plant – Matari switching/ converter station S/C In/Out at K-2/K-3	2	70		2020-21
47		Hubco Coal Power Plant - Matari switching/ converter station S/C In/Out at K-2/K-3	2	5		2020-21
48	Switching Station at Mansehra	Dasu HPP to Mansehra	2	140		2020-21
49		Mansehra to Islamabad West	2	100		2020-21
50		Mansehra to Faisalabad West with 40% series compensation	2	375		2020-21
51	Switching Station at Allot	Neelum Jhelum HPP – Gujranwala D/C In/Out at Allot.	4	2		2020-21
52		Allot – Gujranwala Circuit#2 In/Out at Karot	2	5		2020-21
53		Suki Kinari HPP – Allot	2	100		2020-21
54		Allot – Islamabad West	2	96		2021-22
55	Vehari	Multan – Sahiwal S/C In/Out at Vehari	2	15	2x750	2021-22

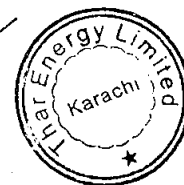
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NTDC TRANSMISSION EXPANSION PLAN

220 kV TRANSMISSION EXPANSION PLAN

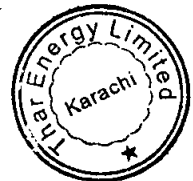
Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
Ongoing Projects						
1		Augmentation of 3x160 MVA T/F with 3x250 MVA capacity at Sheikh Muhammadi 500 kV G/S			3 x 250	2015-16
2		Augmentation of 2x160 MVA T/F with 2x250 MVA capacity at Mardan 220 kV G/S			2 x 250	2015-16
3		Augmentation of 3x160 MVA T/F with 3x250 MVA capacity at Burhan 220 kV G/S			3 x 250	2015-16
4		Augmentation of 2x160 MVA T/F with 2x250 MVA capacity at Quetta Industrial 220 kV G/S			2 x 250	2015-16
5		2nd & 3rd T/F at Okara			2 x 250	2015-16
6		2nd & 3rd T/F at T.T.Singh			2 x 250	2015-16



NTDC TRANSMISSION EXPANSION PLAN

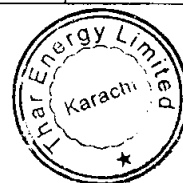
220 kV TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
Ongoing Projects						
1		Augmentation of 3x160 MVA T/F with 3x250 MVA capacity at Sheikh Muhammadi 500 kV G/S			3 x 250	2015-16
2		Augmentation of 2x160 MVA T/F with 2x250 MVA capacity at Mardan 220 kV G/S			2 x 250	2015-16
3		Augmentation of 3x160 MVA T/F with 3x250 MVA capacity at Burhan 220 kV G/S			3 x 250	2015-16
4		Augmentation of 2x160 MVA T/F with 2x250 MVA capacity at Quetta Industrial 220 kV G/S			2 x 250	2015-16
5		2nd & 3rd T/F at Okara			2 x 250	2015-16
6		2nd & 3rd T/F at T.T.Singh			2 x 250	2015-16



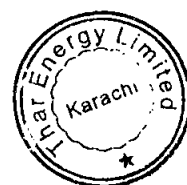
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
7	Chistian New	Vehari – Chistian New	1	65	2 x 250	2015-16
8	R.Y. Khan 500/220/132 kV				2 x 250	G/S has been commissioned 2015-16.
9		Uch I – Guddu S/C In/Out at Shikarpur New	1	50		Commissioned
10		450 MVAR SVC at New Kot Lakhpat 220kV G/S				2015-16
11		In & Out of C-1/C-2 –Ludewala S/C at C-3	1	2		2015-16
12	Ghazi Road	N. Kotlakhpat – Sarfraznagar S/C In/Out at Ghazi Road	1	45	3x 160	2016-17
13	Gujrat New	Mangla – Gujranwala S/C & Mangla – Gakkhar S/C In/Out at Gujrat	2	4	3 x250	2016-17
14		C-3/C-4 to Bannu	1	127		2016-17



