PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED

IN TRIPLICATE

Ref: PQEPCPL/NEPRA/Generation/001
Date: 13 August 2014

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

SUBJECT: **APPLICATION FOR GRANT OF A GENERATION LICENSE**

FOR PORT QASIM COAL-FIRED POWER PROJECT (WITH INTEGRATED SELF-USE JETTY) [1320 (660x2) MW (GROSS ISO)] AT PORT QASIM, KARACHI, SINDH.

Dear Sir,

1. We, Port Qasim Electric Power Company (Private) Limited (hereinafter, "Company" or "Applicant") a company incorporated under the laws of Pakistan, acting through Mr Zhong Haixiang (holding Chinese Passport No. PE0025261) our Director and duly authorized representative hereby apply to the National Electric Power Regulatory Authority ("NEPRA") for the grant of a Generation Licence to the Company pursuant to Section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 ("NEPRA Act").

2. I, Mr Zhong Haixiang, being the duly authorized representative of the Company hereby 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 ("Licensing Regulations"), and undertake to abide by the terms and provisions of the Licensing 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.

3. A pay order in the sum of Rs 687,480/-, being the licence

Registered Office: House No. 11, Street # 56, F-7/4, Islamabad
E-mail: heshiyou@powerchina.cn

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD PAKISTAN

application fee calculated in accordance with Schedule II to the Licensing Regulations is also attached herewith.

4. We thank you in advance for your kind consideration and look forward to your early and favorable response.

Yours sincerely,

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

Mr Zhong Haixiang
Director/Authorized representative

Registered Office: House No. 11, Street # 56, F-7/4, Islamabad
E-mail: heshiyou@powerchina.cn

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED

Annexure I

EXTRACTS OF RESOLUTION BY CIRCULATION PASSED BY THE BOARD OF DIRECTORS OF PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ("COMPANY")

"**RESOLVED** that a Generation Licence Application be filed by and on behalf of the Company with the National Electric Power Regulatory Authority ("**NEPRA**") and to procure the grant by NEPRA of a generation Licence for the Company's proposed 1320 (660 x 2) MW (gross ISO) imported coal-fired power plant (with integrated self-use jetty) at Port Qasim, Karachi, Pakistan (the" **Project**").

RESOLVED FURTHER that each of Mr. Mr. Shen Decai, Mr. Zhong Haixiang, Mr. Fady Bakhos and Mr. Shahzad Shahbaz, being Directors of the Company, and the Chief Executive and the Company Secretary of the Company as may be appointed by the Board of Directors (collectively the **"Authorized Officers"**), be and is hereby authorized acting singly to prepare and file the necessary documentation, pay the necessary filing fees, pay the necessary licence fee, appear before NEPRA as needed, provide any information required by NEPRA in respect of the Project, and do all acts and things necessary for the processing, completion and finalization of the aforementioned Generation Licence Application.

RESOLVED FURTHER that (i) each of the Company Directors, Chief Executive and the Company Secretary may sign and certify copies of this Resolution to be true copies of the original; and (ii) receive/collect the original generation license and related documents, from NEPRA"

Certified to be a true copy of the original

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

Mr. Zhong Haixiang
Authorized Director

Date: 13 August 2014

Registered Office: House No. 11, Street # 56, F-7/4, Islamabad
E-mail: heshiyou@powerchina.cn

B002072

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

1st Floor SLIC Building No.7, Blue Area,
Islamabad

CERTIFICATE OF INCORPORATION

[Under Section 32 of the Companies Ordinance, 1984 (XLVII of 1984)

Corporate Universal Identification No. **0089480**

I hereby certify that **PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED** is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is **limited by shares.**

Given under my hand at Islamabad this 12th day of August, Two Thousand and Fourteen.

Fee Rs. **14,000/-**

(Shaukat Hussain)
Additional Registrar of Companies

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD PAKISTAN

CERTIFIED TRUE COPY

No. ADI 76024
Dated 12/8/14

CERTIFIED TRUE COPY

THE COMPANIES ORDINANCE, 1984
(PRIVATE COMPANY LIMITED BY SHARES)

MEMORANDUM OF ASSOCIATION

OF

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED

I. NAME

The name of the Company is Port Qasim Electric Power Company (Private) Limited (hereinafter referred to as the "**Company**")

II. REGISTERED OFFICE

The Registered office of the Company will be situated in the Islamabad Capital Territory.

III. OBJECTS

The objects for which the Company is established are to undertake any or all of the following: subject to the approval of concerned authority 17/03/2014

1. To design, finance, insure, build, establish, own, operate, maintain, manage electric power generating plants for the generation, supply & transmission of electric power and in relation thereto, to establish, fix, carry out and maintain without limitation, any ancillary works, cables, wires, meter, lines, interconnect facilities, grid stations, transmission facilities, civil, electrical and mechanical works.

2. To carry put a feasibility study for and to carry on the business of power generation and in relation thereto, to generate, accumulate, transmit, distribute and sell electric power anywhere in Pakistan, to the public sector, including the Water and Power Development Authority, National Transmission and Despatch Company, Government and Government bodies, and the private sector subject to any permission required under the law.

3. To manufacture, purchase, import or otherwise acquire, construct, own, process, operate and maintain buildings, apparatus, fixtures, fittings, plants, machinery, materials, and things as may be necessary, incidental to or convenient in connection with power generating plant for the generation of electric power and/or in connection with supply, transmission and distribution of electric power.

4. To enter into any agreement or arrangements with any government or other authority, supreme, municipal, local or otherwise, that may seem conducive to all or any of the objects of the Company and/or to obtain from such government or authority including the State Bank of Pakistan or National Electric Power Regulatory Authority (NEPRA) any rights, concessions, or

privileges, licenses which the Company may think desirable to obtain and to carry out, exercise and comply with any such arrangements, rights, privileges, concessions and licenses.

5. To buy, sell, manufacture, store, repair, alter, improve, exchange or let out, import, export and deal in all works legally permitted, plant, machinery, engines, tanks, cylinders, valves, regulators, testing equipment, tools, utensils, appliances, cookers, stoves, heaters, apparatus, products, materials, substances, raw materials, chemicals, natural gas, liquefied petroleum gas, fuel oil, coal, lubricants, articles and things and to manufacture, experiment with, render marketable and deal in all products legally permitted, incidental to or obtained in the business carried on by the Company.

6. To purchase, take on lease or tenancy or in exchange, hire, take options over or otherwise acquire for any estate or interest whatsoever and to hold, develop, work, cultivate deal with and turn to account, concessions, grants, decrees, licenses, privilege, claims, options, leases, property, real or personal or rights or powers of any kind which may appear to be necessary or convenient for the business of the Company but not to act as a leasing company or property developer.

7. To sell, exchange, mortgage, let on royalty or tribute, grant licenses, easements, options and other rights over and in any manner deal with or dispose of the Company's property or any part thereof for such consideration as may be thought fit and in particular for stocks, shares or securities of any company but in any event not to act as an investment company or leasing company.

8. To establish laboratories and to employ and promote scientific research and invention, patronize such invention and enter into manufacture in collaboration with outside parties for transfer of technology from abroad and to promote transfer of technology from abroad, and to carry on business in all other allied fields permitted by law.

9. To invest and deal with any monies of the Company not required for the time being for any of the purposes of the Company in such investments as may be though proper and to hold, sell or otherwise deal with such investments but in any event not to act as investment company.

10. For the purposes of the business of the Company only, to advance money upon such terms as the Company may approve, and to guarantee the obligations and contracts of customers and others but not to act as a banking company.

11. To apply for, purchase or otherwise acquire and protect, prolong and renew, whether in Pakistan or elsewhere, any patents, patent rights, brevets d'invention, trademarks, design, licenses, protections, concessions and the like conferring any exclusive or non-exclusive or limited right to use any secret or other information as to any invention, process or privilege 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, manufacture under grant, licenses, privileges in respect of, or otherwise turn to account the property, rights and information so acquired and to carry on any business in any way connected therewith.

12. To get insured against losses, damages, risks, accidents and liabilities of all kinds which may affect the Company, whether in respect of servants or employees of the Company, or in respect of

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

property belonging to or leased to hired by the Company, either by setting apart funds of the Company or by effecting such insurance and in later case to pay the premium thereon.

13. To train personnel and workers, both in Pakistan and abroad, to obtain technical proficiency in various specialties connected with the business of the Company.

14. To undertake and execute any project the undertaking whereof may seem desirable, either gratuitously or otherwise.

15. To procure the Company to be registered or recognized in any foreign country or place.

16. To acquire and undertake all or any part of the business, property, goodwill and liabilities of any person or company carrying on any business which the Company is authorized to carry on or possessed of property suitable for the purposes of the Company.

17. To adopt such means of making known the business and/or services of the Company as may seem expedient and in particular by advertising in the press or in other media or by way of participation in exhibitions.

18. To improve, develop, sell, exchange, take on lease, operating lease, mortgage, pledge, hypothecate, assign, transfer, dispose of turn to account or otherwise deal with, all or any part of the present and future property, assets, equipment, immovable and movable, corporeal or incorporeal, tangible or intangible and any right, title and interest therein of the Company, including rights, licence, privileges, concessions, easements and franchises as may seem expedient.

19. To employ or appoint any persons, experts, consultants, advisers, contractors (including O&M contractors), brokers in connection with the business of the Company.

20. To pay for rights or property acquired by the Company, either in cash or fully paid up shares or by the issue of securities, or partly in one mode and partly in another and generally on such terms as may be determined.

21. To open, close and operate bank accounts of the Company with any bank or banks and to draw, make, accept, endorse, discount, execute and issue promissory notes, bills of exchange, bills of lading, warrants, debentures and other negotiable or transferable instruments and do any banking transactions which may be deemed appropriate in the best interest of the Company.

22. To borrow money and to receive the proceeds of loans and to secure payment of money in such manner as the Company may decide is necessary for realization of the purposes mentioned above and in particular by:

(i) the issue of perpetual or redeemable and convertible or nonconvertible PTCs, TFCs, sukuks and other Islamic modes of financing instruments, debentures or debenture stock

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

(perpetual or otherwise), bonds, promissory notes, bills of exchange and such other securities;

(ii) fumishing undertakings and guaranteeing the performance by the Company or any other person or company of any obligation undertaken by the Company or any other persons or company as the case may be, depositing securities, shares and documents of title;

(iii) hypothecating, charging and mortgaging all or any of the properties and assets (both present and future, movable and immovable) of the Company and creating pledge, liens etc., on such properties on the condition that such transactions shall not effect the performance of the Company; and

(iv) appointing attomeys, counsels and giving them powers and authority for executing documents, registering documents, selling and managing the properties, undertaking any business of the Company and furnishing and creating such other securities as maybe considered expedient; and for the purposes aforesaid, or otherwise, execute, complete and deliver agreements and such other documents as may be required;

23. To take, or otherwise acquire, and hold shares in any other company having objects altogether or in part similar to those of the Company or carrying on any business capable of being conducted so as to directly or indirectly benefit the Company but in any event not to act as an investment company.

24. 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 under law.

25. To establish and maintain or procure the establishment and maintenance of any contributory or non-contributory pension or superannuation funds for the benefit of and give or procure the giving of donations, gratuities, pensions, allowances or emoluments to any persons who are or were at any time in die employment or service of the Company, and also to establish and subsidize and subscribe to any institutions, associations, clubs or funds calculated to be for the benefit of or to advance the interests and well being of the Company or of any such other company as aforesaid and do any of the matters aforesaid, either alone or in conjunction with any such other company as aforesaid.

26. To payout of the funds of the Company all expenses of and incidental to the formation, registration, advertisement of the Company and the issue and subscription of the share or loan capital including brokerage and/or commission for obtaining applications for or placing or guaranteeing the placing of shares or any debentures, debenture stock and other securities of the Company and also all expenses relating to the issue of any circular or notice and the printing, stamping and circulating of proxies and forms to be filled up by the members of the Company.

27. To enter into any agreement or any arrangement for sharing profits, union of interest, co-operation, joint-ventures, reciprocal and other concessions, or otherwise with any individual, firm co-operative or other company, association, corporate body, research and education institutions, affiliates, Government or local authority or other legal entity whether national or not, as may be

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

necessary or expedient for the purpose of carrying on any business of the Company, but in any event not to act as managing agents.

28. To distribute among the shareholders of the Company, in specie, any property of the Company, or any proceeds of sale or disposal of any property of the Company, so that no distribution amounting to a reduction of capital be made except with the sanction (if any) for the time being required by law.

29. To settle disputes by negotiation, conciliation, mediation, arbitration, litigation or other means and to enter into compromise with creditors, members and any other persons in respect of any difference or dispute with them.

30. To do all or any of the things herein in any part of the world either as principals, agents, contactors or otherwise, and either alone or in conjunction with others but in any event not to act as managing agents.

31. To carry on the business of buying, selling, manufacturing, importing, exporting, exchanging and otherwise dealing in merchandise of every description and all other articles or things, tangible or intangible, the business of which in the opinion of the Company may be conveniently carried on by the Company or calculated directly or indirectly to enhance the value of or render profitable any of the Company's property or rights.

32. To accept stock or shares in, debentures, mortgage-debentures or othersecurities of any other company in payment or part payment for anyservices rendered or for any sale made to or debt owing from any such company.

33. To receive, declare and distribute profits and to capitalize such portion of the profits of the Company as are not distributed among shareholders of the Company, in the form of dividends, and as the Company may think fit, and to issue bonus shares, as fully paid up in favor of the shareholders of the Company.

34. The Company shall not engage in banking business or business of an investment company, insurance company or leasing/modaraba company, brokerage house or in any unlawful business.

35. To do all and everything necessary, suitable or proper, ancillary or incidental or conducive to the accomplishment of any of the purposes or the attainmentof any of the objects or furtherance of any of the powers herein before setforth, either alone or in association with other corporate bodies, firms orindividuals and to do every other act or thing incidental or appurtenant toor arising out of or connected with the business or powers of the Companyor part thereof, provided the same be lawful.

36. It is hereby declared that:

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

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ★ ISLAMABAD PAKISTAN

(b) 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 or to indulge in business of security services, payment systems, Electronic funds transfers in and outside Pakistan, deposit taking from general public, network market, referral marketing & direct selling banking company, leasing investment, managing agency, insurance business, any of the NBFC business, multi-level marketing(MLM), Pyramid and Ponzi Scheme, commodity, future contract or shares trading business locally or internationally, directly or indirectly as restricted under the law or any unlawful operation.

IV. LIABILITY

The liability of the members is limited.

V. SHARE CAPIITAL

The authorized capital of the Company is Rs. 1,000,000/- (Pak One Million) divided into 10,000 ~~(Ninety Million)~~ Ordinary Shares of Rs. 100/- (Pak Rupee One Hundred) each. The Company shall have power to increase and reduce its capital and divided the shares in the capital for the time being into several classes subject to anypermission required by law.

Ten thousand

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

We, the several persons whose names and addresses are subscribed below, 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 as set opposite to our respective names.

Sr. No.	Name and Surname (present and former) in full (in block letters) and Passport #	Father's / Husband's Name in full	National ity with any former National ity	Occupation	Residential Address (in full)	Number of Shares taken by each subscriber	Signatures
1	**PORT QASIM ENERGY (DUBAI) HOLDING LIMITED.** (represented by its authorized Director, Mr Shen Decai, holding Chinese passport # SE0004555)	N/A	Dubai International Financial Centre incorporated company	Holding Company	Registered Address: Office No.307-308,Level 3 Emirates Financial Towers-North Tower Dubai International Financial Centre P O Box 487389 Dubai, UAE	96 (Ninety-six)	
2	**MR SHEN DECAI** (Chinese Passport # SE0004555)	Shen Mingbao	Chinese	(i) Director Port Qasim Energy (Dubai) Holding Ltd. (ii) Director Sinohydro Resources Ltd.	Room 1401, F-12, First District Of Deshengli, Xicheng District, Beijing, China.	1 (one)	
3	**MR. FADY BAKHOS** (Lebanese passport # RL162219B)	Fady Jean Bakhos	Lebanese	(i) Director Port Qasim Energy (Dubai) Holding Ltd. (ii) Legal Advisor, Al Mirqab Capital S.P.C.	West Bay, Villa # 7, Saha # 88, Doha, Qatar	1 (one)	
4	**MR. SHAHZAD SHAHBAZ** (British Passport # 504896967)	Aitzaz Shahbaz	British (formerly Pakistani)	(i) Director Port Qasim Energy (Dubai) Holding Ltd. (ii) Advisor to Chairman of Al Mirqab Holding.	Villa 14; Suraqa bin Amr Street; Old Airport Area; Doha; Qatar	1 (one)	
5	**MR. ZHONG HAIXIANG** (Chinese Passport # PE0025261)	Zhong Fangyuan	Chinese	(i) Director Port Qasim Energy (Dubai) Holding Ltd.	No. 1, South District of Liubukang, Xicheng District, Beijing, China.	1 (one)	
					Total Number of Shares	**100** (One hundred)	

Dated this ____ day of _____, 2014

Witness to the above signatures: SAIF-UR-REHMAN KHAN
Full Name:
Occupation: BUSSINESS
Passport # 35200-4498647-9
Father's Full Name: AMAN ULLAH KHAN

Signature .....
Nationality: PAKISTANI

Full Address: 47-B, MODEL TOWN
LAHORE

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

CERTIFIED TRUE COPY

THE COMPANIES ORDINANCE, 1984
(PRIVATE COMPANY LIMITED BY SHARES)

ARTICLES OF ASSOCIATION

OF

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED

I. PRELIMINARY

1. **Application of Table "A"**

Subject as hereinafter provided, the Regulations contained in Table "A" provided in the First Schedule to the Companies Ordinance, 1984 shall apply to the Company in so far as these are applicable to Private Companies, with the exception of the Regulations which are modified, altered or added by these Regulations contained hereunder.

2. **Interpretation**

The head notes are inserted for convenience and shall not affect the construction of these Articles, and unless the context or the subject matter otherwise requires:

(a) "**Articles**" means these Articles of Association, as originally framed or from time to time altered in accordance with law.

(b) "**Board**" means a meeting of the Directors duly called and constituted or as the case may be Directors assembled at a Board.

(c) "**Chairman**" means chairman of the Board of Directors of the Company.

(d) "**Commission**" means the Securities and Exchange Commission of Pakistan.

(e) "**Company**" means Port Qasim Electric Power Company (Private) Limited.

(f) "**Debenture**" means Participation Term Certificates and Term Finance Certificates.

(g) "**Director**" means a Director of the Company appointed from time to time pursuant to these Articles.

(h) "**Dividend**" means distribution of profits of the Company to its members.

(i) "**Implementation Agreement**" means the Implementation Agreement to be entered into between the Government of Pakistan and the Company in relation to the power generation project to be established by the Company.

(j) "**Member**" means a member of the Company within the meaning of Clause 21 of sub-section (1) of Section 2 of the Ordinance.

(k) "**Memorandum**" means Memorandum of Association of the Company as originally framed or as altered from time to time in accordance with the provisions of the Ordinance.

(l) "**Month**" means a calendar month according to the English Calendar.

(m) "**Office**" means the registered office for the time being of the Company.

(n) "**Ordinance**" means the Companies Ordinance, 1984 or any modification or re-enactment thereof for the time being in force.

(o) "**Register**" means, unless the context otherwise requires, the register of members to be kept pursuant to section 147 of the Ordinance.

(p) "**Seal**" means the common or official seal adopted by the Company.

(q) "**Section**" means the section of the Ordinance.

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

(s) Words importing masculine gender include the feminine gender.

(t) Words importing singular number include the plural number and vice versa.

(u) Expression referring to writing shall, unless the contrary intention appears be construed as including reference to printing, lithography, photography and other modes of representing or reproducing words in a visible form.

(v) Words importing persons shall include bodies corporate.

(w) Unless the context otherwise requires words or expressions contained in these Articles shall bear the same meaning as in the Ordinance.

3. **Nature of the Company**

The Company is formed as a private limited company within the meaning of Clause 28 of Section 2(1) of the Ordinance and accordingly:

(a) No invitation shall be issued to the public to subscribe for any shares, debentures or debenture stocks of the Company;

(b) The number of members of the Company (exclusive of persons in the employment of the Company) shall be limited to fifty, provided that for purposes of this provision when two or more persons hold one or more shares in the Company jointly, they shall for purposes of this Clause be treated as a single member; and

(c) The right to transfer shares in the Company is restricted in the manner and to the extent hereinafter appearing.

The Company shall approve, ratify and adopt and give full effect to all or any agreements, undertakings, commitments or arrangements if any entered into by the sponsors for and on behalf of the Company prior to incorporation of the Company relating to establishment and operation of said project. However, nothing herein shall be construed as limiting in any manner restricting the authorities of the Company as conferred by the Memorandum.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

II. CAPITAL AND SHARES

A. SHARES RIGHTS

4. Authorized capital

The authorized capital of the Company is Rs.1,000,000/- (Rupees One Million) divided into 10,000 (Ten thousand) Ordinary Shares of Rs. 100/- (Rupees One Hundred) each. The Company has the power from time to time to increase or reduce its capital and divided the shares in the capital for the time being into several classes subject to any permission required by law.

5. Increase in share capital

5.1 Subject to Section 86 of the Ordinance, where at any time the Board decides to increase the issued capital of the Company by issuing any further shares, then subject to any direction to the contrary that may be given by the Company in general meetings, such shares shall be offered to the members in proportion to the existing shares held by each member, and such offer shall be made by notice specifying the number of shares to which the member is entitled, and limiting a time within which the offer if not accepted will be deemed to be declined and after the expiration of such time or on receipt of information from the member to whom such notice is given that he declines to accept the shares offered, the Board may dispose of the same in such manner as it may consider most beneficial to the Company, provided if a member renounces all or any of the shares in favor of any member or any other person who is not a member of the Company, the Board shall accept renunciation.

5.2 If and whenever as a result of an issue of new shares or any consolidation or subdivision of shares any member becomes entitled to hold shares in fraction, the Board shall not be required to issue such fractional shares and shall be entitled to sell whole shares at a reasonable price and pay and distribute to and amongst the members entitled to such fractional shares in due proportion the net proceeds of the sale thereof. For the purpose of giving effect to any such sale the Board may authorize any member to transfer the shares sold to the purchaser thereof and the purchaser shall be registered as the holder of the shares comprised in such transfer but he shall not be entitled to see the application of the purchase money nor shall his title to the shares be affected by any irregularity or invalidity in the proceedings in reference to the sale.

5.3 Subject to the provisions of the Ordinance and the Articles, the Board may allot and issue shares in the capital of the Company as payment or part payment of any property sold or transferred goods or machinery supplied or for services rendered to the Company in the conduct of a business or affairs and any shares which may be so allotted may be issued as fully paid shares.

5.4 Any application or subscription signed by or on behalf of an applicant or subscriber for shares in the Company, followed by an allotment of any shares therein, shall be an acceptance of shares within the meaning of the Articles and every person whom thus or otherwise accepts any shares and whose name is entered on the Register shall for the purpose of the Articles be a member.

5.5 The Company shall be entitled to treat the person whose name appears on the Register of Members as holder of any shares as the absolute owner thereof and accordingly shall not (except as ordered by a Court of competent jurisdiction or as by law required) be bound to recognize any trust on entity or benami, equitable, contingent or any claim to or interest in such shares, on the part of any other person whether or not it shall have express or implied or constructive notice thereof.

6. Shares under Director's control

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

Subject to the provisions of the Ordinance and these Articles, the shares shall be under the control of the Board, who may allot or otherwise dispose of the same or any of them to such persons, on such terms and conditions, and at such times as the Board thinks fit and with full powers to give to any person the call of any shares at a premium or at par or at a discount, or on a redeemable basis, and for such time and for such consideration as the Board thinks fit.

7. **Amount payable on application**

No shares shall be offered to the public for subscription except upon the term that the amount payable on application shall be the full amount of the nominal amount of the share.

8. **Allotment of shares**

The Director shall, as regards any allotment of shares, duly comply with such of the provisions of Section 68 to 73, as may be applicable to the Company.

9. **Share certificates**

9.1 Every person whose name is entered as a member in the Register shall, without payment, be entitled to receive within 90 days after allotment or within forty-five (45) days of the application for registration of transfer, Certificate under the Seal specifying the share or shares held by him and the paid up amount in respect thereof.

9.2 The Company shall not be bound to issue more than one (1) certificate in respect of a share or shares held jointly by several persons and delivery of a certificate for a share to one of several joint holders shall be sufficient delivery to all.

9.3 The Company shall register transfer of the shares in the name of central depository within five (5) days on receipt of an application for registration of such transfer.

10. **Issuance of new certificates**

If a share certificate is defaced, lost or destroyed, it may be renewed on payment of such fee, if any, as may be prescribed under the Ordinance, and if any, as to evidence and indemnity and payment of expenses incurred by the Company in investigating title as the Directors think fit.

11. **Certificate under Seal**

The certificate of title to shares shall be issued under the authority of the Directors' or of a committee of Directors' when authorized thereto by the Directors' in such manner and form as the Directors' may from time to time prescribe, and shall bear the autographic signature of two Directors' or one Director and the secretary of the Company. The Seal shall be affixed to every share certificate issued by the Company.

12. **Trusts not recognised**

Except as required by law, no person shall be recognized by the Company as holding any shares upon any trust, and the Company shall not be bound by or be compelled in any way to recognize (even when having notice thereof) any equitable, contingent, future or partial interest in any share or any interest in any fractional part of a share, (except only as by these Articles or by law otherwise provided) any other rights in respect of any share except an absolute right to the entirely thereof in the registered holder.

13. **Payment of commission**

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

The Company may at any time pay a commission to any person for subscribing/agreeing to subscribe (whether absolutely or conditionally) for any shares, debentures or debenture stock in the Company or procuring or agreeing to procure subscriptions (whether absolutely or conditionally) for any shares, debentures or debentures stock in the Company, so that the amount or rate of commission shall not exceed five percent (5%) (or such other percentage/rate as may be prescribed by the Commission) but so that if the commission in respect of shares shall be paid or payable out of capital, the statutory requirements and conditions shall be observed and complied with, and the amount or rate of commission shall not exceed such percentage on the shares, debentures, debenture stock in each case subscribed or to be subscribed, as may be prescribed by law. The commission may be paid or satisfied, either wholly or partly, in cash or in shares, debentures or debenture stock. The Company may also on any issue of shares pay such brokerage as may be lawful; provided that such brokerage shall not exceed such percentage on the shares, debentures or debenture stock paid up, as may be prescribed by law.

B. TRANSFER OF SHARES

14. Transfer

The instrument of transfer of any share in the Company shall be executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the same until the name of the transferee is entered in the Register in respect thereof. The Company shall keep a book to be called the "Register of Transfers" and therein shall be fairly and distinctly entered the particulars of every transfer or transmission of any share.

15. Form of transfer

15.1 Shares in the Company shall be transferred in any usual or common form which the Directors shall approve or shall be in writing in the form appearing hereunder:

"I [•]of [•]being a [•]National,(hereinafter called the "Transferor") in consideration of (the sum of Rs.[•] (Rupees[•])paid to me by [•]s/o[•]of [•]National of[•] (hereinafter called the "Transferee") do hereby transfer to the Transferee [•]share(s)numbered[•] in the undertaking called the PORT QASIM Electric Power Company (Private) Limited to hold the same unto the Transferee, his or her executors, administrators and assigns, subject to the several conditions on which I held the same immediately before the execution hereof and I [•], the Transferee, do hereby agree to take the said shares subject to the conditions aforesaid.

Signature of Transferor Signature of Transferee

Witness".

15.2 All applications for transfer of shares lodged with the Company must be returned by the Company to the shareholders duly completed within six (6) weeks from the date of its receipt. No share in any circumstances shall be transferred to an insolvent or as otherwise prohibited by law or by these Articles.

15.3 Without prejudice to the above, transfer of shares of the Company shall be subject to any further restrictions/procedures envisaged under the Implementation Agreement.

16. Refusal of transfer of shares

16.1. The Directors may decline to register any transfer of shares to transferees of whom they do not approve and shall be bound to show any reasons for exercising their discretion subject to the provisions of Sections 77 and 78 of the Ordinance.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

16.2. In accordance with applicable laws, the Directors will not permit any transfer of shares resulting in any one person holding in its own right or beneficially owning or controlling voting strength in the Company equal to or exceeding ten percent of the total number of votes in any meeting of the shareholders or the creditors of the Company.

17. **Closure of Register**

On giving seven (7) days previous notice in the manner provided in the Ordinance, the Register may be closed for such period or periods not exceeding forty-five (45) days in any one (1) year as the Directors' may from time to time determine, but so that the Register shall not be closed for a longer period than thirty (30) days at a time.

C. TRANSMISSION OF SHARES

18. **Transmission**

The executors, administrators, heirs or nominees, as the case may be, of a deceased sole holder of a share shall be the only persons recognized by the Company as having any title to the share, but nothing herein contained shall release the estate of a deceased holder (whether sole or joint) from any liability (whether sole or joint) in respect of any share solely or jointly held by him. In any case in which a grant of probate or letters of administration to the estate of a deceased sole or any surviving holder has not been obtained, the Board may, but shall not be bound to recognize the title of any person claiming to be entitled to the deceased holder's shares on production by such claim of a succession certificate or such other evidence of title as the Board may deem sufficient, and upon the claimant furnishing such indemnity, if any, as the Board may require. In the case of a share registered in the names of two or more holders, the survivor or survivors shall be the only persons recognized by the Company as having any title to the share.

19. **Rights upon death or insolvency of a shareholder**

Any person becoming entitled to a share in consequence of the death or insolvency of a member shall, upon such evidence being produced as may from time to time be required by the Directors', have the right, either to be registered as a member in respect of the share or, instead of being registered himself, to make such transfer of the share as the deceased or insolvent person could have made: but the Directors' shall, in either case have the same right to decline or suspend registration as they would have had in the case of a transfer of the share by the deceased or insolvent person before the death or insolvency.

20. **Right of person entitled by transmission**

A person becoming entitled to a share by reason of the death or insolvency of the holder shall be entitled to the same dividends and other advantages to which he would be entitled if he was the registered holder of the share, except that he shall not, before being registered as a member in respect of the share, be entitled in respect of it to exercise any right conferred by membership in relation to meetings of the Company.

21. **Liability for transmission**

The Company shall incur no liability or responsibility whatsoever in consequence of its registering or giving effect to any transfer of shares made or purporting to be made by any apparent legal owner thereof (as shown or appearing in the register) to the prejudice of persons having or claiming any equitable right, title or interest to or in the same shares, notwithstanding that the Company may have had notice of such equitable right, title or interest

or notice prohibiting registration of such transfer, and the Company shall not be bound or required to regard or attend or give effect to any notice which may be given to it of any equitable right, title or interest or be under any liability whatsoever for refusing or neglecting so to do, but the Company shall nevertheless be at liberty to regard and attend any such notice and give effect thereto, if the Board shall so think fit.

D. ALTERATION OF CAPITAL

22. **Power to increase capital**

The Company may, from time to time, by special resolution increase the authorized share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

23. **Further issue of capital**

All further issue of shares capital shall first be subject to such of the provisions of Section 86 as are applicable to the Company. Thereafter, the Directors' may dispose of the same in such manner as they think most beneficial to the Company.

24. **Provisions applicable to new shares**

Except and so far as otherwise provided by the conditions of issue or by these Articles, any new shares shall be subject to the same provisions with reference to transfer, transmission and otherwise as the shares in the original share capital.

25. **Consolidation and sub-division**

The Company may, by ordinary resolution:

(a) consolidate and divide its share capital into shares of larger amount 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 provisos to clause (d) of sub-section (1) of Section 92;
(c) cancel any shares which, at the date of the passing of the resolution, have not been taken or agreed to be taken by any person.

26. **Reduction of share capital**

The Company may by Special Resolution reduce its share capital in any manner subject to any conditions imposed by members and/or consents required by law.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

III. MEETINGS AND PROCEEDINGS

E. GENERAL MEETINGS

27. **Annual general meetings**

A general meeting to be called the annual general meeting, shall be held, in accordance with the provisions of Section 158, within eighteen (18) months from the date of incorporation of the Company and thereafter once at least in every year within a period of four (4) months following the close of its financial year and not more than fifteen (15) months after the holding of its last annual general meeting as may be determined by the Directors.

28. **Other meetings**

All general meetings of the Company other than statutory meeting or any annual general meeting shall be called an extraordinary general meeting.

29. **Extraordinary meetings**

The Directors' may whenever they think fit, call an extraordinary general meeting and an extraordinary general meeting shall also be called on such requisition, or in default, may be called by such requisitionists, as is provided by Section 159. If at any time there are not within Pakistan sufficient Directors' capable of forming a quorum, any Director of the Company may call an extraordinary general meeting in the same manner as nearly as possible as that in which meetings may be called by the Directors.

F. NOTICE AND PROCEEDINGS

30. **Notice of meetings**

Twenty-one (21) days notice at the least (exclusive of the day on which the notice is served or deemed to be served, but inclusive of the day for which notice is given) specifying the place, the day and the hour of meeting and in case of special business, 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, and in case of any foreign company having a registered office outside Pakistan, notice must be given by telex if such foreign company so desires: 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.

31. **Special business**

All business shall be deemed special that is transacted at an extraordinary general meeting, 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 fixing of remuneration of auditors.

32. **Notice for Special Resolution**

Where it is proposed to pass Special Resolution at any meeting, at least twenty-one (21) days notice shall be given specifying the intention to propose the resolution as a Special Resolution, and specifying the date, place and hour of meeting, whether annual or extraordinary and the nature of the business.

33. **Reduced period for notice**

With the consent of all members entitled to receive notice of an extraordinary general meeting or to attend and vote at such extraordinary general meeting, an extraordinary general meeting may be convened by shorter notice than specified above provided the Registrar on the application of the Directors, authorize such meeting to be held at a shorter notice.

34. **Accidental omission of notice**

In a case in which notice of a meeting is given to the shareholders individually, the accidental omission to give notice to any of the shareholders or the accidental non-receipt thereof shall not invalidate the proceedings at any such meeting.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

35. **Quorum**

At least two (2) Members entitled and present in person and representing not less than twenty-five (25) percent of the total voting power either on their own account or as proxies shall be the quorum for a general meeting and no business shall be transacted at any general meeting unless the quorum requisite is present at the commencement of the business.

36. **Effect of absence of quorum**

If within half an hour from the time appointed for the meeting, a quorum is not present, the meeting if called upon the requisition of members, shall be dissolved, in any other case, it shall stand adjourned to the same day in the next week at the same time and place, or to such other day, time and place as the Board may by notice to the members appoint. If at the adjourned meeting a quorum is not present but those members who are present and entitled to vote not being less than three (3), shall be a quorum and they may transact the business for which the meeting was called.

37. **Chairman of meeting**

The Chairman of the Board and in his absence the Managing Director shall preside as Chairman at every general meeting of the Company but if there is no such Chairman or if at any meeting he is not present within fifteen (15) minutes after the time appointed for the meeting, or is unwilling to act as Chairman, any one of the Directors' present may be elected to be Chairman and if none of the Director is present or willing to act as a Chairman, the members present shall choose from amongst themselves to be the Chairman for that particular meeting.

38. **Adjournment**

The Chairman may with the consent of any meeting at which a quorum is present (and shall if so directed by the meeting) adjourn the meeting from time to time and from place to place but no business shall be transacted at any adjourned meeting other than the business left unfinished at the meeting from which the adjournment took place. When a meeting is adjourned for thirty (30) days or more, notice of the adjournment shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of any adjournment or of the business to be transacted at an adjourned meeting.

39. **Voting**

At any general meeting a resolution put to the vote of the meeting shall be decided by an affirmative vote of Members present in person or by proxy and holding or representing not less than fifty-one (51) percent of the issued capital of the Company for the time being.

40. **Demand for poll**

A poll may be demanded only in accordance with the provisions of Section 167. The demand for a poll may be withdrawn at any time by the person or persons who made the demand.

41. **Manner of taking poll**

If a poll is duly demanded, it shall be taken in accordance with the manner laid down in Section 168 and the result of the poll shall be deemed to be a resolution of the meeting at which the poll was demanded. A poll demanded on the election of Chairman or on a question of adjournment shall be taken at once. The demand for a poll shall not prevent the continuation of

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

the meeting for the transaction of any business other than the question on which the poll was demanded.

G. VOTES OF MEMBERS

42. **Right to vote**

Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hand every member present in person or by proxy shall have one vote except for election of Directors' in which case the provisions of Section 178 shall apply. On a poll every member shall have voting rights as laid down in Section 160.

43. **Voting by joint holders**

In case of joint holders, 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.

44. **Member of unsound mind**

A member of unsound mind, or in respect of whom an order has been made by any court having jurisdiction in lunacy, may vote, whether on show of hands or on a poll, by his committee or other legal guardian, and any such committee or guardian may on a poll vote by proxy.

45. **Voting – corporation representative**

45.1 On a poll votes may be given either personally or by proxy. Provided that no body corporate shall vote by proxy as long as a resolution of its Directors' in accordance with the provisions of Section 162 is in force.

45.2 A "Corporation", foundation or a company being a Member of the Company may appoint as proxy or as its representative under Section 162 any person to exercise the same powers on behalf of the corporation or company which he represents to general meeting as that corporation or company could exercise if it were an individual member of the Company.

46. **Proxy to be in writing**

The instrument appointing a proxy shall be in writing under the hand of the appointer or by an agent duly authorized under a Power of Attorney or if such appointer is a Company or corporation under the common seal of the company or corporation or the hand of its attorney who may be appointer. A proxy must be a member of the Company.

47. **Instrument appointing proxy to be deposited**

The instrument appointing a proxy and the power of attorney or other authority (if any) under which it is signed or a notarized copy of that power or authority shall be deposited at the Office not less than forty-eight (48) hours before the time for holding the meeting at which the person named in the instrument proposes to vote and in default the instrument of proxy shall not be treated as valid.

48. **Form of proxy**

An Instrument appointing a proxy may be in the following form, or a form as near thereto as may be:

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

"[*name of company*]

I/We[•] of [•]in the district of [•] being a member(s) of PORT QASIM Electric Power Company (Private) Limited hereby appoint [•]of [•]as my proxy to vote for me/us and on my/our behalf at the annual / extraordinary general meeting of the Company to be held on the[•]day of [•]and at any adjournment thereof

Date: [•]Signature [•]

Witness [•]"

49. **Revocation of authority**

A vote given in accordance with the terms of an instrument of proxy shall be valid notwithstanding the prior death or insanity of the principal or revocation of the proxy or of the authority under which the proxy was executed or the transfer of the share in respect of which the proxy is given, provided that no intimation in writing of such death, insanity, revocation or transfer as aforesaid shall have been received by the Company at the Office before the commencement of the meeting or adjourned meeting at which the proxy is used. No objection shall be made to the validity of any vote except at the meeting or at the poll as which such vote shall be rendered and every vote whether given personally or by proxy not disallowed at such meeting or poll shall be deemed valid for all purposes of such meeting or poll shall be deemed valid for all purposes of such meeting or poll. If any question is raised, the Chairman of the meeting shall decide on the validity of every vote tendered at such meeting in accordance with these Articles.

50. **Irrevocable proxy**

Any proxy declared expressly on its place to be irrevocable shall not be revoked or be deemed revoked by the manner giving such proxy whether by attendance at any meeting held during the period of such proxy or by any other action on his part whatsoever or otherwise during the term of such proxy if such proxy is furnished to and filed with the records of the Company and the Company shall be bound to recognize and give effect to such proxy in accordance with the terms thereof.

IV. MANAGEMENT AND ADMINISTRATION

H. BOARD OF DIRECTORS

51. **Number of Directors**

The number of Directors shall be four (4). Additionally, the Chief Executive, unless already a director, shall be deemed to be a director of the Company in accordance with Section 200(2). The following persons shall be the first Directors of the Company:

(1) **Mr Shen Decai;**
(2) **Mr Zhong Haixiang;**
(3) **Mr Fady Bakhos; and**
(4) **Mr Shahzad Shahbaz.**

52. **Qualification of Directors & share qualification**

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

Save as provided in Section 187, no person shall be appointed as a Director unless he is a member of the Company. The qualification of a Director shall be holding of a minimum one (1) share in the Company at least in his own name.

53. **Chairman of the Board**

The Directors may elect one of their number as the Chairman of the Board and vest in him such powers and functions as they may deem fit in relation to the management and administration of the affairs of the Company subject to their general supervision and control.

54. **Chief Executive**

The Directors may within fourteen (14) days from the date of an election of Directors under Article 73 or within fourteen (14) days from the date on which such office falls vacant for whatsoever reason, elect one of their number or from outside their body to be the Chief Executive of the Company for such period (not exceeding three years) on such terms including remuneration (whether by way of salary, commission, participation in profits, allowances etc. or partly in one way and partly in another) as the Director may fix and vest in him such powers and functions as they may deem fit in relation to the management and administration of the affairs of the Company subject to their general supervision and control. The Chief Executive of the Company, if not already a Director, shall be deemed to be a Director of the Company and be entitled to all the rights and privileges and subject to all liabilities of that office. The Board may by resolution passed by not less than three-fourths of the total number of Directors for the time being or the Company may by Special Resolution remove a Chief Executive before the expiration of his term of office notwithstanding anything contained (if any) in these Articles or in any agreement between the Company and the Chief Executive. Upon the expiry of his period of office, a Chief Executive shall be eligible for reappointment.

55. **Remuneration**

Subject to any approval or limits required by law, terms and conditions and remuneration of;
(a) a Director for performing extra services, including the holding of the office of the Chairman, serving on a committee or devoting special attention to the business of the Company.
(b) the Managing Director/ Chief Executive; and
(c) any Director for attending the meetings of the Directors or a Committee of Directors shall be determined by the Board.

I. POWERS AND DUTIES OF DIRECTORS

56. **General management powers**

56.1 The control of the Company shall he vested in the Board and 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 by these regulations, required to be exercised by the Company in general meeting, subject nevertheless to the provisions of the Ordinance or to any of these regulations and such regulations being not inconsistent with the aforesaid provisions as may be prescribed by the Company in general meeting but no regulation made by the Company in general meeting shall invalidate any prior act of the Directors which would have been valid if that regulation had not been made.

56.2 Without prejudice to the general powers conferred above and any other powers or authorities conferred by these presents on the Directors, it is hereby expressly declared that the Directors shall have the following powers that is to say power:

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

(a) to pay cost, charges and expenses preliminary and accidental to the promotion, formation, establishment and registration of the Company and also to pay to the promoters all costs and charges they have incurred in acquiring properties, machinery or other rights which the Company may take over from them;

(b) to purchase or otherwise acquire from the Company any property, rights or privileges which the Company is authorized to acquire at such price and generally on such terms and conditions as they think fit and subject to the provisions of Section 196(3) to sell, let, exchange, or otherwise dispose of, absolutely or conditionally, any part of the property, privileges and undertaking of the Company upon such terms and conditions and for such consideration as they think fit;

(c) at their discretion to pay for any property rights and privileges acquired by or services rendered to the Company either wholly or partially in cash or in shares (subject to Section 86) bonds, debentures or other securities of the Company and any such shares shall be issued as fully paid-up and any such bonds, debentures or other securities may be either specifically charged upon all or any part of the property of the Company or not so charged;

(d) to secure the fulfillment of any contracts, agreements or engagements entered into by the Company by mortgage or charge of all or any of the property of the Company for the time being or in such manner as they think fit;

(e) to appoint and at their discretion remove or suspend such agents, managers, secretaries, officers, legal advisers, clerks, and servants for permanent, temporary or special services as they may from time to time think fit and to determine their powers and duties and fix their salaries or emoluments and to require security in such instances and to such amount as they think fit and to send any such persons to foreign countries for technical education or otherwise for the purpose of the Company's business and pay all expenses thereof on such terms as the Directors may think fit;

(f) to appoint any person or persons (whether incorporated or not) to accept and hold in trust for the Company any property belonging to the Company or in which it is interested or for any other purposes and not to execute and do all such trusts and also all such deeds, documents and things as may be requisite in relation to any such trust and to provide for the remuneration of such trustee or trustees;

(g) subject to the provisions of Section 196(3)(b), to institute, conduct, defend, compound or abandon any legal proceedings by or against the Company or its officer or otherwise concerning the affairs of the Company and also to compound and allow time for payment or satisfaction of any debts due and of any claims or demands by or against the Company;

(h) to refer any claims or demands by or against the Company to arbitration and observe and perform or resist the awards;

(i) to act on behalf of the Company to all matters relating to bankrupts and insolvents;

(j) to determine who shall be entitled to sign on the Company's behalf bills, notices, receipts, acceptances, endorsements, cheques, releases, contracts and documents;

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

(k) from time to time provide for the management of the affairs of the Company either in different parts of Pakistan or elsewhere in such manner as they think fit and in particular to establish branch office and to appoint any persons to be the attorneys or agents of the Company with such powers (including power to sub-delegate) and upon such terms as may be thought fit;

(l) subject to the provisions of the Ordinance, to invest and deal with any of the moneys of the Company upon such securities (not being shares in this Company) and in such manner as they think fit and from time to time vary or realize such investments;

(m) to execute in the name and on behalf of the Company in favor of any Director or other person who may incur or be about to incur personal liability for the benefit of the Company such mortgage of the Company's property (present or future) as they think fit and any such mortgage may contain a power of sale and such other powers, covenants and provisions as shall be agreed upon;

(n) to give to any persons employed by the Company as remuneration for their services as such a commission on the profits of any particular business or transaction or a share in the general profits of the Company and such commission or share of profit shall be treated as part of the working expenses of the Company;

(o) from time to time to make, vary and repeal by-laws for the regulation of the business, its officers and servants;

(p) to enter into all such negotiations and contracts and rescind and vary all such contracts and execute and do all such acts, deeds and things in the name and on behalf of the Company as they consider expedient for or in relation to any of the matters aforesaid or otherwise for the purposes of the Company;

(q) to establish, maintain, support and subscribe to any charitable or public objects and any institution, society or club which may be for the benefit of the Company or its employees or may be connected with any town or place where the Company carries on business; to give pensions, gratuities, bonuses or charitable aid to any person or persons who have served the Company or to the wives, children or dependents of such person or persons that may appear to the Directors just or proper, whether any person, his widow, children or dependents have or have not a legal claim upon the Company;

(r) subject to the provisions of Section 227, to form a fund to provide for such pensions, gratuities, compensation or to create any Provident or Benefit Fund in such or any other manner as the Directors may deem fit;

(s) to make and alter rules and regulations concerning the time and manner of payment of the contributions of the employees and the Company respectively to any such fund and the accrual, employment, suspension and forfeiture of the benefits of the said fund and the application and disposal thereof and otherwise in relation to the working and management of the said fund as the Directors shall from time to time think fit;

(t) to make and give receipt, releases and other discharges for money payable to the Company and for the claims and demands of the Company;

(u) to delegate any of their powers which are not required to be exercised by them under section 196 of the Ordinance.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

56.3 The Board may exercise or delegate all the powers of the Company to borrow, obtain finances as may be reasonably required and mortgage or charge its undertaking, property and assets (both present and future) and to issue debentures and other securities, whether outright, subject to any conditions, or as collateral security for any debt, liability or obligation of the Company or of any third party.

57. **Borrowing powers**

The Board may from time to time borrow any moneys as may be reasonably required for the purposes of the Company from the members or from other persons, firms, corporations, companies, institutions or banks or the Directors may themselves lend any money to the Company. The Company shall have no power to buy its own shares and shall not give whether directly or indirectly and whether by means of a loan, guarantee, provision of securities or otherwise any financial assistance for the purpose of or in connection with purchase made or to be made by any person of any shares of the Company.

58. **Power to secure**

The Board may secure payment of such sum or sums of money in such manner and upon such terms and conditions as they think fit and in particular by the issue of bearer and registered bonds, perpetual or redeemable debentures or by mortgage or charge or other security on the whole or any part of the property, assets and rights of the Company (both present and future). Any bonds, debentures or other securities issued or to be issued by the Company shall be under the control of the Board which may issue them upon such terms and conditions and in such manner and for such consideration as shall be considered by the Board to be for the benefit of the Company.

59. **Special terms**

Any bonds, debentures or other securities may be issued at a discount, premium or otherwise and with any special privileges as to redemption, surrender, drawing, convertibility into shares, attending and voting at meetings of the Company, appointment of Directors and otherwise, provided that debentures with the right to vote or convertible into shares shall not be issued unless authorized by a Special Resolution.

60. **Duties of Directors**

The Directors shall duly comply with the provisions of the Ordinance and in particular with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it, to the keeping of a register of the Directors, chief executive, managing director, chief accountant, secretary or auditor of the Company and every other person holding not less than ten (10) percent of the beneficial interest in the Company, the number, description and amount of any share in or debenture of the Company or any other body corporate being the Company's subsidiary or holding Company, or a subsidiary of the Company's holding Company which are held by or in trust for him or of which he has a right to become holder whether on payment or not. The Directors shall be responsible for sending to the registrar annual list of members and a summary of particulars relating thereto and notice of any consolidation or increase of share capital or sub-division of shares and copies of Special Resolution and a copy of the register of Directors and notifications of any changes therein.

61. **Benefits**

The Board may pay and agree to pay pension of other retirement, superannuation, death or disability benefits or allowances to any person in respect of any Director or former Director who may hold or may have held any executive office or employment under the Company and

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

for the purpose of providing any such pensions or other benefits or allowances, may contribute to any scheme or fund and may make payments towards insurance or trusts in respect of such persons.

62. **Minute books**

62.1 The Directors shall cause minutes to be made in books provided for the purpose of:

(a) all appointments of officers made by the Directors;

(b) the names of the Directors present at each meeting of the Directors and of any committee of the Directors; and

(c) any resolution and proceedings at all meetings of the Company and of the Directors and of committees of Directors and every Director present at any meeting of Directors or committee of Directors shall sign his name in a book to be kept for that purpose.

62.2 Any such minutes signed by the Chairman of the meeting or of the next following meeting shall be receivable as evidence of the facts therein stated without further proof. The Books containing minutes of proceedings of general meetings of the Company shall be kept at the Office of the Company and shall during business hours (subject to reasonable restrictions as the Board may from time to time impose but so that not less than two (2) hours each day is allowed for inspection), be open to the inspection of any Member without charge.

J. DISQUALIFICATION OF DIRECTORS

63. **Disqualification of Directors**

63.1 No person shall become a Director of the Company if he suffers from any of the disabilities or disqualifications mentioned in Section 187 and if already a Director, shall cease to hold such office from the date he so becomes disqualified or disabled or (a) if removed before expiration of period of office under Section 181 or by a Special Resolution passed by the Company at a general meeting, provided he is not a nominee Director appointed under Section 183; (b) If by notice in writing given to the Company he resigns from his office; (c) he absents himself from three (3) consecutive meetings of the Directors or from all the meetings of the Directors for a continuous period of three (3) months, whichever is the longer, without leave of absence from the Directors; (d) he or any firm of which he is a partner or any private company of which he 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 adviser or a banker; or (ii) accepts a loan or guarantee from the Company in contravention of Section 195.

63.2 Provided however that no Director shall vacate his office by reason only of his being a member of any company which has entered into contracts with or done any work for the Company. These provisions shall not apply to any contract by or on behalf of the Company to give to the Directors or any of them any security for advances or by way of indemnity against any loss which they or any of them suffer by reason of becoming or being sureties for the Company. A general notice that any Director is a member of any specified company or is a member of any specified firm and is to be regarded as interested in any subsequent transaction with such firm or company shall be given for purposes of disclosure under this Article, and any such general notice shall expire at the end of the financial year in which it was given and may be renewed for a further period of one (1) financial year by giving fresh notice in the last month of the financial year in which it would otherwise expire.

K. PROCEEDINGS OF DIRECTORS

64. **Meeting of Directors**

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

64.1 The Directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings as they think fit. At least two (2) Directors personally present shall constitute a quorum, however where the Directors consider that one or more Directors may not be personally present at the designated venue, meeting of the Directors may be duly convened through audio and/or video conference or other modern technologies acceptable to the Board; provided that the secretary shall secure audio or video, as the case may be, recording of the proceedings of such meeting and keep in custody together with other relevant record. Questions arising at any meeting shall be decided by a majority of votes. A Director may and the secretary on the requisition of a Director shall at any time summon a meeting of the Directors. At least four (4) clear days notice must be given to all Directors to summon a meeting of the Board and such notice shall set forth the purpose or purposes of which such meeting is summoned. However, with the consent of all Directors entitled to receive notice of a meeting or to attend and vote at any such meeting, a meeting of the Board may be convened by shorter notice than specified in this Article. Any Director may waive notice in writing of the time, place and purpose of any meeting, either before at or after such meeting.