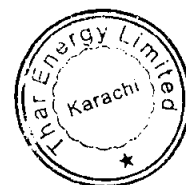
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
15		Uch II – Sibbi	1	125		2016-17
16	Lahore New (South) 500/220 kV	Kot Lakhpat New – Wapda Town S/C In/Out at Lahore New	1	45		2016-17
17		Kot Lakhpat New – Ghazi Road S/C In/Out at Lahore New	1	50		2016-17
18	Lal Suhanra	Lal Suhanra – Bahawalpur	1	40	3 x 250	2016-17
19	Jhimpir	Jhimpir – T.M. Khan Road	1	70	3 x 250	2016-17
20	Mansehra	Allai Khwar – ISPR double circuit In/Out at Mansehra	2	1	2 x 250	2016-17
21	D.M. Jamali	Uch – Guddu S/C In/Out at D.M. Jamali	1	5	1 x 160 + 1 x 100	2016-17
22		Reconductoring of 220 kV Tarbela – ISPR D/C on twin bundled Rail conductor	1	62.5		2016-17
23		Replacement of existing 220 kV Tarbela – Burhan D/C with twin bundled Rail conductor D/C T/L	1	35.1		2016-17



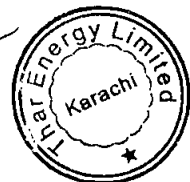
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
24	Nowshera Ind.	G.Brotha – Shahibagh D/C In/Out at Nowshera Ind.	2	5	3 x 250	2016-17
25	D.I. Khan	In & Out of C1/C-2 – C/3 S/C at D.I. Khan	1	100	2 x 250	2016-17
26	Lalian New	Gatti – Ludewala D/C In/Out at Lalian New.	2	4	3 x 250	2016-17
27	2nd Source of supply to 220 kV GIS Islamabad University	In & Out of Manshera – ISPR S/C at Islamabad University	1	40		2016-17
28	Chakdara New	Mardan – Shahi Bagh New S/C In/Out at Chakdara New	1	85	2 x 250	2016-17
29		Augmentation of 1 x 160 MVA T/Fs with 1x250 MVA capacity and Extension of 1x250MVA at Rewat 500 kV G/S			1 x 250 + 1 x 250	2016-17
30	Gharo	Jhimpir – Gharo	1	75	2 x 250	2018-19



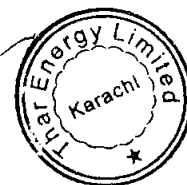
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	Transformer Capacity (MVA)	Expected Year of Commissioning
31	Extension & Augmentation of 220 kV Transformers	Addition of 1x160 MVA T/F at 220 kV Daud Khel	1x160	2018-19
32		Augmentation 3 T/Fs with 3x250 MVA T/Fs at 220 kV Banuu	3x250	
33				
34		Addition of 1x250 MVA T/F at 220 kV ISB University	1x250	
35		Augmentation of all T/Fs with 3x250 MVA at 220/132 kV Nokhar	3x250	
36		Addition of 1x250 MVA T/F at 220 kV NKLP	1x250	
37		Augmentation of all T/Fs with 3x250 MVA at 220/132 kV Wapda Town	3x250	
38		Augmentation of all T/Fs with 3x250 MVA T/Fs at 220/132 kV Ludewala	3x250	
39		Augmentation of 1x160 MVA T/F to 1x250 MVA T/F at 220 kV Bahawalpur	1x250	
40		Replacement of 4x63.5 MVA T/Fs with 2x250 MVA T/Fs 220 kV NGPS	2x250	
41		Addition of 1x250 MVA T/F at 220 kV Rohri	1x250	
42		Replacement & Augmentation of 1x285 MVA & 1x160 MVA T/F s with 2x250 MVA T/Fs at 220 kV Guddu	2x250	



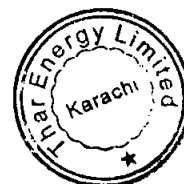
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	Transformer Capacity (MVA)	Expected Year of Commissioning
43	Extension & Augmentation of 220 kV Transformers	Addition of 1x160 MVA T/F at 220/132 kV Khuzdar	1 x160	2018-19
44		Addition of 1x250 MVA T/F at 220/132 kV Loralai	1x250	
45		Augmentation of 3x160 MVA T/F with 1x250 MVA T/F at 220 kV Quetta Industrial	1x250	
46		Augmentation three T/Fs (220/132 kV) with 3x250 MVA T/Fs & Addition of 1x250 MVA T/F at 220/132 kV Sheikhpura	4x250	