64.2 A meeting of the Board for the time being at which the quorum is present shall be competent to exercise all or any of the authorities, powers and discretion by or under the Articles or by or, under any law vested in or exercisable by the Board generally. The quorum for a meeting of Directors shall not be less than one-third (1/3) of their number or two (2) whichever is greater. The Board may by unanimous consent determine that a larger number of Directors shall constitute a quorum for deliberating on specified matters and further that such matters shall be decided upon the affirmative votes of more than a simple majority as may be specified by the Board.

64.3. The directors may hold their meetings through tele/video conferencing in emergent situation where it is not possible for them to be physically present at the venue of the meeting, provided that the minutes of such meeting are approved and signed subsequently by all directors who participated in such meeting, requirements of the requisite quorum and other legal formalities relating to holding of such meetings have been observed and tele/video recording of the proceedings of the meetings are kept for the purpose of the record.

65. **Chairman of Directors Meetings**

The Chairman of the Board who shall be Director representing share holding interest of the Company shall preside at all meetings of the Board but if at any meeting the Chairman is not present within ten (10) minutes after the time appointed for holding the same or is unwilling to act as Chairman, the Chief Executive shall preside but if at any meeting the Chief Executive is not present within ten (10) minutes after the time appointed for holding the same or is unwilling to act as Chairman, the Directors present may choose one of their number to be Chairman of the meeting. In case of an equality of votes, the Chairman shall have and exercise a second or casting vote.

66. **Committees**

The Directors may delegate any of their powers not required to be exercised in their meeting to committees consisting of such member or members of their body as they think fit. Any committee so formed shall in the exercise of the powers so delegated, conform to any restrictions that may be imposed on it by the Directors.

67. **Chairman of committee meetings**

A committee may elect a Chairman of its meeting but if no such Chairman is elected or if at any meeting the Chairman is not present within ten (10) minutes after the time appointed for

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

holding the same or is unwilling to act as Chairman, the members present may choose one of their number to be Chairman of the meeting.

68. **Proceedings of committee members**

A committee may meet and adjourn as it thinks proper. Questions arising at any meeting shall be determined by a majority of votes of the members present. In case of an equality of votes, the Chairman shall have and exercise a second or casting vote.

69. **Validity of Directors acts**

All acts done by any meeting of the Directors or of a committee of Directors or by any other person acting as a Director shall notwithstanding that it be afterwards discovered that there were some defect in the appointment of such Directors or persons acting as aforesaid or that they or any of them were disqualified, be as valid as if every such person had been duly appointed and was qualified to be a Director. Provided that as soon as any such defect has come to notice, the director or other person concerned shall not exercise the right of his office till the defect has been rectified.

70. **Resolution by circulation**

A resolution in writing circulated to all the Directors and signed by all the Directors or affirmed by them through facsimile, telex, telegram or other means of communication acceptable to the Board shall be as valid and effectual as if it had been passed at meeting of the Directors duly convened and held.

L. ELECTION AND REMOVAL OF DIRECTORS

71. **First election of Directors**

At the first annual general meeting of the Company, all the Directors shall stand retired from the office and Directors shall be elected in their place in accordance with Section 178 for a term of three (3) years

72. **Eligibility for re-election**

A retiring Director shall be eligible for re-election provided he serves a notice of his candidature for election in writing at the Office not less than fourteen (14) days before the date of the meeting at which the election of Directors is to take place.

73. **Election in accordance with the Ordinance**

The Director shall comply with the provisions of Section 174 to 178 and Section 180 and 184 relating to the election of Director and matters ancillary thereto. Unless the number of candidates is not more than the number of Directors to be elected, the number of Directors as determined by the Board shall be elected to office by the members in general meetings in the following manner:
(i) a member shall have such number of votes as is equal to the product of voting shares held by him and the number of Directors to be elected;
(ii) a member may give all his votes to a single candidate or divide them between more than one (1) of the candidates in such manner as he may choose;
(iii) the candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest number of votes shall be so declared elected and so on until the total number of Directors to be elected has been so elected.

74. **Filing the casual vacancy**

Any casual vacancy occurring on the Board of Directors may be filled up by the Directors, but the person so chosen shall be subject to retirement at the same time as if he had become a Director on the day on which the Director in whose place he is chosen was last elected as Director.

75. **Removal of Director**

The Company may' remove a Director but only in accordance with the provisions of the Ordinance. The Company may by resolution in a general meeting remove a director appointed under Article 76 or elected in the manner provided for in Article 73 provided that a resolution for removing a Director shall not be deemed to have been passed unless the number of votes cast in favor of such resolution is not less than:
(i) the minimum number of votes that were cast for the election of a Director at the immediately preceding election of Directors, if the resolution relates to removal of a Director elected in the manner provided in or under Article 73; or
(ii) the total number of votes for the time being computed in the manner laid down in Article 73 divided by the number of Directors for the time being, if the resolution relates to removal of a Director appointed under Article 76.

76. **Alternate Directors**

Any Director not permanently resident in Pakistan and any Director so resident but intending to be absent from Pakistan for a period of not less than three (3) months may appoint any person acceptable to the Board to be an Alternate Director of the Company to act for him. Every such appointment shall be by writing under the hand of the Director making the appointment. An Alternate Director so appointed shall not be entitled to appoint another Alternate Director, but shall otherwise be subject to the provisions of the Ordinance and these Articles with regard to Directors. An Alternate Director shall be entitled to receive notice of all the meetings of the Board and to attend and vote as a Director at any such meeting at which the Director appointing him is not personally present and generally to perform all the functions of his appointer as Director in the absence of such appointer. An Alternate Director shall ipso facto cease to be Alternate Director if his appointer for any reason ceases to be a Director or if and when his appointer returns to the district where meetings of the Directors are ordinarily held or removes the appointee from office by notice in writing under the hand of the appointer.

V. THE SEAL

77. **Common Seal**

The Directors shall provide a common seal of the Company which shall not be fixed to any instrument except by the authority of a resolution of the Board or by a committee of Directors authorized in that behalf by the Directors and two (2) Directors or one (1) Director and the secretary of the Company shall sign every instrument to which the common seal is affixed.

78. **Official Seal**

The Director may provide for the use in any territory, district or place not situated in Pakistan, of an official seal which shall be a facsimile of the common seal of the Company with the addition on its face of the name of every territory, district or place where it is to be used. The provisions of Section 213 shall apply to the use of the official seal.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

VI. DIVIDENDS AND RESERVE

79. **Declaration of dividends**

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

80. **Interim dividend**

The Directors may from time to time pay to the members such interim dividends as appear to the Directors to be justified by the profits of the Company.

81. **Dividends payable out of profits**

No dividends shall be paid otherwise than out of the profits of the year or any other undistributed profits from prior years. Also Dividend shall not be paid out of unrealized gain on investment property credited to profit and loss account. No unpaid dividend shall bear interest against the Company.

82. **Dividends payable on amount on shares**

Subject to the rights of the persons (if any) entitled to share with special rights as to dividends, all dividends shall be declared and paid according to the amounts paid on the shares, but if and so long nothing is paid upon any of the shares in the Company, dividends may be declared and paid according to the amounts of the shares.

83. **Reserve fund**

The Directors 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 direction of the Directors be applicable for meeting contingencies or for equalizing dividends or for any other purpose to which the profits of the Company may be properly applied and pending such application may, either be employed in the business of the Company or be invested in such investments (other than shares of the Company) as the Directors may subject to the provisions of the Ordinance from time to time think fit.

84. **Profit carried forward**

The Directors may carry forward any profits which they may think prudent not to distribute without setting them aside as reserve.

85. **Payment of dividend in specie**

With the sanction of a general meeting any dividend may be paid wholly or in part by the distribution of specific assets and in particular of paid-up shares or debentures of any other company or in any one or more of such ways. Where any difficulty arises in regard to such distribution, the Directors may settle the same as they think expedient and in particular may fix the value for distribution of such specific assets or any part thereof and may determine that cash payments shall be made to any members upon the footing of the value so fixed, in order to adjust the rights of all members and may vest any such specific assets in trustees upon trust for the members entitled to the dividend as may seem expedient to the Directors.

86. **Dividends to joint holders**

If several persons are registered as joint holders of any share, any one of them may give effectual receipt for any dividend payable on the share.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

87. **Period for payment of dividend**

The dividend shall be paid within the period laid down in Section 251.

88. **Non-Forfeiture of dividends**

The non-forfeiture of dividends is hereby secured provided that all dividends unclaimed for one (1) year after having been declared may be invested or otherwise made use of by the Directors for the benefit of the Company until claimed and the Company shall not be constituted a trustee in respect thereof. All dividends unclaimed for a period of six (6) years after having been declared may be forfeited and shall in such cases revert to the Company.

89. **Mode of payment**

Any dividend may be paid by cheque sent through the post to the registered address of the members or person entitled thereto.

VII. ACCOUNTS

90. **Books of account**

The Directors shall cause to be kept proper books of account as required under Section 230.

91. **Place where accounts kept**

The books of account shall be kept at the Office or at such other place as the Directors shall think fit and shall be open to inspection by the Directors during the business hours.

92. **Inspection by members**

The Directors shall from time to time determine whether and to what extent and at what time and places 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 account and book or papers of the Company except as conferred by law or authorized by the Directors or by the Company in general meeting. The Company shall within one (1) month of the close of the first, second and third quarter of its year of account, prepare and transmit to the members a profit and loss account for, and balance sheet as at the end of the quarter whether audited or otherwise simultaneously with the transmission of the quarterly profit and loss account and balance sheet to the members, file with the registrar and the commission such number of copies thereof, as may be prescribed.

93. **Annual accounts**

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

94. **Balance sheet and profit and loss account**

A balance sheet, profit and loss account and other reports referred to in the preceding Article shall be made out in every year and laid before the Company in the annual general meeting made up to a date not more than four (4) months before such meeting. The balance sheet, profit and loss account shall be accompanied by a report of the auditors of the Company and the report of Directors. The balance sheet shall include inter alia the following details of all its investments:

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

(a) Particulars of investment;
(b) Date of investment;
(c) Purchase price;
(d) Market Value.

95. **Copy of accounts to be sent to members**

A copy of the balance sheet, profit and loss account and reports of Directors and auditors shall at least twenty-one (21) days preceding the meeting to be sent to the persons entitled to receive notices of general meetings in the manner in which notices are to be given as hereinafter provided.

96. **Compliance with the Ordinance**

The Directors shall in all respect comply with the provisions of Section 230 to 236.

97. **Capitalization of profits**

The Company in a general meeting may upon the recommendation of the Directors resolve that it is desirable to capitalize any part of the amount for the time being standing to the credit of any of the Company's reserve amounts or to the credit of the profit and loss account or otherwise available for distribution and accordingly that such sum be set free for distribution among the members who would have been entitled thereto if distributed by way of dividend and in the same proportions, on conditions that the same be not paid in cash but be applied in or towards paying up to full un-issued shares or debentures of the Company to be allotted and distributed, credit as fully paid up to and amongst such members in the proportion aforesaid and the Directors shall give effect to such resolution.

98. **Audit**

Auditors shall be appointed and their duties regulated in accordance with Section 252 to 255.

99. **Notice to members**

Notice shall be given by the Company to members and auditors of the Company and other persons entitled to receive notice in accordance with Section 50.

VIII. SECRECY

100. **Secrecy**

Every Director, manager, adviser, auditor, trustee, member of a committee, officer, servant, agent, accountant or other person employed in the business of the Company shall if so required by the Directors before entering upon his duties, sign a declaration pledging himself to observe 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 not to reveal any of the matters which may come to his knowledge in the discharge of his duties except when required to do so by the Directors 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 in these presents.

101. **Members' access to Company premises**

No member or other person (not being a Director) shall be entitled to enter upon the property of the company or examine the Company's premises or properties without the permission of a

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED

Director subject to Article 92, to require discovery of or any information respecting any detail of the Company's trading or any matter which is or may be in the nature of a trade secret, mystery of trade, secret process or of any matter whatsoever which may relate to the conduct of the business of the Company and which in the opinion of the Directors will be inexpedient in the interest of the members of the Company to communicate.

IX. RECONSTRUCTION

102. Reconstruction

On any sale of the undertaking of the Company, the Directors or the liquidators on a winding up may if authorized by a Special Resolution, accept fully paid shares, debentures or securities of any other company either then existing or to be formed for the purchase in whole or in part of the property of the Company, and the Directors (if the profits of the Company permit), or the liquidators (in a winding up) may distribute such shares or securities or any other properties of the Company amongst the members without realization or vest the same in trust for them and any Special Resolution may provide for the distribution or appropriation of the cash, shares or other securities, benefits or property, otherwise than in accordance with the strict legal rights of the members or contributories of the Company and for the valuation of any such securities or property at such price and in such manner as the meeting may approve and all holders of shares shall be bound to accept and shall be bound by any valuation or distribution so authorized and waive all rights in relation thereto save only such statutory rights (if any) as are, in case the Company is proposed to be or is in the course or being wound up, incapable of being varied or excluded by these presents.

X. WINDING UP

103. Division and distribution of assets upon dissolution

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 law, divide amongst the members in specie or kind the whole or any part of the assets of the Company (whether they shall consist of property of same kind or not) and may for such purpose set such value as be deemed fair upon any property to be divided its aforesaid and may determine how such division shall be carried out as between the members or different classes of members.

XI. INDEMNITY

104. Indemnity

104.1 Every officer 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 in defending any proceedings whether civil or criminal arising out of his dealings in relation to the affairs of the Company except those brought by the Company against him in which judgment is given in his favor or in which he is acquitted, or in connection with any application under Section 488 in which relief is granted to him by the court.

104.2 No Director, Chairman, Chief Executive, Managing Director or other officer of the Company will be liable for the acts, receipts, neglects or defaults of any other Director or officer or for any loss or expenses happening to the Company through the insufficiency or deficiency of title to any property acquired by order of the Board, or other officer for or on behalf of the Company, or for the insufficiency or deficiency of any security in or upon which any of moneys of the Company shall be invested, or for any loss or damage arising from the bankruptcy, insolvency or tortuous acts of any person with whom any money, securities or effects shall be deposited or for any loss occasioned by any error of judgment or oversight on

his part or for any other loss, damage or misfortune whatever which shall happen in the execution of the duties of his office or in relation thereto, unless the same happens through his own willful act, neglect, default or dishonesty.

104.3 If the Directors or any of them or any other person shall become personally liable for the payment of any sum primarily due from the Company, the Board may execute or cause to be executed any mortgage, charge or security over or affecting the whole or any part of the assets of the Company by way of indemnity to secure the Directors or persons so becoming liable as aforesaid from any loss in respect of such liability.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

We, the several persons whose names and addresses are subscribed below, are desirous of being formed into a Company, in pursuance of these Articles of Association, and we respectively agree to take the number of shares in the Capital of the Company as set opposite to our respective names.

Sr. No.	Name and Surname (present and former) in full (in block letters) and Passport #	Father's / Husband's Name in full	National ity with any former National ity	Occupation	Residential Address (in full)	Number of Shares taken by each subscriber	Signatures
1	**PORT QASIM ENERGY (DUBAI) HOLDING LIMITED.** (represented by its authorized Director, Mr Shen Decai, holding Chinese passport # SE0004555)	N/A	Dubai International Financial Centre incorporated company	Holding Company	Registered Address: Office No.307-308,Level 3 Emirates Financial Towers-North Tower Dubai International Financial Centre P O Box 487389 Dubai, UAE	96 (Ninety-six)	
2	**MR SHEN DECAI** (Chinese Passport # SE0004555)	Shen Mingbao	Chinese	(i) Director Port Qasim Energy (Dubai) Holding Ltd. (ii) Director Sinohydro Resources Ltd.	Room 1401, F-12, First District Of Deshengli, Xicheng District, Beijing, China.	1 (one)	
3	**MR. FADY BAKHOS** (Lebanese passport # RL162219B)	Fady Jean Bakhos	Lebanese	(i) Director Port Qasim Energy (Dubai) Holding Ltd. (ii) Legal Advisor, Al Mirqab Capital S.P.C.	West Bay, Villa # 7, Saha # 88, Doha, Qatar	1 (one)	
4	**MR. SHAHZAD SHAHBAZ** (British Passport # 504896967)	Aitzaz Shahbaz	British (formerly Pakistani)	(i) Director Port Qasim Energy (Dubai) Holding Ltd. (ii) Advisor to Chairman of Al Mirqab Holding.	Villa 14; Suraqa bin Amr Street; Old Airport Area; Doha; Qatar	1 (one)	
5	**MR. ZHONG HAIXIANG** (Chinese Passport # PE0025261)	Zhong Fangyuan	Chinese	(i) Director Port Qasim Energy (Dubai) Holding Ltd.	No. 1, South District of Liubukang, Xicheng District, Beijing, China.	1 (one)	
					Total Number of Shares	**100** (One hundred)	

Dated this ____ day of _____, 2014

Witness to the above signatures: SAIF-UR-REHMAN KHAN
Full Name:
Occupation: BUSINESS
Passport # 35200-3449847-9
Father's Full Name: AMAN ULLAH KHAN

Signature: .....
Nationality: PAKISTANI
Full Address: 91-B, MODEL TOWN LAHORE

PORT QASIM ELECTRIC POWER COMPANY (PVT) LTD ISLAMABAD PAKISTAN

ANNEXURE VI

PROJECT DETAILS AND PROSPECTUS

[Regulations 3(6) and Schedule III of the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999]

1. General

The facility includes a coal-fired electric Power Plant located on the site and the Company Interconnection Facilities (but excluding the Power Purchaser Interconnection Facilities) having a design capacity of approximately 1320MW (gross ISO) and a Coal Jetty that is to be built and used exclusively for the Power Plant due to that the existing facilities for coal transportation and handling available in Port Qasim are insufficient and would be inefficient for our Project.

The description set out herein below is intended to be an indicative broad outline only; and, may change in accordance with evolving Project needs.

2. Power Plant

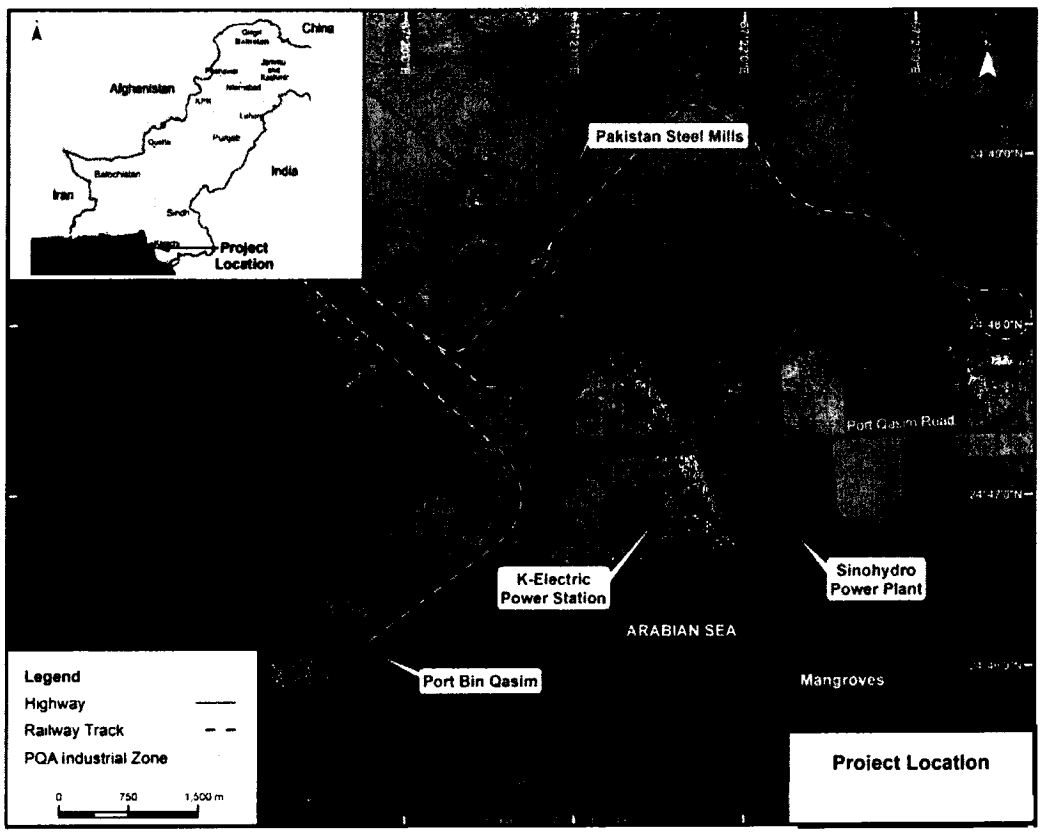
The Power Plant consists of two sets of 660MW supercritical units each with one boiler, steam turbine and generator. The boiler is fueled by imported sub-bituminous coal which will be transported by ship and unloaded at the dock to be constructed at site. Seawater natural cooling tower of secondary circulation is designed to be of water cooling type, using desalinated seawater as makeup water. Boiler adopts flue gas desulphurization. The Power Plant connects with grid by 500kV AC outgoing transmission lines.

2.1 Ambient Conditions

2.1.1 Site Location

The Project is located in Port Qasim Industrial Park, southeast to the city of Karachi, Pakistan, and on the north bank of Arabian Sea. It is about 37 km from the city center of Karachi. The south part of the plant borders with the Arabia sea coast beach and seaway of Port Qasim, and the north part of the plant is in close neighborhood with the trunk road of the industrial park. The geographical coordinates of the 204 acres lands for the Complex are 24°47'2.4" N, 67°22'20.4" E.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN



Karachi is the provincial capital of Sindh Province, the country's capital and chief city, largest seaport and naval port, industry and commerce center, trade and finance center, as well as an international air station in Southeast Asia between Middle East, Africa and Europe.

2.1.2 Transportation

Port Qasim geographically adjacent to main shipping routes, has favorable internal traffic conditions, only 15 km from the Pakistan highway, 14 km from the national railway lines, and only 22 km Jinnah International Airport.

Currently, there is a fifteen-meter-wide concrete road in good condition from Karachi to the Project site. The north side of the site is adjacent to the concrete road of the Industrial Area, about 7.5m in width.

2.1.3 Site Conditions

The topography of the Project site is relatively flat and north high low-lying south. The south side is adjacent to the channel of Arabian Sea, the ground elevation is between -8m—8m.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD PAKISTAN

There is a north-to-south gulley at site southwards to the channel and one natural gas pipeline at both sides of the road to the north of plant site.

2.1.4 Meteorology

The Project is located near Karachi, where is situated in northwest of Indus River delta and bordered by Arabian Sea to the south, the climate is pleasant in most time, with mean lowest temperature of 13 ºC in winter (January and February), mean highest temperature of 34 ºC in summer (May and June), and with slight annual mean rainfall of 200mm only.
Regular meteorological elements for the project are shown in Table 2.4-1.

Table 2.1.4-1 Regular meteorological elements

Meteorological item	Statistical value	Unit	Occurrence time	Year
Mean air pressure for years	1005.7	hpa		1981-2010
Mean air pressure for years (sea level)	1008.3	hpa		1981-2010
Mean relative humidity for years	66.0	%		1981-2010
Mean temperature for years	26.4	ºC		1981-2010
Maximum wind speed by actual measurement and corresponding wind direction	23.7(W)	m/s	2010	1981-2010
Mean wind speed for years	3.5	m/s		1981-2010
Prevailing wind direction for years	SW			1981-2010
Mean precipitation for years	176	mm		1981-2010
Maximum annual precipitation	481.5	mm	1994	1981-2010
Minimum annual precipitation	0.0	mm	1987	1981-2010
Maximum daily precipitation	142.6	mm	2009.07.19	1981-2010
Mean precipitation days for years	18.7	d		1981-2010
Mean thunderstorm days for years	5.6	d		1981-2010
Maximum thunderstorm days for	18	d	1994	1981-2010
Mean foggy days for years	0.6	d		1981-2010
Maximum foggy days for years	7	d	1990	1981-2010
Mean sandstorm days for years	0.5	d		1981-2010
Maximum sandstorm days for years	3	d	2005/2003	1981-2010
Mean sunshine duration for years	2775.4	h		1981-2010
Mean cloud amount for years	2.8	Oktas		1981-2010

Wind direction frequency in full year, winter and summer observed at Port Qasim in year 1980-1985 are shown in Table 2.4-2.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

Table 2.1.4-2 Wind direction frequency at Port Qasim

Wind direction	N	NE	E	SE	S	SW	W	NW	C
Full year	3.3	10.6	4.7	0.9	2.4	25.2	43.8	5.7	3.4
Summer	0.4	0.5	0.6	0.3	4.4	45.4	42.2	5.3	0.9
Winter	7.1	28.3	13.2	2.2	2.1	9.0	25.8	6.2	6.1

2.1.5 Water Source

The Project site has small natural rainfall amount and dry climate and is influenced by tropical storm from the Arabia Sea. It abounds in seawater resources and lacks in fresh water resource. Therefore, desalinated seawater is proposed for the project. The water for the Project is from adjacent sea channel of Qasim south of the site.

2.1.6 Seismic Condition

The peak ground acceleration with 10% probability of exceedance in 50 years takes 0.16g; referring to Chinese Standards, the corresponding seismic intensity is VII and the characteristic period of response spectra is 0.45s.

2.1.7 Geology and Geotechnical Engineering

The Project site is relatively stable region and favorable for construction by reason of active faults are far away from the Project site and no strong earthquake hit the site before even if seismic geological structure of the region is fairly strong.

The Project site with flat terrain and stable stratums, is on the coastal beach. The upper stratum with the sand and clay soil as mains is caused by flood alluvial soil. The medium stratum is gravel silty clay with cementation and the underlying bedrock is strong ~ medium conglomerate.
The depth of ground water at Project site is considered as 0.0m, given the impact sea water at high tide on ground water.

The Project site groundwater (seawater) is strongly corrosive to concrete structure and the rebar of reinforced concrete structure, the surface water is weakly corrosive to concrete structure and moderately corrosive to the rebar of reinforced concrete structure.
The Project site ground soil is strongly corrosive to concrete structure, the rebar of reinforced concrete structure and steel structure.

The Project site belongs to adverse seismic area, the type of ground soil is medium-soft soil and the category of site is Class II.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
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The liquefaction index of saturated sand at Project site is between 0.45 to 53.23, therefore most of which are moderate ~ strong liquefaction, all are none- liquefaction layer except ② fine sand layer and ②1 coarse sand layer.

2.2 Reference Conditions

2.2.1 Tide Level

The highest tide level at 1% frequency in Project site is designed as 5.21m and lowest tide level at 97% guaranteed frequency in site as -1.50m.

2.2.2 Meteorological conditions

The project meteorological conditions in three month with the highest temperature in the recent five years are shown in Table 3.2-1.

Table 2.2.2 10% wet bulb temperature and meteorological conditions

Mean wet bulb temperature(ºC)	Mean dry bulb temperature (ºC)	Mean relative humidity (%)	Mean air pressure (hPa)	Mean wind speed (m/s)
27.6	31.8	72.3	996.5	4.1

2.2.3 Wind Speed

The design wind speed at the height of 10m in ten minutes once-fifty-year and once-a-hundred-year is respectively 25.3m/sand 26.8m/s, and the basic wind pressure of once-fifty-year is 400kN/m2.

2.2.4 Coal Quality

The Project fuel coal is recommended to imported from Indonesia, South Africa and Australia. The analysis of coal quality and ash content is tentatively as Table 3.1-1.

Table 2.2.4 Coal Quality Data Sheet

No.	Item	Unit	Design coal	Remark
1	total moisture (M_t)	%	30	
2	volatile matter (dry ash-free basis) (V_{daf})	%	40.71	
3	Proximate Analysis (Air Dried)			
3.1	Moisture (M_{ad})	%	15	
3.2	Ash (A_{ad})	%	15	
3.3	Volatile Matter (V_{ad})	%	28.5	

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No.	Item	Unit	Design coal	Remark
3.4	Fixed Carbon (FC_{ad})	%	41.5	
4	Air Dried HHV ($Q_{gr,ad}$)	kcal/kg	5650	
5	As Received LHV ($Q_{net,ar}$)	kcal/kg	4340	
6	Hardgrove Gindability Index (HGI)		49	
7	As Received Ultimate Analysis			
7.1	Carbon Car	%	43.30	
7.2	Hydrogen Har	%	3.50	
7.3	Nitrogen Nar	%	1.0	
7.4	Sulphur Sar	%	0.85	
7.5	Oxygen Oar	%	9.0	
7.6	Ash Aar	%	12.35	
7.7	Moisture Mar	%	30	
8	Ash Fusion Temperature (reducing)			
8.1	deformation temperature	ºC	1210	
8.2	softening temperature	ºC	1240	
8.3	Hemispherical temperature	ºC	1280	
8.4	Flow temperature	ºC	1300	
9	Ash Analysis			
9.1	SiO_2	%d	45.1	
9.2	Al_2O_3	%d	25.6	
9.3	Fe_2O_3	%d	13.31	
9.4	CaO	%d	3.0	
9.5	MgO	%d	5.3	
9.6	TiO_2	%d	0.9	
9.7	Na_2O	%d	0.97	
9.8	K_2O	%d	1.50	
9.9	P_2O_5	%d	1.20	
9.10	SO_3	%d	3.12	

2.3 Capacity of the Complex at Reference Conditions

The Project has following design ratings at reference site conditions based on LHV of the fired coal:

Gross Capacity of Power Plant 1,320MW

Net Capacity of Power Plant 1,221MW

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Gross Efficiency of Power Plant ≥41%
Net Efficiency of Power Plant ≥38%

2.4 Performance Curves

The Company will provide all performance and correction factors/curves for the units which include but not limited to the following:
Turbine exhaust steam pressure versus output (base load) and heat rate
Power factor versus output
Unit start-up curves

2.5 Civil Structure Safety Design Factor

The design peak ground acceleration is 0.16g, the corresponding seismic intensity is VII as per Chinese Standards, the design basic wind pressure is 400kN/m2.

2.6 Description of the Complex

2.6.1 General Plot Plan

The design elevation of the Project site will be 5.21m. The north area of site will be backfilled by soil from off-site, and submerged south area will be backfilled by sea sand and stone from channel dredging.
The boundary wall of power plant will be 2.5m in height. The power plant area is designed with two entrances, from which there are both road connected to the PQA road at the north of plant site.
GIS, cooling tower, main power house, coal yard, seawater intake and coal unload jetty are arranged from north to south in the plant area, while auxiliary and ancillary facilities at the east of the power island.

2.6.2Boiler, Turbine and Generator

This Project is expected to operate as a base load unit, but the design will include provisions to allow the units to operate at lower loads if necessary. One such provision will be the capability to operate in a sliding pressure mode. Sliding pressure operation will allow more efficient operation and reduced stress on the turbine and boiler parts.

The boiler converts the energy in the coal to high pressure steam. The steam is then discharged to the turbine. The boiler type is supercritical parameters, single reheat, single furnace, balanced draft, dry ash extraction, outdoor with rainy cover, complete steel structure once-through boiler. The air pre-heater is regenerative trisector rotary type.

The steam turbine-generator converts the energy in the steam to electrical energy. The exhaust steam is then discharged to the condenser. The steam turbine type is also

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supercritical parameters, Reheat, tandem-compound three-Cylinder, four-Exhaust, Condensing. the turbine-generator will operate at 3,000 rpm. Extraction steam is from various sections of the turbine and routed to the various heaters. The cycle is based on eight heaters, four low pressure (LP) heaters, one deaerator heater, and three high pressure (HP) heaters.

The generator is directly coupled to the turbine shaft. The generator converts the mechanical energy developed in the turbine to electrical energy. The generator is filled with hydrogen gas to reduce the windage losses caused by the cooling flow inside the generator. The Cooling type is Water-Hydrogen-Hydrogen. The static exciter supplies the electrical energy to the generator rotor (filed) to control the voltage and phase angle of the power generated in accordance with system needs.

2.6.3 Thermal System

Thermal system adopts the unit system. Turbine adopts 35% B-MCR capacity of HP and LP in series bypass, and 8-stage non-regulated extraction steam (three HP heaters, one deaerator and four LP heaters). Feed water system is equipped with 2×50% steam driven feed water pumps and 1×35% start-up motor driven feed water pump. The condensate system is designed with 2×100% condensate pumps.

2.6.4 Combustion System

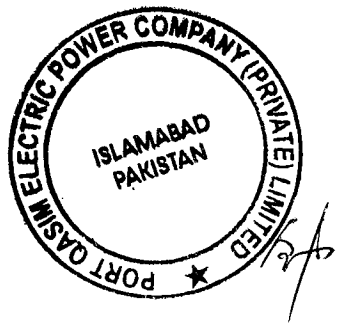
Combustion system adopts positive pressure direct blowing system from the medium speed coal mill by primary air. The pulverized coal system is designed with 6 sets of medium speed mills (5 for operation and 1 for standby) and 2×50% axial-flow type primary air fans. The air and flue gas system uses balanced ventilation mode with axial-flow type of 2×50% forced draft and 2×50% induced draft fans. Five electric fields of electrostatic precipitator will be set. Two boilers share one concrete with inner single or double flue chimney with the height of 200m as per the EIA.

2.6.5 Desulphurization and Denitrification

Desulphurization will adopt limestone-gypsum wet type FGD which the guarantee efficiency is 92%. Boiler will adopt low nitrogen burners and staged combustion air distribution to reduce NOx.

2.6.6 Coal Handling System

The Project Coal unloaded at jetty will be sent to coal yard in the Plant by belt conveyor. The coal yard is designed in open-air and surrounded with wind and dust controlling net. Coal yard will use bucket-wheel stacker-reclaimer for coal settling. Coal will be screened and crushed before entering the boiler coal bunker. Coal conveying adopts two-way belt conveyor, one way for operation and another for standby.



2.6.7 Ash Handling System

Boiler bottom ash adopts wet handling type with circulating water system. The bottom ash will be conveyed directly to bottom ash bin by submerged scraper conveyor (SSC). Each boiler has one SSC with capacity of 7~30t/h and one bottom ash bin with 24-hour storage of bottom ash.

Boiler fly ash adopts positive pressure dense phase pneumatic conveying system. Fly ash collected by boiler economizer and ESP will be conveyed to fly ash silo through vessels and pipeline by compressed air. Both boilers have three concrete fly ash silos (two for coarse ash and one for fine ash) totally with 24-hour storage of fly ash.

2.6.8 Seawater Desalination System

The Seawater Desalination System (SWDS) adopts Seawater Reverse Osmosis (SWRO) type. The Seawater Reverse Osmosis (SWRO) discharged water will be used as the plant service water. The Brackish Water Reverse Osmosis (BWRO) discharged water will be used as the potable water and raw water for boiler make-up water treatment system.

2.6.9 Boiler Make-up Water Treatment System

Boiler make-up water treatment system adopts primary demineralization and mixed bed treatment. Boiler make-up water treatment system and SWDS are both arranged in water treatment plant.

2.6.10 Circulating Water System

Natural cooling tower seawater secondary circulation system will be adopted for cooling water system, each unit is equipped with one natural tower with 12000m2 effective cooling area, both units have 5×50% vertical type inclined flow circulating water pumps, of which two pumps for each unit and one pump is the common standby for both units. Circulating pump is arranged in open-air.

2.6.11 Make-up Water System

Seawater is used as make-up water source. Seawater intake pump is equipped to pump the pressurized seawater flow into the coagulation and flocculation pretreatment facility, and then to the circulating water and seawater desalination plant. The seawater intake system has 4×33% vertical mixed-flow pumps for C.W. system, and 3×50% vertical long shaft pumps for SWDS. All pumps are installed outdoors.

2.6.12 Drainage System

The Project drainage system consists of sanitary sewage system, coal waste water system, oily waste water system, industrial waste water system, strong brine drainage and rain water drainage system, each with independent pipelines. Sanitary sewage, coal waste water, oily waste water and industrial waste water will be recycled after treated up to standard. Strong

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brine drainage from C.W. system and SWDS, as well as drainage from seawater pre-treatment system will be discharged to the central monitoring pond and then pumped to channel of Qasim. The rain water of power plant will be collected by drainage ditch, and pumped to channel of Qasim.

2.6.13 Electrical System

The units will connect with the 500kV switch yard (GIS) by the way of generator-transformer unit, 500kV outgoing line from power plant in 2 circuits connected with gird. 500kV main wiring adopts 3/2 circuit breaker connection form. Each unit is equipped with one generator transformer and one auxiliary transformer; both units are equipped with one common startup and standby transformer. 500kV shunt reactors will be required at both of the 500kV outgoing lines. 500kV switchgear will have 2 complete bays. One incoming line and one outgoing line constitute 1 complete bay.

Single busbar will be used as 11kV auxiliary busbar. Two sections of (Section A and B) 11kV auxiliary busbars will be set for each unit. 11kV load of auxiliaries for steam turbine and boiler will be separately connected to these two sections of busbar. Each unit will be installed with 2 turbine LV transformers, 2 boiler LV transformers and 2 ESP LV transformers. The two LV transformers for each system will be mutually standby and will be separately connected to 11kV auxiliary busbar.

2.6.14 Control System

Centralized control mode will be adopted for boiler, turbine, generator and NCS. There will be one Central Control Room (CCR) for the two units. Unit startup/shutdown and normal operation can be realized both locally and in CCR. Grid operator station will be arranged in CCR.

DCS will be adopted for the Project. BOP system will be monitored and controlled in Local Control Room (LCR) by microprocessor based PLC or DCS control equipment. BOP control network is provided to realize the controlling and monitoring of BOP system through operator station in CCR and with cooperation of field operators.

Each unit will be provided with a set of DCS. The common system of two units will be connected with the unit DCS system respectively. Supervision and control of the common system can be achieved in operator station of either unit, while the other will be blocked at the same time. Each unit DCS includes two sets of large screens, five sets of operator stations (including DEH), and two sets of engineer stations (including DEH).

2.6.15 Civil Works

The main power house will be of steel frame with steel bracings. The transverse structure will be of rigid jointed frame with steel bracings, and longitudinal structure will be of hinge

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jointed frame with steel bracings. Turbine-generator pedestal will be of cast-in-place reinforced concrete frame structure and will be isolated by gaps from adjacent floors for vibration consideration. Main power house and turbine-generator pedestal will adopt reinforced concrete foundation supported by cast-in-place piles.

The hyperbolic-type natural draft seawater cooling towers will be designed in reinforced concrete structure, Cast-in-place pile will be considered in ground treatment.

2.6.16 Ash Yard

The ash and gypsum produced by the Project are suggested to comprehensive utilization firstly, however ash yard is considered while the utilization can't be realized at initial period of Plant operation.

To avoid the impact of the industrial park planning, set off-site ash yard at the outside of industrial park, about 10 kilometers straight away from the northeast of power plant. The ash yard will be designed as plain type, the experience stacking height of ash is about 10m~15m, and initial ash yard is designed with five-year storage amount, covering an area of 49 hectares.

In addition, an on-site ash yard of plain type will be located at the southeast of plant area, the stacking height of ash reaches 11m which can meet 1.5-year storage amount, covering an area of approximately 18 hectares.

2.7. Fuel Supply and Storage

The coal for the power plant will be from Indonesia, South Africa and Australia, and transported by ship.

The design annual coal-unloading quantity is 4,660,000 ~ 5,200,000 tons. One 70,000T coal-unloading jetty and ancillary facilities will be newly built at south of the Plant, however dredging of the channel and turning basin will be divided into two phases, i.e. 50,000T ship at first phase, and 70,000T ship at further phase in order to get the highest benefit according to the change of ship rent in shipping market.

The ship unloading facility of the jetty will adopt 2 bridge-type grab ship unloaders with single rated output at 1600t/h, totally 3200t/h. The coal unloaded from the jetty will be conveyed to the coal yard in the Plant by belt conveyor. The storage capacity of the coal yard will not be less than the coal demand for 30 days of power plant operation.

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3. Coal Jetty

3.1 General Layout

General layout design is based on the general layout plan of power plant and shoreline water area conditions, natural conditions, berth scale, handling technology etc., which is described as below:

Build one coal unloading jetty of 70,000T at seaside of the plant, with the berth length of 280m (where 100m of the west side is also used for heavy-lift unloading in construction period).

Front line (apron) of jetty is located near the -6.0m contour, consistent with the controlling red line at the south, and basically along the foot of south cofferdam. Front line of jetty is basically parallel to the contours. Front line of jetty is 46m away from the rear slope crest of cofferdam.

Berthing area at apron of jetty is 65m wide, with design water depth of -15.5m. The turning basin is in the shape of ellipse, with long axis of 580m, short axis of 430m. Design water depth of turning basin is the same as that of approach channel, which will be dredged in two stages. In stage one, dredged to -12.5m together with the channel, for navigation of 50,000T bulk carrier; in stage two, dredged deeper to -14.0m, for navigation of 70,000T bulk carrier.

Based on process layout and use requirement, the total width of jetty is 23m, where ship unloader adopts the rail gauge of 18m, seaside rail is 3m away from the apron of jetty, rear side rail is 2m away from the back edge of jetty. One approach bridge is located at west side of jetty to connect with the land area of power plant, and the approach bridge is 12m wide.

A complex building is located at rear of the jetty, for arrangement of substation and worker waiting room.

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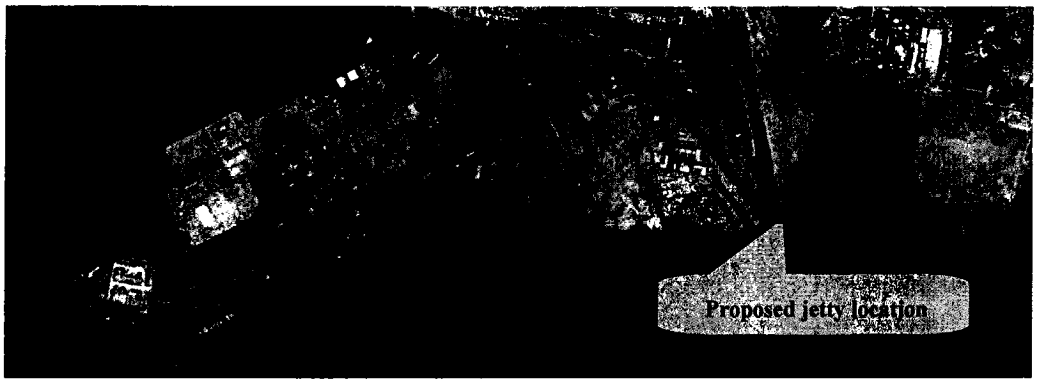

Fig. 1LocationOf Proposed Jetty

3.2 Channel

3.2.1 Channel Layout

(1) Width of channel

For option 1 to build a new 70,000T coal unloading jetty, the width of channel takes 150m, the heavy cargo vessel can also take advantage of the channel to navigate.

(2) Depth of channel

According to the topographic map measured in march 2014, the natural mud surface elevation of the area from the Port Qasim to the plant is -2.56~-8.5m. In order to reduce the dredging quantities, the vessels can navigate to the port by taking the tide, the tide-bound water level takes 2.0m (MSL), the design bottom elevation of channel for navigation of 70,000T bulk carrier=2.0-15.9=-13.9m, takes -14.0m;the design bottom elevation of channel for navigation of 50,000T bulk carrier=2.0-14.5=-12.5m; the design bottom elevation of channel for navigation of heavy cargo vessel=0-9.5=-9.5m,

(3) Approach channel

For the option of building a new 70,000T jetty at the seaside of power plant, the vessels can navigate to the turning basin of 7# berth in Port Qasim by the approach channel of Port Qasim, through the new channel to the apron of the proposed jetty. The maintenance depth of Port Qasim approach channel is 14.0m, the width is 200~250m, the width and depth can both meet the navigation requirements of design vessels. At present, the natural depth of the

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area from the Port Qasim to the proposed jetty is relative small, and it is needed to build a new channel to connect to the approach channel of the Port Qasim. The Length of the new channel is about 4.0km, the channel direction is 67.5°~247.5°, the width of the new channel takes 150m, the design bottom elevation of the new channel takes -14.0m.

Since the dredged materials under -12.5m include a large proportion of sandstone, mudstone and conglomerate, the cost of dredging work for these materials is relative high. In order to reduce the project investment, it is proposed to carry out the dredging work of channel in two stages, in the first stage, the depth of the channel is dredged to -12.5m (including the turning basin), the depth can accommodate the navigation of 50,000T bulk carrier, with a total dredging quantity of 630×104m3; the depth will be dredged to -14.0m (including the turning basin) in the second stage, for navigation of 70,000T bulk carrier, the added dredging quantity is 145×104m3.

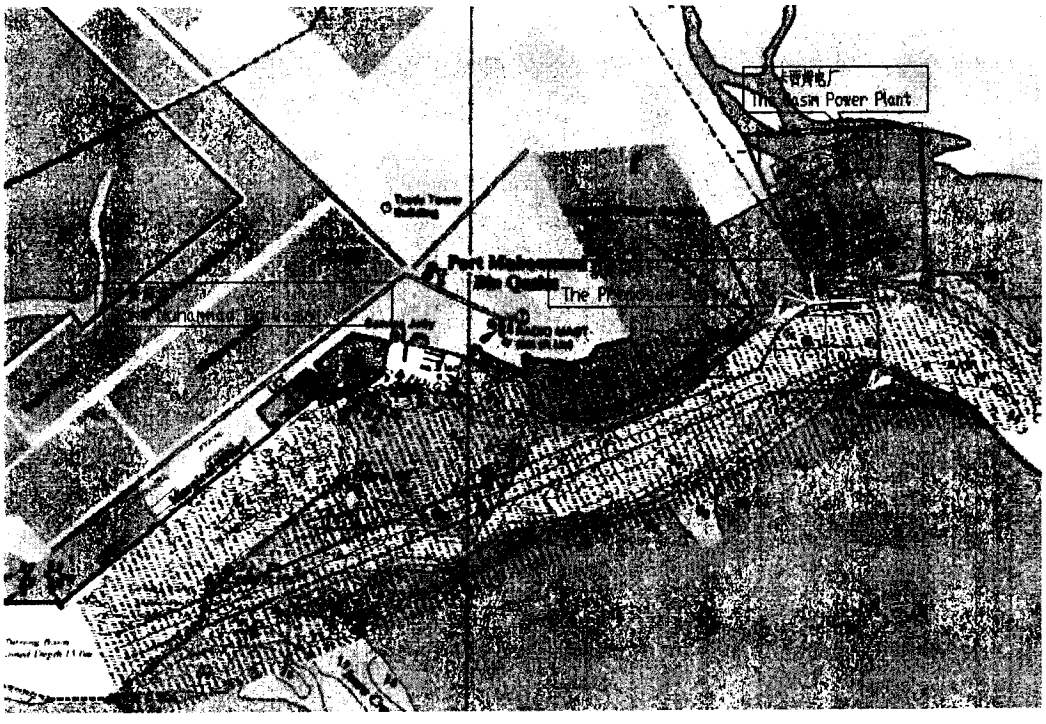

Fig. 2 LayoutOf The New Channel

3.2.2 Dredging Quantities

(1)Dredging quantities

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The design bottom elevation of turning basin and the new channel in the first stage is -12.5m, in the second stage is -14.0m, the design bottom elevation of the berth area is -15.5m. According to the topographic map measured in March 2013, the natural water depth of the area from Port Qasim to the propose jetty is -2.56m~-8.5m, the depth can't meet the design requirements, these areas need to be dredged. The comprehensive excavation slope takes 1:3, the ultra-depth takes 0.4m, and the ultra-width takes 4m. After calculation, dredged quantities in first stage are 630×104m3, in the second stage 145×104m3 be will added.

(2)Treatment of Dredged Material

According to the geological survey, dredged materials mainly include muddy clay, silty clay, conglomeratic silty clay, fine sand, gravelly sand, sandstone, mudstone and conglomerate. Muddy clay and silty clay can be easily dredged, standard penetration test N-values of other dredged materials are relatively high, and there are some rock excavation volumes.

Considering the properties of the dredged materials and dredging quantities, it is preliminarily determined to use cutter suction dredger to carry out the dredging work. About 145×104m3 dredging soil shall be backfilled into the plant land, and 50×104m3 dredging soil shall be filled into the reclamation area which is 1.5km away from west of the plant. At present, the east area of 4# Russian next to the plant is beaches, which is very close to the project. About 435×104m3 of rest dredging soil shall be filled into this area. Project Constructor has been confirming the feasibility of using two areas as reclamation area. Project Constructor shall survey the land-using situation around the plant to make sure whether somewhere else can be used for storing dredging soil so that costs of cofferdam construction may be decreased.

Temporary cofferdam need to be constructed for the 2#,3# mud dumping areas, in order to accurately calculate the quantities that can be reclaimed and provide necessary basic data for structure design of cofferdam, it is needed to carry out topographic and geological survey in proposed mud dumping area.

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Fig. 3 LocationOf Mud-Dumping Areas

3.3 Handling Technology

3.3.1 Coal-Unloading Technology

Two (2) bridge type grab ship unloaders (see figure 6.3-1) are arranged on the coal-unloading jetty, each with rated capacity of 1600t/h, rail gauge of 18m and outreach of 30m. One (1) route belt conveyor is arranged within the gauges.

When unloading, the bridge-type grab ship unloaders grab coal from ship's hold and unload it to the belt conveyor via feeding devices of the unloaders. Then belt conveyor system transport coal to the power plant.
Three (3) 189HP trimming dozers are used for the clearing of ship's hold.

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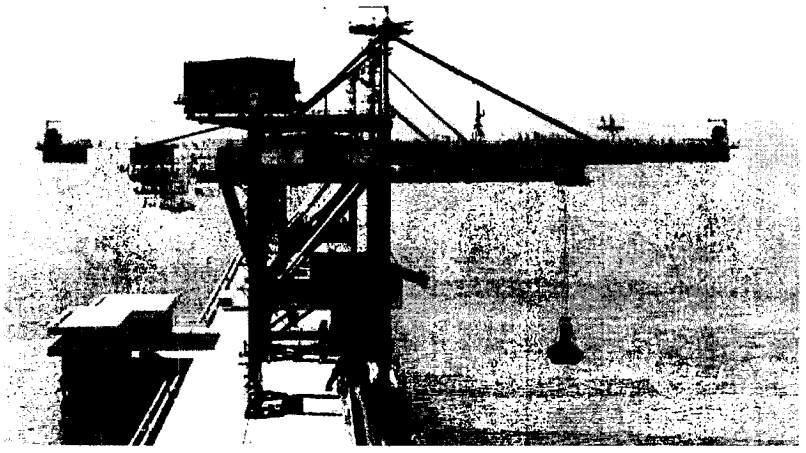

Fig. 4 Bridge Type Grab Ship Unloader

3.3.2 Belt Conveyor

The belt conveyor has belt width of 2000mm, belt speed of 3.5m/sand rated capacity of 3200t/h. When unloading, belt conveyor transports coal from the bridge-type grab ship unloaders to the coal transport system of the power plant via T1 and T2 transfer station.
BC1 belt conveyor at jetty apron adopts open-type arrangement, and wind deflectors are set on both sides of the belt conveyor trestle. BC2 belt conveyor adopts closed gallery.

3.3.3 Process Flow Of Coal Unloading
Ship → Bridge Type Grab Ship Unloader → Belt Conveyor → Coal Transport System Of The Power Plant

3.4 Marine Structure

Pile-supported structure is adopted in design.

The length of jetty is 280m, the width is 23m, and the top elevation is 5.20m.The jetty uses the pile-supported structure.

The jetty uses pile-supported structure with beams and slabs, the bent span is 8m. Φ1300~1400mm bored piles are adopted for the foundation. There are 4 vertical piles under each bent, and one pile is arranged under each rail between two frame bents. The upper structure is composed of cast-in-situ transverse beams, cast-in-situ longitudinal beams, and precast slabs.

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There are 2 rails with gauge of 18m set on the jetty for operation of ship unloader. Both rails are set under the rail beams. In this option, the 100m long area at west of the coal unloading jetty is used for handling heavy lifts.