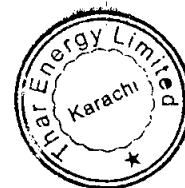
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
47	Faisalabad West 500/220/132 kV	Faisalabad West – T.T. Singh	1	45	3 x 250	2018-19
48		Faisalabad West – Lalian New	1	80		2018-19
49	Islamabad West	In/Out of Burhan – ISPR S/C at Islamabad West	12	15		2018-19
50		In/Out of Mansehra/ Islamabad University – ISPR D/C at Islamabad West	2	25		2018-19
51						
52	Mirpurkhas New	In & Out of the Hala Road- T.M. Kah S/C at Mirpurkhas New	1	70	2 x 250	2018-19
53	2nd Source of supply to 220 kV Hala Road	In & Out of Jamshoro – T.M.Khan S/C at Hala Road	1	10		2018-19
54	Mastung	Sibbi – Mastung	1	120	2 x 250	2019-20
55	220kV Kohat	Peshawar New – Kohat	1	50	2 x 250	2019-20
56	220kV Kamra	In/Out of Islamabad West–ISPR S/C at Kamra	1	5	2 x 250	2019-20
57	Lahore North	In/Out of Ghazi Road/Ravi – K.S.K D/C at Lahore North	2	5		2019-20
58		In/Out of Lahore Old – Ravi S/C at Lahore North	1	10		2019-20



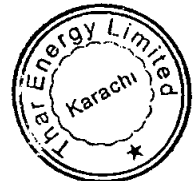
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
59	Peshawar New	In/out of Peshawar – Shahibagh D/C at Peshawar New	2	12		2019-20
60	220kV Jamrud	Peshawar – Jamrud	1	10	2 x 250	2019-20
61	220 kV Shadman	Shadman – Bund Road	1	15	2 x 250	2019-20
62	220 kV Arifwala	In & out of Yousafwala- Kassowal D/C at Arifwala	4	5	2x250	2019-20
63	220 kV Jauharabad	In/Out of C-1/C-2/C-3/C-4 – Ludewala D/C at Jauharabad	2	5	2 x 250	2019-20



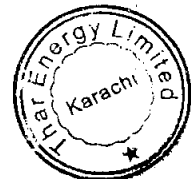
NTDC TRANSMISSION EXPANSION PLAN

Sr. No.	New Substation	220 kV Transmission Line/ 220/132 kV Transformer Description	No. of D/C Lines	Length of D/C Line (km)	Transformer Capacity (MVA)	Expected Year of Commissioning
64	220 kV H.Faqirian	H.Faqirian – Ludewaia	1	58	2x250	2020-21
65	220 kV M3-Industrial	In & out of Faisalabad West- Lalian New S/C at Multan Industrial	2	12.5	2x250	2021-22
66	220 kV Alizai	Alizai-Kohat	2	110	2x250	2021-22



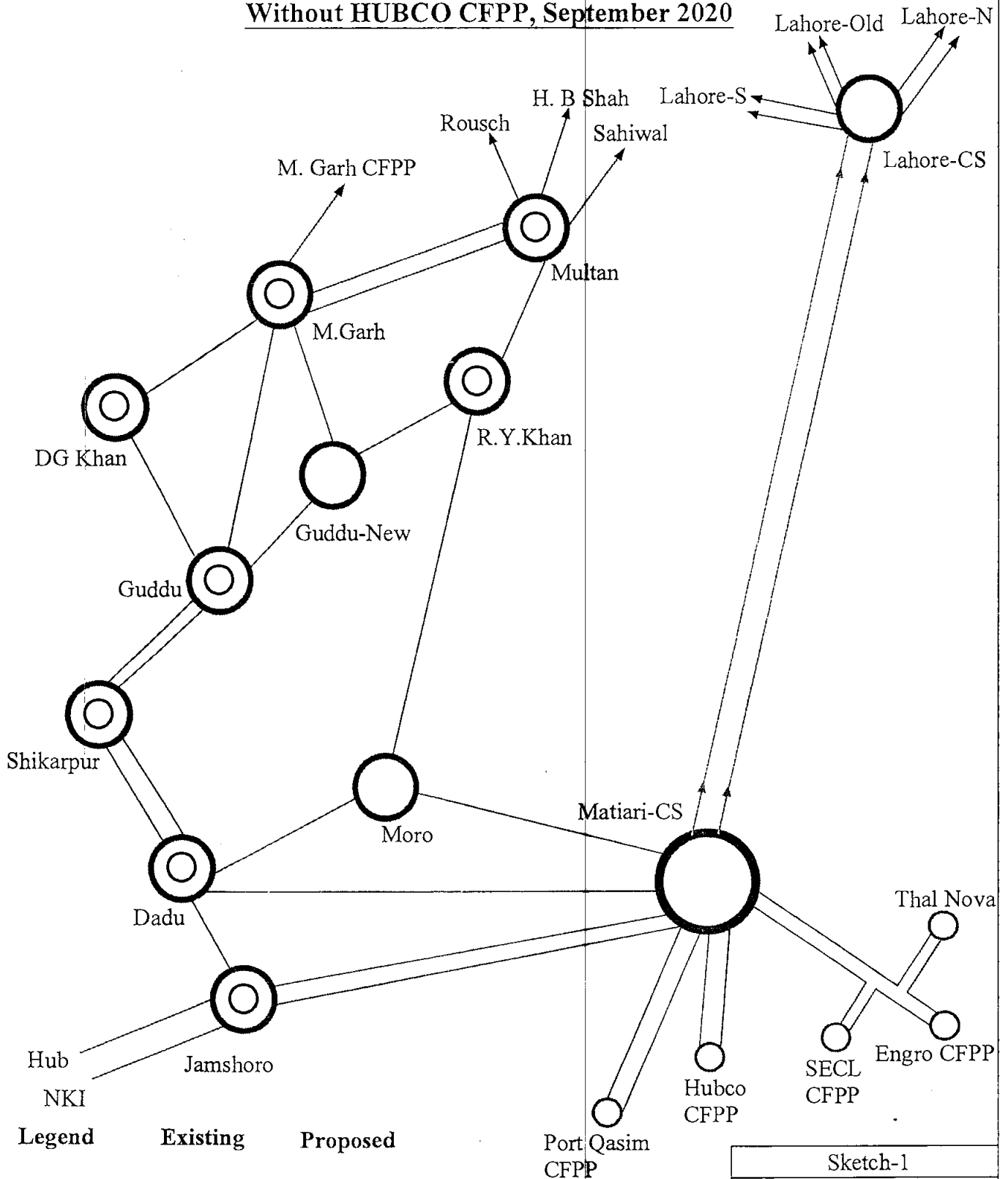
DISCO-wise Peak Demand Forecast (MW)