The length of the approach bridge is 23m, the width is 12m, the top elevation is 5.20m.The approach bridge uses pile-supported structure with beams, and the bent span is 8.5m. Φ1300~1400mm bored piles are adopted for the foundation. 3 vertical piles are arranged under each bent. Because the approach bridge needs to bear the heavy cargo loads, so the upper structure is composed of cast-in-situ transverse beams, cast-in-situ longitudinal beams, precast slabs.Simply supported plate is used to connect the approach bridge and the cofferdam.

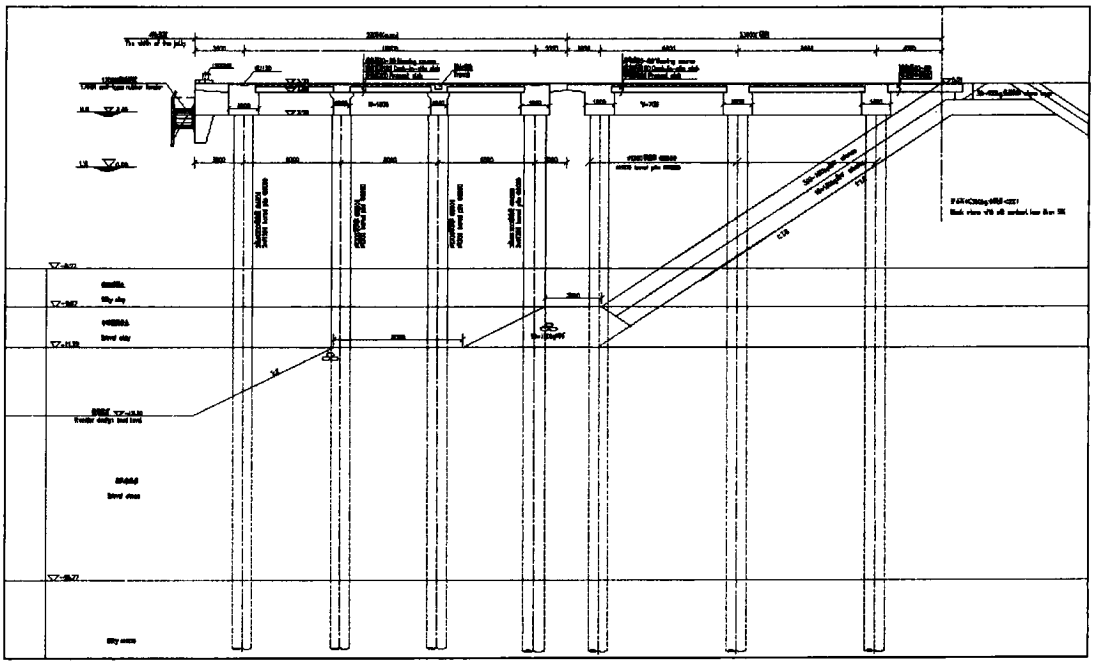

Fig. 5 Section of Pile-Supported Structure

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中国进出口银行
China Eximbank
THE EXPORT - IMPORT BANK OF CHINA

ORIGINAL

Ref. No.: 2014-021

Date: Jul. 24th 2014

To: SINOHYDRO RESOURCES LTD.

LETTER OF INTENT

Re: Port Qasim 2 × 660MW Coal-fired Electric Power Project, Pakistan

We refer to your application for a credit facility to finance the captioned project. We have examined all the documents provided and would like to issue this Letter of Intent in line with the conditions that the facility amount will not exceed 75% of the total investment amount from the borrower.

This Letter of Intent is issued on the prerequisites that the captioned project shall meet the requirements of China Eximbank's credit policy and credit terms and there shall be no adverse change in the capital or money markets which could affect the performance of this Letter of Intent as of the date first above written throughout to the signing date of the Loan Agreement.

This Letter of Intent, however, is not yet a legally binding financing commitment, but serves only for your purpose of tender participation and cost analysis. China Eximbank shall have the right to revoke this Letter of Intent taking into account of the law, policy, the financial and business condition of loan applicant and the project.

This Letter of Intent will be valid until Jul. 19th, 2015, upon which this Letter of Intent shall automatically expire unless otherwise extended with our written consent. The validity period will

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凯晨世贸中心东座
Tel: (010)

West Tower, Chemsunny World Trade Center, No. 30, Fu Xing Men Nei Street,
Xicheng District, Beijing, 100031, P.R. China
Fax: (010)

邮编：100031

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not limit our right to revoke this Letter of Intent. In the meantime, the terms and conditions set forth herein may be reviewed or revised from time to time at the sole discretion of China Eximbank taking into account of the market conditions then prevailing.

The grant of this facility is subject to our final approval. China Eximbank will have the right to determine whether to grant this facility and to determine the terms and conditions of this facility taking into account of the evaluation results and project construction conditions.

THE EXPORT-IMPORT BANK OF CHINA

By: _____

(Mr. CHEN Zhen)

Title: Deputy General Manager

Corporate Banking Department

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
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Tel: (010)

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Xicheng District, Beijing, 100031, P.R. China
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邮编：100031

Reply: Since the Company is newly established and incorporated on August 12th, 2014, the filed Annual Return is not available right now. However, the relevant information was provided to NEPRA in Annexure V/1 of our application dated August 13th for your kind reference.

IV. *Cash balance of the company as required pursuant to Regulation 3(5)(d)(i) of the Regulations.*

Reply: As stated in section III above, the Company is newly established and therefore, the Company bank account is under opening process, which will be completed soon. After this, shareholders of the Company will inject adequate equity as per relevant regulations and laws.

Please see Schedule IV as the letter from Industrial and Commercial Bank of China Islamabad Branch for the statement on our bank account.

V. *Latest Financial Statement of the company as required pursuant to Regulation 3(5)(d)(iii) of the Regulations.*

Reply: As stated above, the Company is newly established and therefore, the Financial Statement is not available right now. However, Financial Statements of the Company's main sponsor Sinohydro Resources Limited, China (as part of Powerchina Group) has been submitted in Annexure XI of ur application dated August 13th for your kind reference.

VI. *Profile of Sub-contractors, if any, along with expressions of interest of such sub-contractors as required pursuant t o Regulation 3(5)(d)(v) of the Regulations.*

Reply: The main Sub-contractors of the Project include SEPCOIII Electric Power Construction Corporation and Sinohydro Harbour Co., Ltd. Please See Schedule VI for the profiles and EOIs of the both companies.

VII. *Verifiable references with reference to experience of the Applicant and its Sub-Contractors as required pursuant to Regulation 3(5)(d)(vi) of the Regulations.*

Reply: Please see Schedule VII as required verifiable references.

VIII. *The type, technology, model, technical details and design of the facilities proposed to be acquired, constructed, developed or installed as required pursuant to Regulation 3(5)(g)(a) of the Regulations.*

Reply: Please see Schedule VIII as required.

IX. *Feasibility study of the project as required pursuant to Regulation 3(5)(h) and 3(6)(A)(a)(l6) of the Regulations.*

Reply: Please see Schedule IX as required.

X. *Technology, size of plant, number of units as required pursuant to Regulation 3(6)(A)(a)(2) of the Regulations.*

Reply: Please see Schedule X as required.

XI. *Fuel: type, imported/indigenous, supplier, logistics, pipelines etc as required pursuant to Regulation 3(6)(A)(a)(3)of the Regulations.*

Reply: Please see Schedule XI as required.

XII. *Emission Values as required pursuant to Regulation 3(6)(A)(a)(4)of the Regulations.*

Reply: Please see Schedule XII as required.

XIII. *Cooling water source: tube wells, sealriver/ canal, distance from source, etc. as required pursuant to Regulation 3(6)(A)(a)(5) of the Regulations.*

Reply: Please see Schedule XIII as required.

XIV. *Interconnection with national grid company, distance and name of nearest grid, voltage level (single line diagram) as required pursuant to Regulation 3(6)(A)(a)(6) of the Regulations.*

Reply: NTDC has been authorized to carry out interconnection works. This will be supplemented at later stage when the relevant works are completed. Please see Schedule XIV for details.

XV. *Information regarding Infrastructure (roads, rail, staff colony, amenities) as required pursuant to Regulation3(6)(A)(a)(7) of the Regulations.*

Reply: Please see Schedule XV as required.

XVI. *Project cost, information regarding sources and amounts of equity and debt as required pursuant to Regulation 3(6)(A)(a)(8) of the Regulations.*

Reply: The Project cost is approximately 2.3 billion USD. Sponsors of the Project are Sinohydro Resources Limited and Al Mirqab Capital, while the equity shares ratio between the two parties is 51%:49%. The equity/debt ratio of the Project is tentatively determined to be 25%:75%, while the debt section is to be financed from Chinese banks, e.g. Export and Import Bank of China, China Development Bank, etc.

Please see Exim Bank of China's letter of Intent in Schedule XVI for your kind reference.

XVII. *Project commencement and completion schedule with milestones as required pursuant to Regulation 3(6)(A)(a)(9) of the Regulations.*

Reply: The construction period is tentatively decided to be 42 months after

VIII. The type, technology, model, technical details and design of the facilities

1 Principles on Unit Selection

1) Main equipment will be Chinese-made equipment with proven design;

2) The main and auxiliary equipment has advanced technology, good quality, high reliability and availability;

3) The unit has high efficiency.

The project is a newly built project. At this stage, it is proposed to construct 2×660 MW supercritical units and FGD device, with no expansion being considered.

2 Main equipment and Parameters

2.1 Boiler

Mode: To be determined

Type: supercritical parameters, single reheat, single furnace, balanced draft, dry ash extraction, outdoor arrangement with rain cover, complete steel structure once-through boiler, ∏ shaped

Air Pre-heater (APH): regenerative trisector rotary

Combustion mode: opposite firing of front/rear wall or four corners tangential-firing

Boiler ignition mode: high-energy igniter → light oil → pulverized coal

Atomization mode of oil ignitor: mechanical

Steam temp. Regulating mode: 1) superheater: two-stage spray de-superheating

2) Reheater: flue gas baffle or spray de-superheating

Min. load of stable combustion: 35% BMCR

Main Parameters of Boiler

Item	Unit	BMCR
Mode		
Max. continuous superheated steam flow rate	t/h	2116
Rated pressure of superheated steam	MPa(g)	25.4
Superheated steam temp.	℃	571
Rated flow of reheated steam	t/h	1715
Reheated steam temp.	℃	569
Rated pressure of reheated steam inlet	MPa(g)	4.79
Rated pressure of reheated steam outlet	MPa(g)	4.60
Rated temp. of reheated steam inlet	℃	328.6
Rated temp. of feed water	℃	292.6
Flue gas temperature at APH outlet (revised)	℃	135
Guaranteed efficiency of boiler (calculated as per lower calorific value)	%	92.7

APH		Regenerative tri-sector rotary
Primary air temp. of APH inlet/outlet	℃	26/379
Secondary air temp. of APH inlet/outlet	℃	30/370
Combustion mode		Opposite firing of front/rear wall or four corners tangential-firing
Operation mode		Constant pressure or constant-sliding-constant pressure

2.2 Steam Turbine

Mode: N660-24.2/566/566

Type: Supercritical, Reheat, 3-Cylinder, 4-Exhaust, Condensing

Main Parameters of Steam Turbine

Item	Unit	TMCR
Mode		N660-24.2/566/566
Rated power	MW	660
Rated steam flow before main stop valve	t/h	1994.25
Rated steam pressure before main stop valve	MPa	24.2
Rated steam temp. before main stop valve	℃	566
Rated steam flow before reheated steam valve	t/h	1623.647
Rated steam pressure before reheated steam valve	MPa	4.263
Rated steam temp. before reheated steam valve	℃	566
Rated exhaust pressure	kPa	10.2
Rated speed	r/min	3000
Regenerative system		3 HP heaters, 4 LP heaters & 1 deaerator

2.3 Generator

The generator is directly coupled to the turbine shaft. The generator converts the mechanical energy developed in the turbine to electrical energy. The generator is filled with hydrogen gas to reduce the windage losses caused by the cooling flow inside the generator.

The static exciter supplies the electrical energy to the generator rotor (filed) to control the voltage and phase angle of the power generated in accordance with system needs.

Type : QFSN-660-2

Rated power: 660MW

Rated power factor: 0.8/0.95（lagging/leading）

Rated voltage: 22kV

Rated speed: 3000r/min

Frequency: 50Hz

Phase:	3
Pole:	2
Stator winding connection:	YY
Connection terminal:	6
Cooling type:	Water-Hydrogen-Hydrogen
Excitation:	Statistic excitation

2.4 Main Transformer

The rated capacity of main transformer will be selected as per Code for Design of Fossil Fired Power Plant GB 50660-2011. The main transformer will be single-phase oil immersed and double winding transformer, off-load tap changing type, forced-directed oil and forced-air cooling, with no standby single phase transformer.

2.5 Main Electrical Wiring Scheme

Based on current system plan, the main electrical wiring scheme of this project is as follows:

2×660MW units will be connected into power grid with voltage level at 500kV. 500kV switchgear will be built inside the power plant, and no future expansion needs to be considered.

2×600MW units will be connected to the switchgear in the form of generator-transformer unit, and 2×500kV outgoing lines will be connected into power grid. 500kV shunt reactors will be required at both of the 500kV outgoing lines. 500kV switchgear will have 2 complete bays.

One incoming line and one outgoing line constitute 1 complete bay.

There will be no generator circuit breaker or isolating switch between generator and main transformer.

Neutral point of generator will be grounded via single-phase grounding transformer with resistance on secondary side; neutral point at 500kV HV side of main transformer is designed as direct grounding.

The main electrical wiring scheme will subject to the final access system, which has not been determined yet.

3 Structural and Architectural

3.1 Architectural design

3.1.1 Main Power House

Main power house consists of turbine house, deaerator bay, bunker bay, boilers and central control building.

There will be 17 column spacings, each with column distance of 9.000m and 10.000m. One expansion joint, with width of 1.50m, will be set between two units. The total length of main power house will be 167.50m.

Turbine house will be designed with span of 30.60m and longitudinal length of 167.50m. The top elevation of crane rails will be 26.40m. The three-floor turbine house will be designed at elevations of ±0.000m, 6.900m and 13.700m respectively. The operation floor will be at elevation of 13.700m.

The four-floor deaerator bay will be designed at elevations of ±0.000m, 6.900m, 13.700m and 26.800m respectively. The deaerator bay will be designed with span of 10.00m and

longitudinal length of 167.50m. Its elevation of roof will be 38.0m. Deaerator will be arranged at 26.80m floor.

Four-floor bunker bay will be designed at elevations of ±0.00m, 17.00m, 42.90m and 51.10m. The bunker bay will be designed with span of 14.00m and longitudinal length of 167.50m. The elevations of roof are 51.10m and 58.10m. Coal conveyors floor will be arranged at 42.90m floor while transfer station at 51.1m floor.

Boilers will be arranged outdoors, with operation floor at elevation of 17.00m.

3.1.2 Other Main Production Buildings

Other main production buildings will be mainly of steel structure or concrete frame-bent structure, combined with enclosure of sandwiched corrugated metal sheets (single) or concrete block.

3.2 Structural Design

The designed service life for buildings structure and structure elements is 50 years.

The main power house consists of turbine house, deaerator bay and bunker bay.

Based on below consideration, the main building adopts steel structure:

1) Steel structure is more and more widely used for its advantage of light weight, suiting for soft ground, easy to install, shortening the construction period. For another, no embedded parts need to be reserved on column or beams so as to make easy for installation of pipe or other mechanical facilities, which can push the project into service and gain better economic benefits.

2) Because of the high cost of the local material and the manpower for concrete work, the concrete structure has no competitive advantage compared with steel structure.

3) The steel structure is simple and light which show a nice elegant appearance, and nice impression of the plant will be increased.

4) By consideration of overseas philosophy, when the plant is out of service life and to be scraped, the construction waste should be avoid as possible, and the material should be re-utilized as possible, so the steel structure is widely used for overseas project.

The main power house will be of steel frame with steel bracings. The transverse structure will be of rigid jointed frame with steel bracings, and longitudinal structure will be of hinge jointed frame with steel bracings.

The turbine house roof consists of steel girder, steel bracing system, purlins and sandwiched corrugated metal sheets. The other roofs and floors of main power house (except turbine house) will be of cast-in-situ reinforced concrete supported by corrugated metal sheet formwork which will be on steel beams. The shear connectors will be of studs. Steel grating will be adopted in some local areas.

Steel girders will be adopted for the crane in turbine house. Coal bunker will be of steel structure. Central control building will be of steel frame and all the floor slabs and roof slabs will be of cast-in-situ reinforcing concrete supported by corrugated metal sheet formwork which will be on steel beams floors.

Boiler steel structure will be designed and provided by boiler manufacturer. Boiler operation floor will use steel grating. The steel beams for the platform of boiler operation floor will be designed and provided by boiler manufacturer. The shaft of boiler elevators will be of steel structure. The claddings and roof for elevator shaft and machine room will be enclosed by

sandwiched corrugated metal sheets.

Turbine-generator pedestal will be of cast-in-place reinforced concrete frame structure and will be isolated by gaps from adjacent floors for vibration consideration.

BFPT pedestal will be supported on turbine platforms by spring vibration isolators.

The coal mill foundation adopts massive block R.C foundation. Rubber vibration pad will be used under the part of coal mills foundation where it covers on the main building foundation.

The two gables at fixed end and extension end will adopt steel structure, with vertical bracing set in transverse. Longitudinal wind load will be undertaken by steel columns of gable, and then be transferred to the space structure of heater platform and roof respectively.

4 Buildings, Structures and Facilities of CW System

The CW system with natural draft cooling tower is to supply water for cooling the main condenser and the auxiliaries like oil coolers, closed water cooler and vacuum pump in the main power house.

CW system shall include natural draft cooling towers, collecting pond under the natural draft cooling towers, gravity return trench, forebay, CW pump house and CW pipelines, etc.

5 Ash Yard

5.1 Cofferdam in Offsite Ash Yard

A cofferdam will be built around ash yard in the use of materials inside, with height of 2.5m, top elevation of 5.5~6.22m, internal and external side slop of 1:2, and top width of 2m. The cofferdam slope will be protected by using dry stone. Drainage channel will be set at cofferdam foot to prevent it from rainwater washing.

5.2 Environmental Protection

a) Protection of underground water resources

In order to prevent fly ash and bottom ash from polluting underground water after being wetted by rainwater, anti-seepage geomembrane will be laid on bottom of ash yard and inner slope of cofferdam, forming a basin-shaped anti-seepage system, which can isolate fly ash and bottom ash from contacting outside world.

b) Greening

Green belt, growing with trees in 20m width, will be designed at exterior area of ash yard to reduce windy dust.

When ash yard is expected to reach full capacity, the ash surface shall be covered with 0.3m-thick soil and planted with grass.

c) Ash Surface Spraying

To ensure the water supply for compaction and rolling, flexible auto sprinklers will be used with spraying water taken from power plant common water source or from water collecting pond. During windy season, ash surface exposed will be sprayed more frequently than usual, if necessary, covered with soil to avoid environmental pollution from fly ash.

5.3 Ash Yard Management

Ash will be stacked in blocks, minimizing stacking working surface. In order to facilitate comprehensive utilization in the future, fly ash and bottom ash will be stacked separately. When stacking, the ash will be rolled and compacted from bottom to top layer by layer. When

ash yard is expected to reach full capacity, the ash surface shall be afforested or converted into cultivated land.

To facilitate the management of ash yard in operation period and the storage of machines and tools, a management station, covering an area of 2500 m^2, which contains eleven (11) garages and four (4) offices, will be built nearby the ash yard.

Main equipment for ash spreading, rolling and compaction purpose will be provided as follows:

Bulldozers (power plant type, plus U-shaped scoop)	Three (3) sets
Road rollers	Two (2) sets
Sprinklers (equipped with high-pressure water guns)	Three (3) sets
Maintenance tool cars	One (1) set
Hand operated vibrating roller	One (1) set
Shovel loader	One (1) set

5.4 On-site Ash Yard

Brick retaining wall will be built around ash yard with height of 0.8m. The side that is close to plant area can utilize the boundary wall of power plant.

Anti-seepage: anti-seepage geomembrane will be laid on bottom of ash yard.

Wind dust-controlling: set wind dust-controlling nets around the ash yard. The side that is close to coal yard can share the wind dust-controlling nets of coal yard.

Ash surface spraying and management in operation period will be the same as that of offsite ash yard.

6 FGD System

The flue gas system mainly consists of original flue gas duct, clean gas duct and gas dampers. The flue gas from the original flue gas duct behind ID fan will be drafted into SO_2 absorption tower directly, and then discharged into atmosphere through clean gas duct and chimney. By-pass flue gas duct system is adopted for FGD system of this project. In the event of FGD failure and out of service, boiler can continue operating by by-pass flue gas duct system.

X. Technology, size of plant, number of units

1 Power Plant site

SEPCO III and HBED started site survey and plant site selection on 23rd October, 2013 under the guidance of Power China. PQA provided four plant sites. No.2 plant site was ultimately selected with the comparison of the four sites by site location, coal unloading jetty, and seawater quality and environment analysis.

The plant site is located in North Coast of Arabian Sea, in Port Qasim Industrial Area in the south-east of Karachi. It is about 37 kilometers from Karachi downtown and about 45 kilometers from the highway.

The area between site plant and Arabian Sea is tidal-flat area. Seaways are separated by mangrove forest. South of the plant site is connected with the Port Qasim Seaway which is on the north of tidal-flat area. North of the plant site is adjacent to the main road of the industrial park. There are spare bushes, weeds and mangroves, and some bare sand land in the site and there is no building. The plant site is flat, the north-west part is high and south-east part is low. Some southeast area is submerged in seawater.

2 Power Plant Scale

The project is a 2 × 660MW power plant and shall be completed in one phase without extension due to limitation of the site size.

3 Main Design Principles

1) Standard: Chinese Codes and Standards are applied for the Project; Environmental protection shall meet the Pakistan standard and Word Bank Standard; Fire fighting and power grid interconnection shall meet Pakistan regulation and standard.

2) Units: 2x660MW supercritical coal-fired wet cooling units; supercritical PC boilers with condensing steam turbine generators;

3) Grid interconnection: the power shall be interconnected to Matiari 500kV substation which is about 180km away from the power plant, with two-circuit of 500kV outgoing lines.

4) Coal supply: Subbituminous coal imported from Indonesia and other countries.

5) Coal unloading jetty: New-built coal unloading jetty or reconstructed coal unloading jetty of Qasim Port berth with the load of 30,000t, 50,000t and 70,000t are analyzed and 70,000t load of new-built pile type jetty is recommended within the south boundary of the site area.

6) Cooling type: Sufficient comparison and demonstration from such as the environmental impact, project implementation, operation and maintenance, whole life period cost are analyzed and seawater secondary circulating cooling tower of one tower per unit is recommended.

7) Make-up water source: The make-up water for secondary circulating cooling water adopts pretreated seawater; Service water, potable water and fire fighting water adopt desalinated seawater.

8) Flue gas desulfurization(FGD): FGD shall be built together with the power plant; limestone-gypsum wet FGD processing is adopted.

9) Ash yard: There shall be on-site emergency ash yard in the plant site, the capacity of which could meet the requirement of the power plant operation for 1.5 years. The off-site ash yard could be built to the northeast of plant site, about 10 km away and outside the Port Qasim.

Industrial Area. The initial capacity of off-site ash yard could maintain the power plant operation for 5 years and have enough space to be expanded for hold the operation for 20 years.

10) Startup and Standby power supply: The startup and standby power supply of the units shall connected by 500kV bus in the power plant.

4 Primary Technical and Economic Data

Plant land occupation:	39.81hm^2
Gross Power plant efficiency:	42.03%
Rate of standard coal consumption for power generation:	292.3g/kW.h
Auxiliary power rate:	8.0%
Number of staff of power plant:	298
Annual power generating capacity:	9504GWh

5 Technology Selection and Design Standards

5.1 Technology Selection

(1) Supercritical and Subcritical Technology

The terms "subcritical" and "supercritical" refer to main steam operation conditions being either below or above the critical pressure of water (221.255 bars). The significance of the critical point is the difference in density between steam and water. Above the critical pressure, the density of water and steam is the same.

The efficiency of supercritical units is higher than that of the subcritical units. The heat rate of the subcritical units with the primary pressure of 173.8 bars is 2% lower than that of the supercritical units with the primary pressure of 248 bar.

As for unit parameters, the increase of initial steam parameters not only involves improvement of thermal efficiency, but also involves overall economic efficiency. Of which, the most important is the amount of investment. The increased investment on increasing initial steam parameters can reduce power generation cost and the increased investment can be recovered within reasonable period. With the increase of fuel cost, the supercritical technology will be more competitive. Therefore, supercritical units will be adopted in this project for higher efficiency and benefit and the reduction of fuel cost.

In China, the supercritical technology was introduced in the 1980s and experienced three generation, the parameters of which were as follows: 24.2MPa,538℃/566℃, 24.2MPa,566℃ /566℃ and 25 (or 26.25) MPa, 600℃/600℃. So far, the quantity of 600MW units adopted the supercritical technology which has been put into service is more than one hundred. Therefore, the supercritical technology has been proven to be more safe and reliable.

(2) Unit Capacity

The unit capacity is 660MW. The unit capacity of the project only takes up a small proportion of the total installed capacity of the system, stability and safety can be assured. For more details, please refer to attached special report, Appendix L.2: Unit Capacity Analysis.

(3) FGD

Limestone-gypsum wet FGD will be adopted in this project. The efficiency shall be not less than 92%.

For more details, please refer to Chapter VI: Flue Gas Desulphurization.

(4) Water Supply

The seawater will be the water source of the power plant. Some seawater taken into the power plant will be used for the make-up water of the C.W. system, the others, after aeration, clarification, ultra filtration (UF) and seawater desalination system treatment, will be used for boiler make-up water treatment, or as service water, potable water, fire fighting water, etc. For more details, please refer to section 5.9 and 5.13.

5.2 Design Codes and Standards

Technical Code for Designing Fossil Fuel Power Plant (GB 50660-2011)

Technical Code for General Plan Transportation Design of Fossil Fuel Power Plant (DL 5032-2005)

Technical Code for Design of Civil Structure of Fossil-fired Power Plant (DL 5022-2012)

Technical Code for Design of Waste Water Treatment of Fossil Fuel Power Plant (DL/T 5046-2006)

Code for Hydraulic Design of Fossil Fuel Power Plant (DL/T 5339-2006)

XI. Fuel

Fuel Type: According to the design and research of Pakistan Port Qasim power station, the general design for the heat of the boiler is 4300-4500 kcal. Principles of coal selecting is as follows:

COAL SPECIFICATIONS AND LIMITS

Analysis to be carried out in accordance with ISO standards.

PARAMETER	BASIS	UNIT	TYPICAL	LIMITS
PROXIMATE ANALYSIS				
Total Moisture	ARB	%	30	<35 max
Net Calorific Value As Received	NARB	Kcal/kg	4340	>3800
Inherent Moisture	ADB	%	15	
Ash Content	ARB	%	10	
Total Sulphur	ARB	%	1	<1.8
Volatile matter	ADB	%	28.5	
Fixed Carbon	ADB	%	By difference	
HGI			49	
Size (0 - 6mm)			<30%.Max.200	
ASH FUSION TEMPERATURE				
Initial Deformation	RED	°C	1210	
Spherical	RED	°C	1240	
Hemispherical	RED	°C	1280	
Flow	RED	°C	1300	

Imported Coal: The project adopts imported coal from Indonesia, South Africa and/or Australia.

Suppler: Apex Dragon Holding limited, etc.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

XII. Emission Values

1 Prevention & Control of Air Pollution

1) Adopt five-electric-field ESP with and efficiency not less than 99.7%, while considering 50% efficiency of FGD system, so that smoke dust concentration at chimney outlet can be ensured below 50mg/Nm^3.

2) FGD will be provided in this project, adopting limestone-gypsum wet FGD processing, and the efficiency is not lower than 92%. Concentration of SO_2 at chimney outlet is 174.5mg/Nm^3, which can meet the standards of Pakistan and World Bank Finance Corporation.

3) Low NO_X burner equipped on boiler adopts staged air distribution, ensuring NO_X emission at boiler outlet not more than 450mg/Nm^3 (far below standard limit) when firing bituminite.

4) A 200-meter-height double-tube chimney with internal diameter at single tube outlet of 7.0m will be constructed to facilitate pollutants diffusion, in the next phase, the chimney height will be further confirmed in preparing EIA.

5) Install continuous online monitoring system to monitor smoke dust, SO_2, NO_X and other pollutants.

The air pollutant emission is shown as below.

Pollutant emission level in this phase

No.	Item	Unit	Actual emission value	Limit value
1	Particulate	mg/Nm^3	23.67	50
		t/h	0.106	
		t/a	765.58	
2	SO_2	mg/Nm^3	174.54	200~850*
		t/h	0.784	
		t/a	5646.6	
3	NO_x	mg/Nm^3	450	510*
		t/h	2.022	
		t/a	14557.88	

Note:1) For dry flue gas, 1.01325×10^5Pa, 0^0C, 6% oxygen content; the annual utilization hours are 7200hr.

2) * Emission of SO_2 and NO_X must meet emission standards in Pakistan.

2 Prevention & Control of Water Pollution

In this project, waste water was treated in a centralized manner by using sanitary sewage treatment plant and industrial waste water treatment plant and then will be reused.

Production waste water mainly from boiler make-up water treatment system (acid/alkali waste water), condensate polishing system and APH flushing, will be collected, pressurized and discharged to industrial waste water treatment plant. The treated wastewater being collected by reuse water pond will serve as the make-up water of bottom ash handling system, humidifying water of dry ash, washing water for coal handling system and existing water for HVAC.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

Coal slime water treatment plant will be built to treat flushing water from coal handling system by coagulation, sediment and dosing. The treated wastewater will be reused for spraying the coal yard.

The sanitary sewage water treatment system will collect all domestic water in the power plant area, which mainly includes bathing and washing drainage water, toilet drainage water, canteen drainage water and so on.

Sanitary sewage water in the power plant will be discharged through underground pipeline to the regulating pond of sanitary water, and then pumped into the complete sewage treatment equipment. The treated water will be disinfected before discharging into the clear water basin and then be reused for plant greening.

The oily waste water treatment plant, with capacity of $2\times25m^3/h$, will be built. The oily waste water will flow into the oil separate basin and then pumped into the oil/water separator to get rid of the oil. The treated water will be discharged into the industrial waste water pipeline and waste oil transported outside the plant periodically.

Concentrated seawater of CW system and of SWDS, as well as drainage of seawater pre-treatment system will be discharged to the central monitoring basin and then pumped to Bay of Qasim.

The rainwater of power plant will be collected by rainwater drainage ditch and then pumped to Bay of Qaism.

3 Prevention &Control of Fly Ash and Bottom Ash

This project adopts positive-pressure dry fly ash handling system and wet bottom ash handling system. SSC directly connects to bottom ash bin. The fly ash and bottom ash collected will be used in comprehensive manner, or delivered to ash yard for stacking in the case of poor utilization.

Dry ash handling system will be adopted for two (2) 660MW units, with total capacity of 94.23×10^4 t/a, including fly ash of 62.01×10^4 t/a and bottom ash of 10.97×10^4 t/a, mill rejects of 4.66×10^4 t/a, and desulphurization gypsum of 16.58×10^4 t/a.

Ash will be stacked in blocks, minimizing stacking working surface.

Ash yard impermeable measure: To avoid underground water being polluted by wet ash, impervious geomembrane will be paved on ash yard bottom and internal slope of ash dam to form basin-like impermeable system, thus preventing coal ash from going out.

Ash surface sprinkling and covering soil: Sprinkling car is adopted during operation period to ensure damping and rolling of ash yard and sprinkling on ash surface. In the case of heavy wind, the exposed ash surface shall be frequently sprayed and covered with soil for greening if necessary, to control fly ash pollution. When ash yard is expected to reach full capacity, the ash surface shall be covered with 0.3m-thick soil.

4 Noise Control

The noise in power plant is mainly caused by vibration and friction of various equipment and sourced from generator, exciter, various pumps and fans, coal mills, cooling towers, etc.

Noise, as one of public hazards, is attributable to three dispensable factors, i.e. noise source, route of transmission and receiver; therefore, effective ways to control noise in power plant focus on reducing source noise, controlling transmission and improving individual protection.

As for the control on sound source, it is suggested to carry out noise simulation test and select energy-saving low-noise equipment in design as much as possible according to test result, raise requirements on noise value during equipment tendering and provide assorted sound cover and silencer. And the following measures will be taken:

Install silencer at boiler exhaust vent and fan inlet;

Provide sound cover for coal mills and other main equipment;

Adopt rigid coupling for turbo-generator set;

Select low-noise exciter;

Arrange reasonably the location for high-noise building, such as cooling tower, away from the sensitive point and plant green belt serving as noise buffer at the plant boundary.

CCR adopts sound proof wall, sound absorbing roof and sound proof door within the allowable limits.

Staffs working in high noise areas shall wear earplugs.

XIII. Cooling Water Source

1 Water Source

The plant site is classified as semi-arid without fresh water source, and the seawater is the only reliable water source for cooling water and other water consumption of the Project. Therefore, desalinated seawater is proposed for the project.

The seawater for the project is from Bay of Qasim. The seawater intake pump house locates at south of the power plant. The seawater flows through intake channel into the fore-bay of the seawater intake pump station and is pumped into the seawater pre-treatment system.

SWRO effluent will be used as boiler make-up water, service water, potable water and fire fighting water, etc.

According to the water source condition, seawater secondary circulating cooling supply system is planned. One natural draft cooling tower will be built for each unit.

2 Tides, Waves and Currents

Refer to Section 4.3 for seawater tide level and wave data.

The offshore tide on Arabian Sea normally heads towards west during the northeast monsoon period (November~ March) and towards east during the southwest monsoon period (May~ September). Approach channel is a deep groove in the Delta, near which there are lots of sand bank and shoal. Under the influence of islands, coastline and topography, the currents in the channel region are obviously reversing with small waves. The current velocity changes in a certain range, with mean tide rising and ebb velocity about 0.6m/s, and the maximum velocity in 1.0~1.8m/s. The velocity of tide ebb is normally faster than that of tide rising in the approach channel, in a flow direction parallel with the ship line.

3 Seawater Temperature

From the data observed at the port inside channel from January 1980 to March 1982, it is known that the minimum and maximum monthly mean temperature of sea surface was respectively 18 ℃and 32 ℃, and of 10m depth undersea were respectively 29 ℃ and 31.8℃. The sea surface was with maximum salinity of 40.3 ‰ and minimum salinity of 28.1 ‰. The tidal creek at Port Qasim belongs to the intertidal zone in lack of fresh water, with average salinity about 36 ‰.

The monthly mean temperature of sea surface in year 1989-1994 observed at the measured point (Figure 1) nearest the plant in Port Qasim is shown as below:

Table 1 Sea surface temperature

Year	Month	Mean temperature of sea surface (℃)
1989-1994	Jan-Mar	25.1
	Apr-Jun	30.2
	Jul-Sep	29.5
	Oct-Dec	26.3

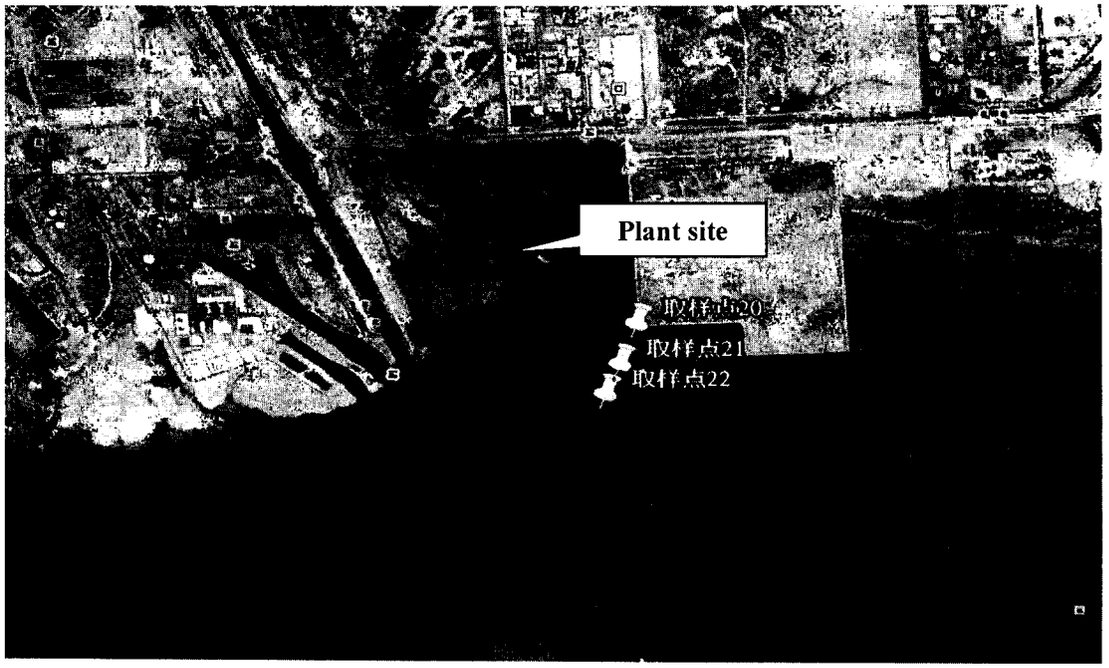

Figure 1 Sampling points for silt grain size analysis

4 Seawater Quality

The representative seawater collected from BQCS (power plant in Port Qasim) near the proposed project is with parameters as follows:

Table 2-1 Parameters of representative seawater quality

Item	Value	Unit
Acid and alkali（PH）	7.8	
Conductivity	49000	μs/cm^2
Total dissolved solids（TDS）	39000	mg/l
Turbidity	12	NTU
Total suspended solids（TSS）	30	mg/l
Total hardness（TH as $CaCO_3$）	7200	mg/l
Calcium as $CaCO_3$	1100	mg/l
Magnesium as $CaCO_3$	6100	mg/l
T-Alkalinity as $CaCO_3$	135	mg/l
CL^-	22700	mg/l
Biochemical oxygen demand（BOD）	27	mg/l
Chemical oxygen demand（COD）	256	mg/l
Fossil oil and animal oil	None	mg/l
Note: NUT is the unit of turbidity measurement.		

SEPCOIII conducted seawater sampling near the plant site and entrusted the testing to Pony Testing International Group, with results as below.

Table 2-2 Result of seawater sampling testing

Item	Value	Unit
Acid and alkali（PH）	7.71	
Chemical oxygen demand（COD_{Mn}）	2.11	mg/l
Biochemical oxygen demand（BOD_5）	1.6	mg/l
CL^-	20300	mg/l
Total organic carbon（TOC）	1.25	mg/l
Suspended solid matter（SS）	52	mg/l
Dissolved solid matter	26500	mg/l
Total solid matter	26500	mg/l
Total hardness（TH as $CaCO_3$）	6870	mg/l

According to observation datum of inside channel near the plant site from Jan 1980 to Mar 1982, the minimum and maximum suspended matter was respectively 0.015g/l in Jan and 0.20g/l in Aug. Due to the tide and wave disturbance to silt tide flat near the bottom of inside channel at the port, the suspended matter at 10m underwater was with higher concentration.

Sea water quality information of the 12 months will be provided by Pakistan TCI Company when the seawater quality analysis of the whole year is finished.

5 Channel Silt

The powder and fine sand deposited at port channel are mainly from:

1) The adjacent shallow bay (Korangi Bay，Gharo Bay，Isaro Bay and other smaller bays);

2) The suspended substance brought from low places inside the channel by rising tides;

3) Water discharged by the rainstorm into the channel and neighboring bays;

4) Earth filling inside the channel;

5) Powder and fine sand brought by north and northeast wind in winter into the port channel area, especially in the channel area with scarce or no mangrove.

The silt size grading is shown as below:

Table 3 Silt Size Grading

No. of sampling points	Sampling point 20	Sampling point21	Sampling point 22
Latitude	N24°46′49.85″	N24°46′43.93″	N24°46′39.50″
Longitude	E67°22′31.64″	E67°22′28.95″	E67°22′26.94″
Grain size	Proportion	Proportion	Proportion
0mm	0%	0%	0%
0.005mm	16.0%	18.2%	13.5%
0.075mm	96.8%	94.2%	96.8%
0.090mm	98.2%	95.5%	98.0%
0.125mm	99.0%	97.8%	99.0%
0.250mm	99.2%	99.0%	99.2%
0.335mm	99.5%	99.4%	99.5%

6 Marine Organism

Seawater salinity is high in Qasim for most of the year (about 37~41%) except the non-monsoon season. High salinity is a key factor to affect the marine animal and algae. High salinity, appropriate sediment and silt bed form environmental conditions for marine animal and algae, and hydrological condition at the seaport is much different from that at the bay. At present, organic biological filtration absorption is lacking inside the bay. The algas in this region are mainly tropical and subtropical species.

As the main plant species, mangrove in this region is sparser than that in other regions, since there is no fresh water injection in this region. There are just a few algae in this region, as the silt in water is lack of hard substances and is with high salinity.

Pelagic species like fish, shrimp and crab are common, as well as lots of juvenile prawn and fish populations. The most common fishes are Terapon jarbua, mudskipper and pony fishes, etc, and boleophthalmus dussumieri is the most common and suitable for growing here.

The commercial fishing is in ways of net throwing, beach purse-seining and net casting. The shrimp fishing is very simple with purse-seining in the port channel bed. The offshore bay usually is the fishing center, mainly with juvenile shrimps and a variety of fishes.

Zooplankton: known from samples collected in study period, there are rich seasonal planktonic animals in sea area near the project, such as ctenophore, chaetognath and juvenile fishes. From Mar to Aug, juvenile fishes are very common, with the maximum density of $125*125/m^3$ in April, while in Jan, Mar, Apr and Jul, fish balls are in small quantity.

The zooplankton species nearby the port include: juvenile fishes, fish balls, crustaceans, annelids larvae, gastropod larvae, bivalve larvae, heterogastropoda, chaetognaths, pteropods, cysticerus, hydrozoans, jellyfishes, coscinodiscus, hemidiscus hardmannianus, ceratium, chaetoceros, pyrrhophyta, noctiluca scintillans, and the like.

Phytoplankton: centric diatom, flagellates and tintinds are the most common, while pennate diatoms, coccolithophorids, formanaiferan and radiolarians are the least common.

XV. Information Regarding Infrastructure

The Information regarding Infrastructure of the project is as follow:

1 Infrastructure of staff colony

The Project's living facilities include EPC contractor workers' living quarters,China subcontractor living quarters and Pakistan subcontractor living quarters. Living area is located in the northeast of the factory area, covers an area of about 80000 square meters. Workers' living quarters can accommodate 700 people; China living quarters can accommodate 2000 people; Pakistan living quarters can subcontractor 9000 people. There are sixteen rows of houses ,one dormitory building ,staff restaurant and other living facilities in the EPC contractor workers' living quarters. Staff living area plan to use brick houses and shall be built by local construction team. Living quarters to subcontractors in China and Pakistan,the second unit office plan to use double prefabricated houses, there are one hundred and forty rows of houses in total .All materials are provided by the Chinese manufacturers, and by the manufacturer to send technical personnel at the scene to guide installation. Staff restaurant, central office and other large space building designed by the Chinese manufacturers, all materials are provided by the Chinese manufacturers, and by the manufacturer to send technical personnel at the scene to guide installation.

2 Infrastructure of road

The length of the road which is designed in the plant is about 6500 meters. There are two main roads into the plant, one is located in the west side of the plant, the other road is located in the east of the plant. The eastern main road goes through the living area and office area. The eastern main road and the western main road can be in the factory form a loop.

3 Infrastructure of rail

The length of the bounding wall which is around the plant is about 2500 meters. The bottom of the wall is concrete structure and the superstructure uses concrete block to build. On the top of the wall there are 0.5 meters high three prong barbed wide fencing. The height of the wall which is above the ground is 2.5 meters.

4 Infrastructure of construction

Production facilities mainly include equipment repository,staff office, construction crane etc. Equipment repository designed total 4500 square meters , is located in the plant on the east side. According to the construction requirements， there are two sets 20t gantry cranes, nine sets 40t gantry cranes, nine sets 8t tower cranes, two sets 40t tower cranes, two sets 80t tower cranes and five sets batching unit in the plant.

5 Infrastructure of construction and lives water

The construction and lives water will be provided by Karachi Water and Sewerage Board (KWSB), the direct distance from the proposed connection point to the site is around 18 Km. We plan temporarily to use the DN200 as the water transmission main piping line to supply water to living and office area, subcontractor colony and site construction water area. At present, we are investigation the NOC requirement since the pipe line pass through the private land, Pakistan Railways and National Highway Authority.

The estimated daily consumption quantum is around 600,000 gallons per day. The quantum of the EPC contractor's living and office area is 800 m^3 per day. We plan to construct an impounding reservoir with capacity of 1500 m^3 to satisfy the lives water daily requirement of EPC contractor. The drinking water will be provided by means of barreled water. The impounding reservoirs with capacity of 1000 m^3 and 1200 m^3 will be constructed respectively in living colony of subcontractor and site concrete batching plant area. The sewage water will be discharged after treatment.

6 Infrastructure of construction and lives electricity

The project site team is contacting with K-Electric to provide electricity connection point with capacity of 6.6 kVA, 11 kV grade. We will construct a 11 kV substation at site and connected with 400 V substation through cables. We proposed to set up 6 low voltage substations at site and distributed at main power house of Unit 1 area, power house of Unit 2 area, ESP and chimney area of Unit 1, ESP and chimney area of Unit 2, Substation and concrete batching plant area and lives and office area respectively.

In the meanwhile, we also consider sufficient diesel generators for the standby use.

Remark: At present, the K-Electric only agreed to provide the electricity connection point of 132 kV and require us to construct a 132 kV substation. Furthermore, K-Electric will appoint all the equipment supplier and subcontractor, and the ownership will also belong to K-Electric. Additionally, we also need to connect the 132 kV substation to site by using 11 kV lines. An amount of 2 million us dollar will also be required to submit as the security deposit. Now we are contacting the sinohydro Resources to coordinate with government of Pakistan and K-Electric to provide the 11 kV connection point.

XVI . LOI

中国进出口银行
China Eximbank
THE EXPORT — IMPORT BANK OF CHINA

ORIGINAL

Ref. No.: 2014-021

Date: Jul. 24th 2014

To: SINOHYDRO RESOURCES LTD.

LETTER OF INTENT

Re: Port Qasim 2 × 660MW Coal-fired Electric Power Project, Pakistan

We refer to your application for a credit facility to finance the captioned project. We have examined all the documents provided and would like to issue this Letter of Intent in line with the conditions that the facility amount will not exceed 75% of the total investment amount from the borrower.

This Letter of Intent is issued on the prerequisites that the captioned project shall meet the requirements of China Eximbank's credit policy and credit terms and there shall be no adverse change in the capital or money markets which could affect the performance of this Letter of Intent as of the date first above written throughout to the signing date of the Loan Agreement.

This Letter of Intent, however, is not yet a legally binding financing commitment, but serves only for your purpose of tender participation and cost analysis. China Eximbank shall have the right to revoke this Letter of Intent taking into account of the law, policy, the financial and business condition of loan applicant and the project.

This Letter of Intent will be valid until Jul. 19th, 2015, upon which this Letter of Intent shall automatically expire unless otherwise extended with our written consent. The validity period will

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

中国 北京市西城区复兴门内大街 30 号
凯晨世贸中心西座
Tel: (010)

West Tower, Chemsunny World Trade Center, No. 30 Fu Xing Men Nei Street,
Xicheng District, Beijing, 100031, P.R. China
Fax: (010)

not limit our right to revoke this Letter of Intent. In the meantime, the terms and conditions set forth herein may be reviewed or revised from time to time at the sole discretion of China Eximbank taking into account of the market conditions then prevailing.

The grant of this facility is subject to our final approval. China Eximbank will have the right to determine whether to grant this facility and to determine the terms and conditions of this facility taking into account of the evaluation results and project construction conditions.

THE EXPORT-IMPORT BANK OF CHINA

By: _____

(Mr. CHEN Zhen)

Title: Deputy General Manager

Corporate Banking Department

XVII. Project Construction Schedule

1 Construction features

1) The project site will be backfilled by separated areas to shorten the construction period, north area of coal yard will be backfilled by soil from ash yard site, and submerged south area of coal yard (including coal yard) will be backfilled by sea sand and stone from channel dredging.

2) The coal unloading jetty consists of material unloading function for construction, the unloading platform and transportation road shall be finished before the boiler steel main girder erection so that the steel material can be delivered in advance.

3) The project site has shallow underground water level, therefore most foundation construction need dewatering.

2 Construction Schedule

The project is tentatively considered that the project approval is the commencement point; the construction period is totally 42 months as calculated from the project approval to commercial operation of Unit 1, and 4 months later of the commercial operation of Unit 2.

For detail milestone relative month see following table.

Power plant Milestone Schedule

SN	Milestones	Unit 1# (months)	Unit 2# (months)
1	Project Approval (China, Pakistan)	0	-
2	EPC Contract Signed	0	-
3	Completion of Basic Design	1.5	-
4	Completion of Site Ground Backfilling	2.5	-
5	Commencement of Main Power House Piling	3	7
6	Commencement of Jetty Channel Dredging and Site Filling	2	-
7	Completion of Ground Treatment in Main Power House	8	12
8	Project Commencement (concrete casting of bed cushion of Main Power House Foundation)	9	-
9	Completion of Construction Jetty	17	-
10	Foundation Work of Main Power House and Boiler Completed Up to 0m	12	16
11	Commencement of Lifting and Erection of Boiler Steel Structure	12.5	16.5
12	Completion of Lifting and Erection of Boiler Girders	19	23
13	Placing Steam Separator in Position	20	24
14	Main Power House Topping off	25	29
15	Completion of Hydraulic Reclamation	10	-
16	Chimney External Shaft Topping Off	27	-

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

SN	Milestones	Unit 1# (months)	Unit 2# (months)
17	Placing Turbine Sole Plate in Position	24	28
18	Placing Generator Stator in Position	28	32
19	Cooling Tower Topping off	26	30
20	Qualified (DM) Water Available by Chemical System	33	-
21	Completion of Boiler Hydraulic Test	33.5	37.5
22	DCS Energization	31	35
23	Auxiliary Power Energization	31.5	35.5
24	Completion of Turbine Cylinder Covering	35	39
25	Completion of Coal Unloading Jetty	34.5	-
26	Completion of FGD Commissioning	38	42
27	Completion of Boiler Acid Cleaning	38	42
28	Initial Boiler Ignition	39	43
29	Completion of Boiler Steam Blowing	39.7	43.7
30	Completion of Turbine Oil Circulation	38.5	42.5
31	Initial Startup of Complete Unit Set	40.5	44.5
32	Success of 168h Continuous Trial Full Load Operation	42	46
33	Commercial Operation	42	46

The Jetty Milestone Schedule

SN	Milestones	month
1	Preliminary work	3
2	Construction of cofferdam	6
3	Construction of dredging	23
4	Construction of approach bridge	3
5	Construction of heavy cargo terminals	12
6	Construction of general cargo terminals	11
7	Commercial Operation	24

XIV. Interconnection

1 Interconnection Scheme

The power plant will be interconnected to the planned Matiari 500kV switchgear which through two-circuit 500kV lines with the length of 180km. The conductor type is quadrifid GREELEY. The maximum transmit capacity of the conductor is 2200MVA (40℃). The short-term and long-term interconnection scheme is shown in Figure 1-1 and 1-2 separately.