Name	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Growth (%)
LESCO	4588	5020	5407	5811	6167	6479	6739	6984	7249	7517	7788	5.4
GEPCO	2190	2353	2519	2696	2859	3013	3173	3340	3513	3689	3876	5.9
FESCO	2962	3118	3297	3487	3704	3930	4167	4465	4786	5165	5549	6.5
IESCO	2347	2494	2650	2856	3025	3202	3377	3562	3752	3944	4138	5.8
MEPCO	3570	3805	4044	4287	4535	4786	5042	5303	5568	5838	6113	5.5
PESCO	2958	3104	3255	3412	3574	3741	3915	4096	4282	4476	4677	4.7
HESCO	1251	1301	1354	1408	1465	1524	1585	1649	1716	1786	1858	4.0
QESCO	1709	1768	1829	1893	1961	2030	2102	2177	2255	2337	2422	3.5
TESCO	653	674	696	719	752	777	803	830	858	887	918	3.5
SEPCO	1074	1141	1210	1282	1358	1436	1517	1602	1691	1783	1879	5.8
DISCOs Demand (undiversified)	23302	24778	26261	27851	29399	30919	32422	34009	35671	37422	39217	5.3
Coincidence Factor (%)	80.85%	80.85%	80.85%	80.85%	80.85%	80.85%	80.85%	80.85%	80.85%	80.85%	80.85%	
DISCOs Demand (Diversified)	18840	20034	21233	22518	23770	24998	26214	27497	28840	30256	31708	5.3
T & T Losses (500 & 220kV)	498	530	561	595	628	661	693	727	763	800	838	
% T & T Losses (500 & 220kV)	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	
NTDC Demand	19338	20563	21794	23114	24398	25659	26907	28224	29603	31056	32546	5.3
Auxiliary Consumption	588	625	662	703	742	780	818	858	900	944	989	
% Auxiliary Consumption*	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	2.95	
PEPCO Demand w/o Export to KESC**	19926	21189	22457	23816	25140	26439	27725	29082	30503	32000	33535	5.3
Growth Rate (%)		6.34%	5.98%	6.05%	5.56%	5.17%	4.86%	4.89%	4.89%	4.91%	4.80%	
Export to KESC	650	650	650	650	650	650	650	650	650	650	650	
PEPCO Demand With Export to KESC**	20576	21839	23107	24466	25790	27089	28375	29732	31153	32650	34185	5.2
Growth Rate (%)		6.14	5.8	5.9	5.4	5.0	4.7	4.8	4.8	4.8	4.7	



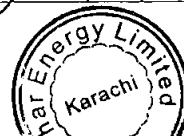
Study of Interconnection of 330 MW HUBCO CFPP