ANNEX-4

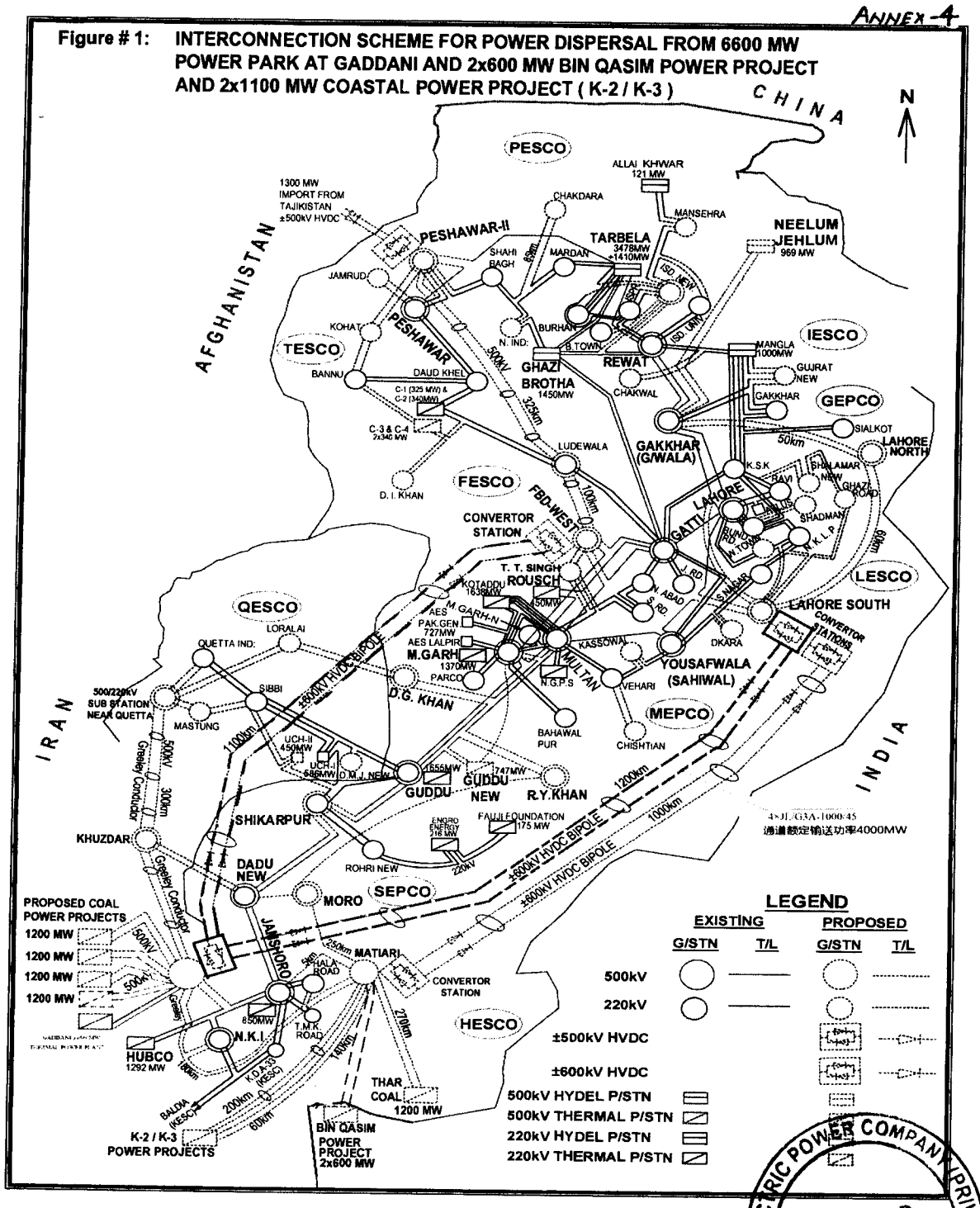

Figure 1-1 Short-Term Interconnection Scheme of Qasim Coal-fired Power Plant

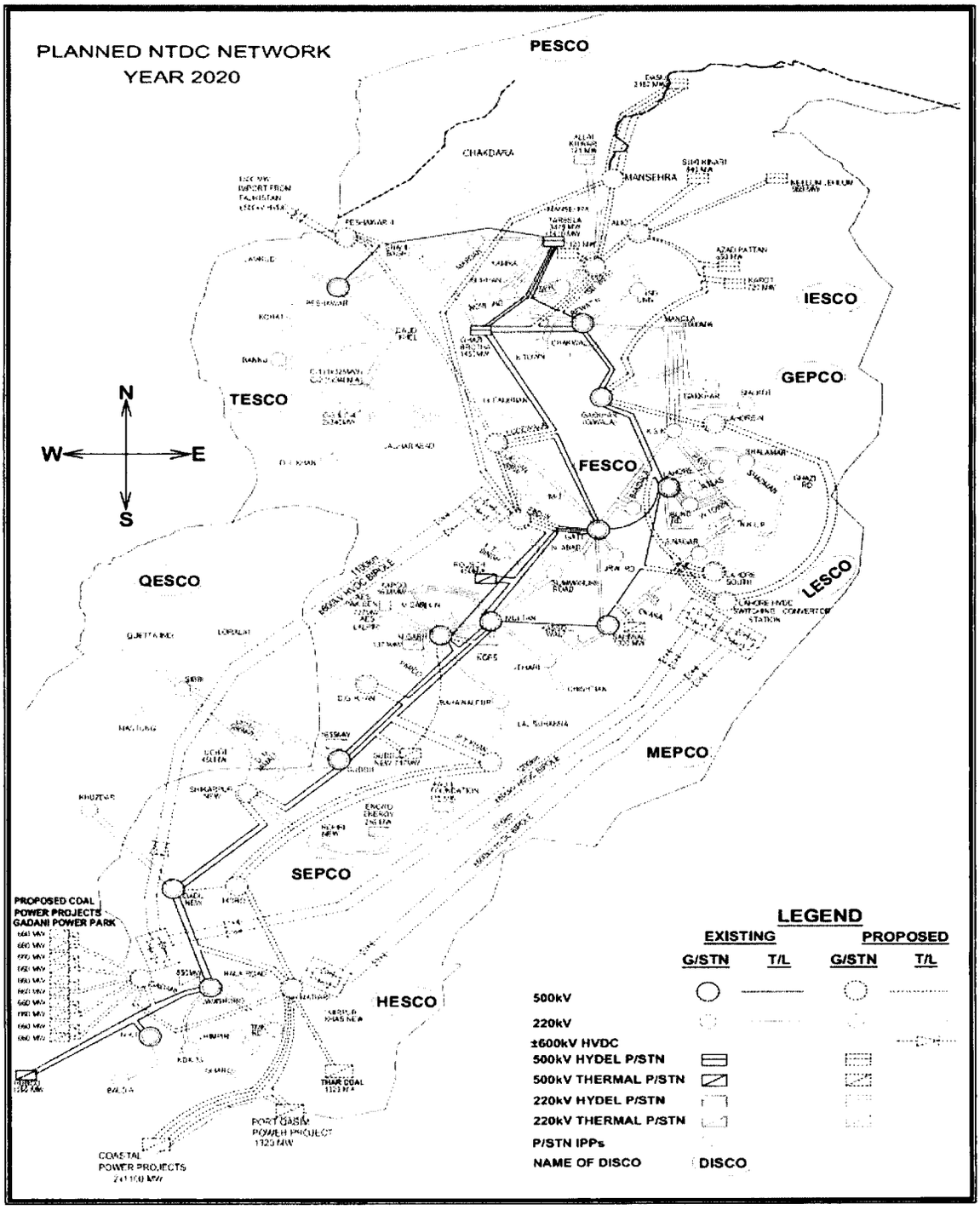

Figure 2.9-2 Long-Term Interconnection Scheme of Qasim Coal-fired Power Plant

XIX. Safety Plans & Emergency Plans

1 Health and Safety Risks Identification, Environmental Impact Assessment and Control

The QASIM project HSE plan has been made. The plan aimed to achieve the desired results by pre-planning at the beginning of the project, and create the HSE management model project in Pakistan. The main contents are as follows:

1. Project Description
2. HSE policy and goals
3. HSE management system
4. Related HSE laws and regulations in Pakistan
5. HSE contract with owner
6. General HSE management execution
   - 6.1 Risk assessment
   - 6.2 HSE management before entry site
   - 6.3 HSE training
   - 6.4 HSE inspection
   - 6.5 HSE meeting
   - 6.6 Work permit system
   - 6.7 Safety induction training
   - 6.8 HSE performance assessment
7. Safety and housekeeping management
   - 7.1 Scaffolding
   - 7.2 Traffic in site
   - 7.3 Work at height
   - 7.4 Night work requirement
   - 7.5 Electrical safety
   - 7.6 Monsoon precaution
   - 7.7 Working in confine spaces
   - 7.8 Chemical hazard
   - 7.9 Excavation and trenching
   - 7.10 Fire protection and prevention
   - 7.11 Cranes and material handling
   - 7.12 Mechanical equipment and tools
   - 7.13 Welding, cutting and heat treatment
   - 7.14 Abrasive Blasting, Painting & Coating
   - 7.15 Radiography

7.16 Commissioning and operation

7.17 Housekeeping plan

7.18 Safety equipment standard plan

8. Health management

9. Environment management

10. Emergency plan

11. Incident &accident management

12. HSE recording management

2 The procedures list which shall be followed at QASIM project

No.	Document Name
1	HSE Management Manual
2	HSE Policy, Objective, Target and Program Procedure
3	Hazard Identification, Risk Assessment and Risk Control Procedure
4	Construction HSE Risk Control Plan Procedure
5	Environmental Aspects Identification and Impact Evaluation Procedure
6	HSE Competence, Training and Awareness Procedure
7	HSE Training Procedure
8	HSE Laws, Regulations and Other Requirements Control Procedure
9	HSE Communication, Participation and Consultation Procedure
10	HSE Meeting and Safety Day Procedure
11	HSE Reporting and Notification Procedure
12	Tool Box Meeting Procedure
13	HSE Operation Control Procedure
14	HSE Responsibility Procedure
15	Management Procedure of Safety Planning of Construction Process
16	HSE Management Procedure of Temporary Facilities
17	Safety Facilities Management Procedure
18	HSE Investment Control Procedure
19	Personnel Protective Equipment Procedure
20	Work Permit Procedure
21	Special (Equipment) Operator Procedure
22	Electricity Safety Procedure
23	Confined Space Procedure
24	Lock-out/Tag-out Procedure
25	Scaffolding Safety Procedure
26	Working at Height Procedure
27	Lifting Operation Safety Procedure
28	Housekeeping Procedure
29	Construction Safety Procedure of Special Seasons

30	Safety Procedure of Working at Night
31	Special Equipment Safety Procedure
32	Instrument Safety Procedure
33	Blasting Construction Safety Procedure
34	On Site Traffic and Transportation Procedure
35	Dust and Poisonous Gas Procedure
36	Radiography Procedure
37	HSE Procedure of Welding, Cutting and Grinding Work
38	Working Near Water Procedure
39	Manual Handling Procedure
40	Hand Protection Procedure
41	Respiratory Protection Procedure
42	Noise Control Procedure
43	Subcontractor HSE Management Procedure
44	Excavation HSE Management Procedure
45	Concrete Construction HSE Management Procedure
46	Steel Erection Safety Procedure
47	Turbine and Boiler Installation HSE Management Procedure
48	Electrical and IC Installation HSE Management Procedure
49	Anti-Corrosion and Heat Insulation HSE Management Procedure
50	Demobilization HSE Procedure
51	Female Worker and Underage Worker Procedure
52	Occupational Health Procedure
53	First Aid Procedure
54	Office and Camp HSE Procedure
55	Visitor Control Procedure
56	Air Pollution control Procedure
57	Archaeology Procedure
58	Community Procedure
59	Soil and Sedimentation Procedure
60	Waste Disposal Procedure
61	Working in Heat and Cold Environment Procedure
62	Pest Control Procedure
63	Water Quality Management Procedure
64	Travel Safety Management Procedure
65	Regional Management Procedure
66	Hazardous Chemical Procedure
67	Operation And Maintenance HSE Management Procedure
68	Project Design HSE Management Procedure
69	Management Regulations for Procurement of HSE
70	Inspection personal safety management regulation
71	HSE Procedure of Equipment Storage and Transportation

72	Commissioning HSE management Procedure
73	Emergency Preparedness and Response Procedure
74	Oversea Emergency Response Procedure
75	HSE Performance Measurement and Monitoring Procedure
76	HSE Inspection Procedure
77	Implementation Rules of Violation Control
78	HSE Incentive and Disciplinary Procedure
79	Environmental Monitoring Procedure
80	HSE Legal Compliance Evaluation Procedure
81	HSE Incident Reporting, Investigation and Handling Procedure
82	HSE Nonconformity, Corrective and Preventive Action Control Procedure
83	Fire safety management control procedures
84	Hot work on the construction site safety management program
85	Project fire fighting management regulations
86	The public security management system
87	Project convoy management system
88	The construction site security management system
89	Project public security management regulations
90	Project of public security event processing regulations

3 In order to provide necessary guidance for taking immediate action when any incidents or accidents happened, and protect the personal and property safety, the following Emergency Response Plans shall be drafted on the basis of risk analysis and shall be followed strictly.

No.	ERP Name
1	Flood prevention emergency plan
2	Fire, explosive emergency plan
3	Chemical hazardous incident emergency plan
4	Heatstroke prevention emergency plan
5	Traffic accident emergency plan
6	War and riot incident emergency plan
7	Abduction incident emergency plan
8	Radiography incident emergency plan
9	Crane incident emergency plan
10	Personal injury accident emergency plan
11	Infection incident emergency plan
12	Food poisoning incident emergency plan
13	Medium leakage incident emergency plan
14	Flood prevention emergency plan
15	Riot and war emergency plan
16	Personal evacuate emergency plan

XXI. Plant characteristics

1 Generator

The generator is directly coupled to the turbine shaft. The generator converts the mechanical energy developed in the turbine to electrical energy. The generator is filled with hydrogen gas to reduce the windage losses caused by the cooling flow inside the generator.

The static exciter supplies the electrical energy to the generator rotor (filed) to control the voltage and phase angle of the power generated in accordance with system needs.

Type :	QFSN-660-2
Rated power:	660MW
Rated power factor:	0.8/0.95（lagging/leading）
Rated voltage:	22kV
Rated speed:	3000r/min
Frequency:	50Hz
Phase:	3
Pole:	2
Stator winding connection:	YY
Connection terminal:	6
Cooling type:	Water-Hydrogen-Hydrogen
Excitation:	Statistic excitation

2 Excitation

Generator excitation system is self parallel excitation static system It is comprised of Excitation Transformer, silicon controlled rectifier（SCR), automatic voltage regulator（AVR), deexcitation and over voltage protection device, start excitation device, necessary monitor, protection and warning devices.

3 Outgoing 500kV Relay Room

500kV relay room will be set in 500kV GIS building. Control device, protection device, measuring device, metering device, automatic device etc. will be installed it.

4 System Dispatching Automation

4.1 Tele-control equipment

Tele-control equipment mainly includes data network interface unit for power dispatching, AGC system, AVC system, PMU system, and network protection device.

4.2 Tariff Metering System

Tariff metering will be provided at following points.

•Every incoming 500kV step-up transformer circuit (one main meter);

•Every 500kV outgoing line (one main meter and one back up meter);

•High voltage side of the Startup/Standby Transformer (one main meter and one back up meter).

4.3 Relay Protection of GIS

Protection devices for 500kV Bus, 500kV circuit breakers and 500kV outgoing line will be provided. Fault recorder system will be set in power plant. The protective relay will be able to satisfy the requirements on sensitivity, stability and reliability.

4.4 Communication with the Grid

The grid communication equipment in the power plant will be supplied as per requirements of local power grid. The detail design will be determined based on the system access report from local grid company.

5 Dispatch Automation

According to the scale of the project and status in the power syetem, dispatching mode will be set two dispatching centers, namely main dispatching centers and standby dispatching centers, dispatching system will be managed by NTDC temporarily.

5.1 Dispatching Automation System

The function of system is collecting and transporting remote information for the power plant (remote information including protection signals, position signals of CB and isolator, electric energy single and etc.)

5.2 Transmission Mode of Telecontrol Information and Channel

Power Plant would communicate with dispatching centre using dual telecontrol channel （as standby mutually).

The telecontrol communication device and dispatching centre would adopt communication criterion which meet the request of main station of dispatching centre.

Telecontrol channel: The two four-line-telecontrol-channel between power plant and dispatching centre would have necessary quality for transmission, and its error ratio would be less than 10-5 when SNR is 17dB. The transmission rate is 1200bit/s、600bit/s.

5.3 Telecontrol Information

According to the regulation of electric power dispatching automation and corresponding rules, power plant would enact the acquisition information and do corresponding adjustment according to the demand of dispatching centre.

Tele-measurement

- Generator exit: Active power, Reactive power, current, voltage;
- The high voltage side of Generator Transformer: Active power, Reactive power, current;
- The high voltage side of high voltage auxiliary power transformer and standby transformer: Active power, Reactive power, current;
- 500kV outgoing lines: Active power, Reactive power, current;
- 500kV bus voltage, frequency;

Tele-signal

- Whole plant fault signal;
- Dispatched CB position signal;
- Dispatched disconnector and grounding disconnector position signal;

- Neutral grounding disconnector position signal of Generator Transformer;
- Tap position signal of Generator Transformer;
- Main protection action signal of generator and Generator Transformer;
- Main protection action signal of High voltage auxiliary power standby power transformer and Startup-standby transformer;
- Main protection action signal of 500kV line, CB and bus;

5.4 Telecontrol Equipment

The configuration of telecontrol system would be considered together with network computerized monitoring and control system (NCS), no longer alone sets remote terminal unit (RTU), but set two telecontrol workstations which are diplex configuration in NCS. The telecontrol workstation sends telecontrol information to main station of dispatching centre. The acquisition equipment of telecontrol information at network control uses together with NCS.

The measurement and control unit which used in collecting telecontrol information of Generator-Transformer Unit and Standby Transformer, and it directly communicates with telecontrol workstation.

5.5 The Request of Power Energy Tariff Point Setting

Power energy tariff point setting as follows:

- Two 500kV outgoing lines, main and check meter which precision would be 0.2S.

Power energy check point setting as follows:

- The high voltage side of Standby/Maintenance Transformer, main meter which precision would be 0.2S.
- The high voltage side of Generator Transformer, main meter which precision would be 0.2S.
- Generator exit, main meter which precision would be 0.2.
- The high voltage side of Unit Transformer, main meter which precision would be 0.2.
- The high voltage side of Excitation Transformer, main meter which precision would be 0.2.

Power plant sets 13 multifunction watt-hour meters, 3 energy meter panel, and 1 set of electrical energy remote terminal unit.

The watt-hour meter can record and save bidirectional active and reactive energy data, and have RS-485 output and impulse output. Electrical energy remote terminal unit would have more than four communication interface and support multi-stipulations, which can communication with different master stations. The communication mode can adapt for network transmission mode, phone dialing and special channel. 2 phone dialing to national electric power dispatching centre would be considered in this project temporarily.

According to relevant technical code, the precision of CTs are 0.2S and PTs are 0.2, the cable voltage drop of PT secondary side is less than 0.2% of rated secondary voltage. CT adopt special coil and PT adopt special coil or unattached circuit.

6 Project Loading

a. The Project load changing rate is the steady rate at which the load can be changed.

Allowable load change rate of the Unit:

The Unit lifetime and performance will not be reduced when load change rate is less than 4%MCR per minute in the range of 40% ~ 100%MCR. The Unit can bear the following load change rate without affecting its stable operation:

- From 50% ~ 100%MCR 5%MCR per minute
- From 30% ~ 50%MCR 3%MCR per minute
- Under 30%MCR 2%MCR per minute
- Load Step 10%MCR per minute

b. Unit load percentage in this Schedule refers to the load at the Generator terminals as a percentage of gross capacity of the respective unit.

c. The Project can operate within the voltage range of ±5% at the 500kV high voltage system. The voltage regulator shall be adjustable continuously in the range of 2.5% of generated rated voltage.

d. The Project can operate with the frequency range given in the table below:

Frequency Range (Hz)	**Time Limitation (second)**
51.0～51.5	>30
48.5～51.0	Continuous
48.5～48	>300
48.0～47.5	>60

e. The Project shall be subject to tripping if frequency and/or voltage fluctuations outside the ranges stated in (c) and (d) occur.

XXII. Control, Metering, Instrumentation and Protection

1 General

1.1 Project description

The project is newly-built power plant .Two coal fired supercritical units with 660 MW capacity will be built.

1.2 Abbreviations

· BOP: Balance of Plant

· BPC: Turbine Bypass Control

· BFPT: Boiler Feed Pump Turbine

· CCR: Central Control Room

· CEMS: Continuous Emission Monitoring System

· CCTV: Close Circuit Television

· DCS: Distributed Control System

· DEH: Digital Electro Hydraulic

· DAS: Data Acquisition System

· ESP: Electrostatic Precipitator

· ESR: Engineer station room

· ETS: Emergency Trip System

· ECS: electric control system

· EER: Electronic Equipment Room

· FSSS: Furnace Safeguard Supervisory System

· FSS: Fuel-firing safety system

· FGD： Flue Gas desulfurization

· HVAC: Heating & Ventilation and Air Conditioning

· I/O: Input / Output

· LVS: Large Video Screen

· LCR: Local Control Room

· MEH: BFPT micro-electro-hydraulic control system

· METS: BFPT micro-emergency trip system

· MTSI： BFPT micro-supervisory instrument

· MCS: Modulating Control System

· NCS: Networked control system

· PLC: Programmable Logic Controller

· SBC: Soot Blower Control

· SCS: Sequence Control System

· SOE: Sequence of Event Recorder

· TSI: Turbine Supervisory Instruments System

· VMS: Vibration Monitoring System

2 Centralized Control and Automation Level

1) Centralized control mode will be adopted for boiler, turbine, generator and NCS. There will be one CCR for the two units. Unit startup/shutdown and isolated island operation can be realized both locally and in CCR. Grid operator station will be arranged in CCR.

2) DCS will be adopted for this project. MCS will be designed as whole-course automatic adjustment for all adjusting systems, except for combustion adjustment which is automatically adjusted only above the lowest stable-combustion load. SCS will be designed according to functional group level, sub-functional group level and drive level.

3) In CCR, the operation management of each unit will be controlled by two or three operators. The DCS operator workstation (including LCD and keyboard/mouse) will be taken as the monitoring and controlling center. Unit startup and shutdown, monitoring & control during normal operation, and handling of emergency & abnormal conditions will be realized with minor intervention and cooperation of shift operators.

4) BOP system (including ash handling system, water treatment system and coal handling system etc.) will be monitored and controlled in LCR by microprocessor based PLC or DCS control equipment(operator station, keyboard and mouse etc.). And BOP PLCs or DCSs will BOP control network which is provided to realize the controlling and monitoring of BOP system through operator station in CCR and with cooperation of field operators. So BOP system can be monitored and controlled either in LCR or CCR.

5) FGD DCS will adopt the same hardware and same supplier as the DCS used for the main plant. The FGD is included in unit Control System. During normal operation, the control and monitoring of FGD can be implemented in CCR and LCR.

3 I&C Automation Configuration

1) DCS is the main control system of each unit. In addition to DCS, there are DEH, ETS, TSI, BFPT MEH, BFPT METS, BFPT MTSI, boiler tube leakage monitoring system, VMS, BOP control network. The details will be shown in Appendix M.23: POWER PLANT CONTROL NETWORK OUTLINE DIAGRAM F06221K-K-01.

2) Each unit will be provided with a set of DCS. The common system of two units will be connected with the unit DCS system respectively. Supervision and control of the common system can be achieved in operator station of either unit, while the other will be blocked at the same time. Each unit DCS includes two sets of large screens, five sets of operator stations (including DEH), and two sets of engineer stations (including DEH).

Unit monitoring control system mainly includes:

(1) Unit DCS. The main functions of DCS include: DAS, MCS, FSSS, SCS, Generator-transformer, ECMS, SBC, bottom ash removal system, and BPC, circulating water pump house are included in the unit DCS, Auxiliary power for common parts of two units, fuel pump control and other common system are included in the common network of two units. Monitoring and control of the common network can be achieved in operator station of each unit, but the operation can put in effect only in the operator station of one unit, while the other one will be blocked at the same time. FSS will adopt triplex level redundancy controller.

(2) Remote I/O will be used for signals relatively concentrated in large quantity such as metal temperature of water wall, superheated and reheated; as well as temperature of generator coil and stator core.

(3) DEH Control System and ETS will be provided by turbine manufacture. Hardware consistent with unit DCS will be adopted as far as possible. ETS will adopt triplex level redundancy controller.

(4) TSI (provided by turbine manufacture) will be connected with DCS/DEH by hardwiring, reserving communication interface with DCS.

(5) BFPT MEH, BFPT METS,BFPT MTSI will be provided along with turbine by BFPT manufacture. MEH and METS adopt the same hardware with unit DCS, and MTSI adopts the same equipment with that of main turbine.

(6) Local monitoring and control instruments (including boiler industrial TV)

(7) SBC is included in the unit DCS, and the soot blower power panel will be provided along with boiler by manufacture.

(8) When serious accident of DCS is happened ,the unit can be shut down safely under the rule of "fail-safety" through the several hardwired emergent push buttons that mounted on the operator console in order to protect persons and equipments. These push buttons will be independent from the DCS.

(9) Boiler PCV control device, furnace smoke temperature measuring system, FSSS equipments (including oil system instrument, angle valve, ignition panel, etc.) will be provided along with boiler by boiler manufacture.

(10) Two units are provided with one set of a boiler tube leakage monitoring system.

(11) CEMS will mainly be intended for analysis of flue gas to the chimney. CEMS will measure the concentration of SO2, NOx, flue dust emissions, O2, CO, flue gas flow, temperature and pressure etc. And the measurement signals will be sent to DCS.

(12) In order to monitor the condition of important large drives, the VMS will be able to perform vibration monitoring of the main shaft associated with the turbine and all important bearings (e.g. feedwater pump etc.). VMS will acquire turbine's data from TSI and other large drives' data from local vibration measuring instruments. And the vibration signals will also be sent to DCS for monitoring. The control cabinet of VMS will be located at EER.

(13) BOP (including ash handling system, water treatment system and coal handling system etc.) will be monitored and controlled in LCR by microprocessor based PLC or DCS control equipment. And BOP PLCs or DCSs will interface with BOP control network which can realize the control and monitoring of BOP systems though operator stations arranged in CCR. So BOP system can be monitored and controlled either in LCR or CCR. Water treatment system includes the following: plant oily water system, raw water pre-treatment system, chlorination system, hydrogen generation station system, boiler feed water treatment system, sea water desalination system, steam-water sampling and chemical dosing system, integrated water treatment system, condensate polishing system, industrial sewage water treatment system and sewage treatment system. Ash handling system includes the following: air compressor system, fly ash handling system, ESP system.