Without HUBCO CFPP, September 2020



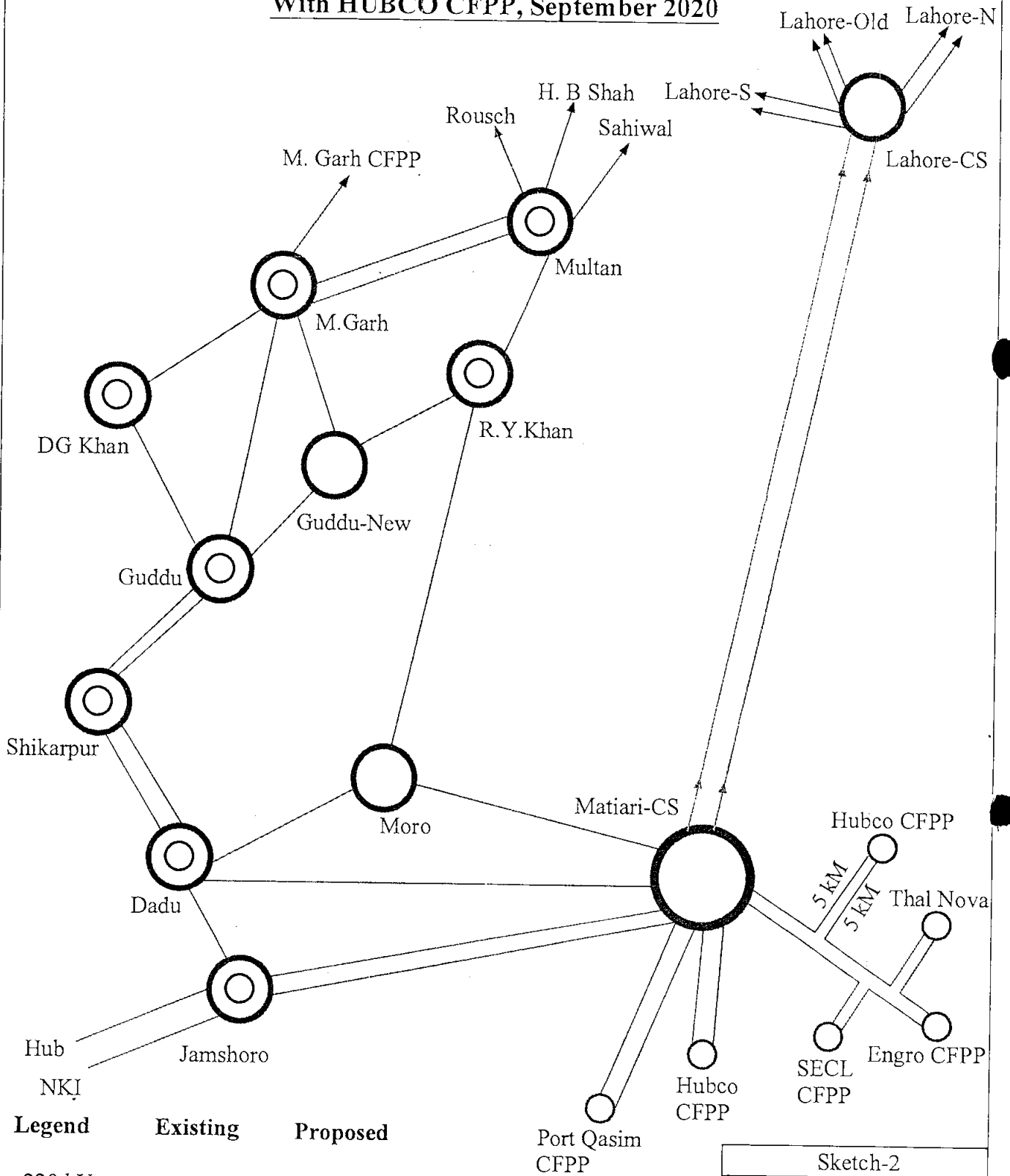
Legend	Existing	Proposed
220 kV	_____	_____
500 kV	_____	_____
600 kV HVDC	_____	_____

Sketch-1			
HUBCO Coal Fired Power Plant			
Power Planners International			
DATE 2016	SHEET 1	DWG NO. HUBCO Sketch-1.DWG	REV



Study of Interconnection of 330 MW HUBCO CFPP

With HUBCO CFPP, September 2020



Legend	Existing	Proposed
220 kV	_____	_____
500 kV	_____	_____
600 kV HVDC	_____	_____

Sketch-2			
HUBCO Coal Fired Power Plant			
Power Planners International			
DATE 2016	SHEET 1	DWG NO. HUBCO Sketch-3.DWG	REV



Study of Interconnection of 330 MW HUBCO CFPP

With HUBCO CFPP, January 2021