(14) HVAC of central control building will have interfaces (hardwired or communication) with common DCS system.

(15) Two units are provided with one set of a simulation system.

4 CCR and EER

1) The CCR will be arranged in central control building. DCS operator stations, LVS, shift supervisor station and fire alarm panel, BOP PLC or DCS operator station, emergency trip push-buttons, Furnace flame TV, will be laid in CCR. CCR headroom will be about 3.6 m.

Engineering stations will be placed in ESR. Unit DCS, DEH, ETS and TSI cabinets etc. will be laid in EER, which will be located near the respective unit. ESR and EER will also be arranged in the central control building. Detailed equipment arrangement drawing will be submitted during basic design stage.

One central control building common to 2 units will be located between #1 and #2 boiler.

2) Engineer room, shift room, locker room, meeting room etc and relevant auxiliary facilities will be arranged close to CCR for the convenience of operation and management.

3) EER and LCR will be provided for BOP where control cabinets and operator station used for operation testing and inspection will be provided.

5 Information and Security Monitoring System

Information and security monitoring system includes LAN network, CCTV, Access Control System, Anti-intrusion Security System, Fire detection and alarm system, supervisory information system (SIS).

5.1 LAN Network

Local Area Network (LAN) encompassing various plant buildings will be provided. The Station LAN will interconnect with all buildings and will facilitate smooth transfer of data from one building to another. Every office and occupied areas with working staff will be wired with adequate outlets for network access. The main equipments of the system will be set in the communication and network equipment room of main power house.

The LAN network will be installed with CAT 6 cables. Every workplace will have 2 network plugs. Two servers will be installed into one network cubicle. The LAN cables will be connected to the distribution frame connecting with network switch.

5.2 CCTV

CCTV will be installed for the project. The system includes 130 monitoring points (coal handling system is excluded). The CCTV subsystem will be placed at the following areas: turbine house subsystem, central control building subsystem, BOP subsystem, security subsystem. All cabinets for these areas will be placed at local EER.

5.3 Access Control System

Access Control System will be set for the project. The system includes 120 access control points. The access control subsystem will be placed at the following areas: turbine house subsystem, central control building subsystem, BOP subsystem, administration building area subsystem. All cabinets for these areas will be placed at local EER.

5.4 Anti-intrusion Security System

Anti-intrusion Security Systems will be set in the project. Along the plant wall, the system will set 50 infrared radiation protection points and 30 CCTV monitoring points (including in CCTV system).

5.5 Fire detection and alarm system

A fire detection and alarm system will be set for the project. The system will be designed following Chinese fire code, and local related design specifications will be taken as reference. Fire detection and fire alarm zone comprises main power house zone, BOP zone, and non-plant area.

A central control panel will be provided in CCR, and sub panels will be provided in #1 unit zone of turbine house, #2 unit zone of turbine house, water treatment plant zone, coal handling zone and non-plant zone. The central control panel and sub panel will be interconnected to form a looped network. The control and alarm console will be installed in CCR.

5.6 Supervisory Information System

This project set a plant-level supervisory information system (SIS), of which the database points are about 50000 points.

5.7 Management Information System

The project will only set a reserved interface for Management Information System.

6 Configuration of main monitoring and control equipment

1) This project will adopt state-of-the-art DCS control system, since it has high cost/ performance ratio, and can fully utilize system functions. Besides, it can also prolong unit service life, save operation and maintenance expense. Consequently, the producing cost can be reduced, and production managing level and market competitiveness can be improved.

2) Main I&C equipment

(1) Transmitters with internationally recognized brand (smart type) will be adopted.

(2) Critical logic switches of pressure, level, flow and temperature will adopt internationally recognized brands.

(3) Critical analyzers will adopt internationally recognized brands.

(4) High temperature & pressure sampling valve, drain valve will adopt imported product.

3) Actuator

Internationally recognized brands will be adopted for automatic adjusting elements and critical actuators. Intelligent integrated electric actuators will be selected.

7 I&C Laboratory

The instrument configuration and the size of I&C laboratory will be designed complying with DL/T 5004-2010 *Guide for Furnishing Test Apparatus, Maintenance Device and Architectural Area of Fossil Fuel Power Plant*. The laboratory equipment will be configured according to the requirement of I&C system. Special maintenance and testing equipment will be supplied together with individual automatic system.

XXIII. Training & Development

The contractors shall, at its own cost provide training, including on-site and classroom training in the English language, so that such training is complete, no later than twenty-eight (28) months from the Commencement Date, for suitably qualified and experienced O&M Personnel in accordance with Progress Event Schedule, to provide such personnel with the knowledge required to operate the Power Station in accordance with the O&M Manuals, the manufacturer's instructions and guidelines, and the level of competence of a Reasonable and Prudent Operator.

The contractors shall prepare and submit to the Company for approval a draft training manual no later than twelve (12) months from the Commencement Date. The Company shall provide its comment on the Training Manual within thirty (30) days of receiving the same from the contractor and the contractor shall revise the draft Training Manual to accommodate any comments received from the Company as are reasonable and in accordance with the requirements, including the Technical Specifications, and shall within fifteen (15) days of the receipt of final comments from the the Company reissue the Training Manual to the Company for approval.

The contractors shall provide to the Company one (1) copy of the finally approved Training Manual and the electronic file, including the Technical Specifications.

1 TRAINING OF OWNER'S PERSONNEL

(1) The contractors shall undertake to train at site installation, operation and maintenance of the offered plant equipment, free of cost, engineering personnel selected by the Owner. The period and the nature of training for the individual personnel shall be agreed upon mutually between the contractors and the Owner covering the following areas as a minimum in order to enable these personnel to individually take the responsibility of operating and maintaining the power station in a manner acceptable to the Owner:

i) Training on DDCMIS, UPS systems, SWAS, flue gas analysers, as well as other Steam Generators/Turbine Generators/related C&I system equipment including related electrical areas such as generator and excitation system.

ii) Training for special packages for various PLC based systems.

The training shall include all the related areas like design familiarization, training on product design features and product design softwares of major equipment and systems, engineering, manufacturing, erection, commissioning, training on operating features of equipment, quality assurance and testing, exposure to various kinds of operation and maintenance problems.

The contractors shall furnish complete details of the package-wise training at site in all disciplines (viz.) electrical, mechanical, control & instrumentation etc. for Owner's approval. The engineering personnel shall be given special training at site through class room lectures of the equipment manufactured and/or by the collaborators. The engineering personnel should become familiar with the equipment being supplied by

the contractors. The contractors shall also make necessary arrangements for the trainees to get trained on simulators. The exact format of training course shall be mutually discussed and finally subject to approval of the Owner.

It shall be clearly understood that it shall be the duty of the contractors to train the Owner's engineers and operators such as to make them fully fit and proficient to operate and maintain the entire equipment completely satisfactorily during its running. The training shall also cover minor repair works and maintenance works like lubrication, overhauling adjustments, testing and replacement procedures to be adopted for the equipment offered.

(2) The following groups of engineering personnel shall receive training:

a) Plant Management

b) Operation Management

c) Mechanical Maintenance Personnel

d) Electrical Maintenance Personnel

e) Shift Engineers

f) C&I Engineers

g) Other groups as may be indicated by the Owner

(3) Total period for above training shall be forty (40) man-months at manufacturers' works & facilities in China, in accordance with the details specified below. To and fro rail/road/air fare of trainees between the place of posting of the trainees and place of training shall be borne by the Owner. Local transport during the training period, lodging and boarding expenses and other incidental expenses shall be borne by the contractors during the total period of training. The number of trainees in each group shall be decided in mutual consultation with the contractors.

Sl. No.	**Equipment / System**	**Nos. of Person**	**days**	**Man Days**
1.0	BOILER			
	Operation (shall be in operating station in a similar facility in China)	12	20	240
	Maintenance (shall be in operating station in a similar facility in China)	10	10	100
2.0	TURBINE			
	Operation (shall be in operating station in a similar facility in China)	12	10	120
	Maintenance (shall be in operating station in a similar facility in China)	10	10	100
3.0	Turbine Driven BFP	10	5	50
4.0	HCSD System	10	5	50

5.0	Coal Handling System	10	5	50
6.0	Other BOP Area	10	10	100
7.0	GENERATOR	5	10	50
	Excitation System	5	10	50
	Generator Circuit Breaker	5	10	50
8.0	C & I			
	Turbine Control System	4	15	60
	Boiler Control & DCS	4	15	60
	Station C&I (includes DDCMIS)	4	15	60
	Offsite C&I	4	15	60
9.0	**TOTAL MAN DAYS**			**1200**
10.0	**TOTAL MAN MONTH**			**40**

NOTE Site training details will be worked out mutually by the contractors and the Owner after execution of this Agreement, in line with the Agreement.

(4) The contractors shall provide the training equipment and material during training period. All the software, films, video cassettes, transparencies, notes etc. used in the training programme shall remain the property of the Owner at the end of the Agreement.

(5) The contractors shall draw up a preliminary training programme both at site and manufacturer's works to be included in the offer. The detailed training ("Training Manual") programme shall be submitted after execution of this Agreement and shall be subject to the Owner's approval.

The contractor's supervisory and erection personnel deputed to site works shall continuously and intensively instruct and train the Owner's personnel engaged in erection or operation and maintenance of the plant at site during erection, testing and commissioning as well as during operation and maintenance. This shall cover all aspects of site work on the plant including special instructions and care required in attending to various jobs, whether or not they are incorporated in the relevant manuals.

(6) The methodology of imparting training shall be supplemented with computer based training including supply of software packages, etc. shall be provided by the contractors and shall be subject to the Owner's approval.

XXIV Approval of Environmental Study

Reference No. EPA __ Tech/EIA/CFPP/17/2014

ENVIRONMENTAL PROTECTION AGENCY

GOVERNMENT OF SINDH

[illegible]

Date. 17th June, 2014

SUBJECT: - **APPROVAL OF ENVIRONMENTAL IMPACT ASSESSMENT OF PORT QASIM COAL-FIRED POWER PROJECT**

1.	**Name and Address of Proponent:**	Sinohydro (Hong Kong) Holding Company Ltd (as main sponsor). 5001, 50th Floor, Central Plaza, 18 Harbour Road, Wanchai, Hong Kong
2.	**Description of Project:**	Pakistan Port Qasim Coal-fired Power Project(660x2MW). The project is jointly developed by Sinohydro (Hong Kong)Holding Company Ltd and Al Mirqab capital S.P.C. A project company in Pakistan will be established for the development of the project.
3.	**Location of Project:**	Port Qasim, Karachi.
4.	**Date of Filing of EIA:**	30th March, 2014

5. After careful review of the Environmental Impact Assessment (EIA) the Environmental Protection Agency (EPA), Sindh, has decided to accord its approval subject to the following conditions:

(i) The Sinohydro(Hong Kong) Holding Company Limited(hereinafter referred as "proponent") shall comply with all Environmental Quality Standards applicable to the project activities and in force during construction and operation phase of the project.

(ii) Emissions from stacks and the ambient air quality will be monitored to ensure compliance of Environmental Quality Standards in force.

(iii) An Environmental Impact Assessment for effective and environmental friendly ash disposal system will be developed and submitted to Sindh EPA for approval.

(iv) The proponent shall submit quarterly monitoring reports for stack emissions, ambient air quality and wastewater in order to check compliance status of Environmental Quality Standards.

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED ISLAMABAD PAKISTAN

DIRECTOR GENERAL
Environmental Protection Agency
Government of Sindh, Karachi

Always Remember Reduce, Reuse, Recycle

17th June, 2014

(v) The proponent shall ensure installation of proposed emission control measures before commissioning of the power plant.

(vi) A dedicated wastewater treatment plant will be constructed to ensure compliance of the wastewater with Environmental Quality Standards in force.

(vii) Adherence to mitigation measures recommended in the EIA report must be strictly ensured to minimize any negative environmental effect on the ecology of the project area.

(viii) Due to land reclamation activity, a plan will be developed for conservation and rehabilitation of mangroves in the PQA limits. For this purpose proponent will sponsor plantation of mangroves in the existing swamps. This plan should be developed in consultation with the NGOs like WWF and IUCN Pakistan.

(ix) The proponent shall hire an Independent Monitoring Consultant (IMC) having expertise in carrying out Environmental & Social Impact monitoring. IMC shall monitor the implementation of proposed activities against the commitments made in EIA report and during public hearing. The report of the same shall be submitted to SEPA on quarterly basis during construction and annually after commissioning.

(x) Implementation of Environmental management plan, components of mitigation, monitoring, communication and environmental training will be the sole responsibly of proponent.

6. This approval and any considerations thereof shall be treated as null and void, if the conditions are not complied with above mentioned in para-5 and the proponent unreasonably refuses to comply with the conditions after noticed by SEPA.

7. The proponent shall be liable for compliance of EIA/IEE Regulations, in force relating to conditions for approval, confirmation of compliance, entry, inspection and monitoring.

8. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force.

9. The approval is accorded only for the project activity described in the EIA Report. Proponent shall submit separate EIA or IEE as required under regulation for significant and material changes of the design of the project.

10. The approval comes into effectiveness right upon its issuing and will be automatically transferred to the project company after its establishment. All the rights and obligation of the proponent under this approval will be succeeded by the project company.

DIRECTOR GENERAL
Environmental Protection Age
Government Of Sindh

Naeem Ahmed Mughal
Director General

IX. Feasibility Study

F06221K-A-01

Pakistan Port Qasim Coal-fired Power Project

Feasibility Study Report

工程咨询（甲级）	20320070011	质量管理	05014Q20020R3L
工程设计（甲级）	A113005001	环境管理	05014E20017R3L
工程勘察（甲级）	030001-kj	职业健康安全管理	05014S20017R3L

中国电建 POWERCHINA

河北省电力勘测设计研究院
HEBEI ELECTRIC POWER DESIGN & RESEARCH INSTITUTE

August, 2014 SHIJIAZHUANG

PORT QASIM ELECTRIC POWER COMPANY (PRIVATE) LIMITED
ISLAMABAD
PAKISTAN

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CONTENTS

CHAPTER I GENERAL

1.1 Background

Power Construction Corporation of China (Power China) and QInvest (Qatar) plan to jointly invest, build and operate Qasim 2x660MW Thermal Power Plant (the Power Plant or Project) in Port Qasim, in Karachi, Pakistan to promote the development of electric power industry of Pakistan.

1.1.1 Electric Power Development Planning

Pakistan government plans to make new policies to encourage private investment in transmission grid construction and strengthen grid structure.

The coal-fired units installation plan is as follows:

To newly build 4 coal-fired power plants with the total installed capacity of 1240MW in 2015, among which 1000MW will be coal-fired units in Karachi utilizing imported coal and 4274MW will be coal-fired units replacing the oil-fired units;

To build 17 coal-fired power plants with the total installed capacity of 18727MW in 2016~2020, among which 6480MW will be coal-fired units in Karachi utilizing imported coal and 3800MW will be coal-fired units with coal from Tal Coal Mine;

To build Sindh coal-fired power plant with the installed capacity of 5280MW relying on Sindh Coal Mine in 2025;

In 2021 ~2030, the new increased total installed capacity of coal-fired units with coal from Tal Coal Mine will be 15000MW.

In 2030, Pakistan will build hydropower bases in the north, and coal-fired thermal power bases in the south. 500kV AC power grid covers the whole country, and an AC&DC interconnected grid, by which the coal-fired thermal power bases will supply power to the middle and north areas through EHV DC transmission lines.

1.1.2 Role of the Power Plant

The power plant is located near Port Qasim, Karachi in Pakistan and close to southern coastal area. The power plant will be the thermal power base in the south of Pakistan in the future. The units can be directly interconnected with 500kV main grid to meet the power demand of Karachi and could supply power to the middle and north areas.

1.1.3 Site Selection

SEPCO III Electric Power Construction Corporation (SEPCO III) and Hebei Electric Power Design & Research Institute (HBED) started plant site selection and site survey on 23rd

October, 2013 under the guidance of Power China. Pakistan Port Qasim Authority (PQA) provided four candidate plant sites. No.2 plant site was ultimately selected with the comparison of the four sites by site location, coal unloading jetty, and seawater quality and environment analysis.

1.1.4 Letter of Registration and Letter of Intent

The Letter of Registration and Letter of Intent are shown in Appendix E and Appendix F respectively.

1.2 Project Sponsors

The sponsors are Sinohydro Resources Ltd. (SHR), a subsidiary of Power China, and Al Mirqab Group (AMG) a subsidiary of QInvest, Qatar. SHR is responsible for the project implementation.

SHR and AMG establish joint venture with the shareholding of 51% and 49% respectively. SHR will conduct financing from China's financial institution. The proportion of equity and bank loan is tentatively 25%: 75%.

1.2.1 Power China

Power China was restructured in 2011combining Sinodydro、Hydrochina and 58 subsidiaries from China State Grid. The company consists of 14 survey and design institutes, construction companies, manufacturing and maintenance companies originally belonged to Sinohydro Group, Hydro China Corporation, State Grid Corporation of China and China Southern Power Grid. Power China provides comprehensive and full-range of services from investment, financing, planning, investigation, designing, consulting, civil works construction to M&E installation and manufacturing services in the fields of hydropower, thermal power, renewable energy and infrastructure. Power China is a leading company in planning, design, construction, manufacturing, operation and maintenance of hydropower, thermal power, and power transmission and substation in the world.

Power China has registered capital of RMB 30 billion Yuan, total asset of RMB 347.4 billion Yuan with 200,000 employees. In 2013, Power China had annual revenue of RMB 225.7 billion Yuan with the profit of RMB 9 billion Yuan, and ranked 354th in the Fortune 500 and the 16th in the Top 100 Chinese multinational enterprises, the 14^{h} in the world Top 225 international projects contractors and the 15th in the world Top 150 design engineering companies

Power China is also a leader in the field of thermal power, power grid and renewable energy development, such as the design and construction of thermal power projects (1000MW and below), natural gas, solar power, biomass power, distributed energy, nuclear power projects

and AC&DC power transmission and substation projects(1000kV and below).

1.2.2 SHR

SHR is a holding company of SINOHYDRO Group under the management of Power China, and was established in 1st July, 2012 with registered capital of 2.5 billion RMB. Up until the end of 2012, SHR has 2 wholly-owned subsidiaries, 6 holding companies and 1 joint-stock company in 6 countries.

Business Scope of SHR includes the concession of electricity, oil, non-ferrous metal and mineral resources and the investment of real estate, environmental conservation, key infrastructure, the technical consulting services, import-export trade and the contracting of overseas projects.

SHR is a legal entity to execute marketing, project construction, O&M and risk management of overseas investment business on behalf of SINOHYDRO. SHR has superior capability of capital operation and project development in power and mineral resources sectors.

1.2.3 QInvest

QInvest is Qatar's leading financial services firm and, with operations across the Middle East, Africa and Europe, is one of the most prominent Islamic financing institutions in the world. QInvest has built world class investment and advisory capabilities, with the highest standards of governance and transparency underpinning its client-focused approach. The firm's priority is to deliver high-value propositions, considered solutions and tangible results for its clients and shareholders.

QInvest's three business divisions are Investment Banking, Principal Investments and Asset Management. It has unrivalled expertise in structuring Islamic products and provides clients with Sharia'a compliant solutions quickly and competitively.

QInvest was licensed by the Qatar Financial Centre Authority in April 2007 and is authorized by the Qatar Financial Centre Regulatory Authority. QInvest's shareholders include Qatar Islamic Bank and other institutional investors, as well as high-net-worth individuals. The firm has authorized capital of US$ 1 billion and paid up capital of US$ 750 million.

1.2.4 Al Mirqab Group (AMG)

AMG is one of the largest private business groups in the Gulf Region and Qatar. In Qatar the group has extensive interests in several sectors including Financial Institutions, Real Estate, Hospitality, Retail, Transportation & Logistics, Contracting & Construction, Selected Industrial, Business Services etc. The group also actively invests on a global basis both in developed and emerging markets. Investments are in the US, Europe, Asia and the Middle East. Globally the main sectors of investment are Financial Institutions, Real Estate,

Hospitality, Retail and Selected Industrial. Some of the major global investments of the group include Barclays, Credit Suisse, Hyde Park (the most prestigious real estate development in London). Additionally it has one of the largest portfolios of high end Star hotels in Europe. Going forward the group wants to increase its investments in the Energy, Resources/Mining and Infrastructure sectors particularly in the Emerging Markets. Group Turnover and Net Asset Value are several billion US Dollars.

1.3 Study Scope

1.3.1 Project Scope

The project scope includes:

- Water and electricity supply, road construction and ground leveling;
- Power island, BOP and other buildings;
- Seawater intake and discharge facilities;
- Ash yard, including ash transportation road;
- Coal unloading jetty and channel dredging

1.3.2 Study Scope

- Feasibility of the Project according to electrical power demand and planning.
- Unit technology and size selection and its relation with construction conditions.
- External conditions such as geology, hydrometeorology, fuel and transportation, ash handling, water intake and discharge, traffic transportation, grid interconnection, environment protection, etc. and general plot plan.
- Project conceptual design
- Project investment estimation and economic benefit.
- Risk Analysis.

1.4 Study Process

1.4.1 Study Overview

In November 2013, Memorandum for Project Development Agreement was signed between SHR and AI Mirqab Capital

On November 26, 2013, as the sponsor, SHR hold the first liaison meeting to clarify the study scope and formally started the technical and economic evaluation and financing of the project.

On December 4, 2013, Pakistan Private Power Infrastructure Board (PPIB) issued project registration number, which is a key step toward legal procedure.

On December 27, 2013, HBED received Authorization Letter regarding Executing Project Feasibility Study and Preliminary Planning issued by SHR, based on which the project team was established immediately to carry out the concerned work.

In December 2013, topographical, geological exploration and data collection of hydrometeorology were started, topography and hydrometeorology report were finished in middle February, and geological exploration report was completed in March 2014.

From middle of December, 2013 to early January 2014, survey of coal unloading jetty and off-plant coal delivery route was executed in view of finalizing PQA port berth reconstruction plan and the new-built jetty plan. Report about coal unloading jetty was completed on February 10, 2014. The coal unloading jetty plan was reviewed on February 12 by SHR with inclination of the new-built jetty plan, since then the related survey began to carry out.

From January to February, 2014, SHR entrusted the Hagler Bailly Pakistan (HBP) to conduct the preparation of Environment Impact Assessment (EIA) and coordinate with related parties to provide information support. To speed up the project schedule, the EIA is based on the plan of PQA port berth reconstruction. The work will be conducted when the plan of new-built coal jetty and ash yard is determined.

At the end of February, 2014, topographical, geological exploration and hydrological observation of the new-built jetty and sea channel were started at the end of February 2014. Jetty and channel topographical report was completed in mid March, and geological exploration report of the jetty was completed in end April. The hydrological observation report will be finished in October 2014 due to rainy and dry season observation, based on which the feasibility study plan will be reviewed and revised in the future.

From the end of February to early March, 2014, negotiated with Pakistan National Transmission & Dispatch Co. Ltd. (NTDC) for the interconnection scheme and NTDC was entrusted to compile interconnection report.

At the beginning of March, 2014, in order to meet project commercial schedule, it is required to finish the first draft of feasibility study report by March. Therefore, on the premise of incomplete information of geological conditions of power plant, jetty and channel, the ground treatment plan and dredging cost was designed tentatively, based on which the first draft of the feasibility study report was completed on 24, March, 2014.

From 25th March to 27th March, 2014, SHR organized Sinohydro Gansu Energy Investment Co., Ltd, SEPCO III and HBED for the review of the first draft of feasibility study report. The revised report was completed on 11th April with the amendment by HBED and CCCC Third Harbor Consultations Co., Ltd based on the comments from SEPCO III and SHR.

During the survey and site selection in November 2013, HBED and SEPCO III decided to take seawater cooling tower scheme based on the coastal conditions of the site. Both of the preliminary feasibility study report and feasibility study report took this scheme. The review

of cooling scheme was held on 16th, April 2014 to demonstrate the feasibility of seawater once-through cooling scheme. Based on this review and HBP's suggestion. HBED revised the cooling scheme report and still suggest taking seawater cooling tower scheme (one tower for each unit).

The ash yard was supposed to be to the northeast of plant site. about 10 km away and outside the Port Qasim Industrial Area. However. the supposed off-site ash yard was preliminarily selected and the relative land acquisition and environmental impact assessment (EIA) were in process. Therefore. one on-site emergency ash yard which is in the plant site was decided to be built in the left area within the scope of the land requisition after getting approval of the EIA. The final location of off-site ash yard at the supposed area is recommended on 12th, August 2014 after reconnaissance with HBP. The storage capacity of off-site ash yard is planned for 5 years and extension condition by considering the ash and gypsum utilization.

From 18th to 19th June. 2014. SHR organized the internal review meeting in the scope of Power China. Some experts from Henan Electric Power Survey & Design Institute and Sichuan Electric Power Design Institute were invited to take part in the discussion. HBED improved the feasibility study report according to the meeting summary. which could be presented to be external reviewed.

From 6th to 7th July. 2014. China International Engineering Consulting Corporation (CIECC) organized the specialists to carry out the external review meeting in Beijing. The meeting focused on the electric power market demand. construction conditions. the rationality of technical solutions. the ability of the project construction related parties. investment estimation. financial benefit and risk analysis. etc.. based on which CIECC finalized the <Consultation Report> on 11 August. 2014.

HBED revised and closed the feasibility report pursuant to the <consultation report> at end of August. 2014.

1.4.2 Conclusions of Preliminary Feasibility Study

According to the preliminary feasibility study. the project is urgent to meet the of power demand. so it is necessary for the government of Pakistan to accelerate the construction. Considering good condition for realizing the coal unloading jetty in Port Qasim. PQA proposed four sites for the power plant around the port. and required that the final site to be determined soon so that the study work can be carried out timely.

The main conceptual design based on site conditions was as follows:

The coal unloading jetty is tentatively proposed to be built at the sea port berth of Port Qasim owned by PQA. and one 4 km of tubular belt coal conveyor will be installed to convey the

coal to the power plant. The optimized jetty scheme would be determined later based on the port, channel and site conditions during feasibility study stage after getting completed reconnaissance data.

To accelerate geological survey and foundation work, the general plot plan was fixed based on the site topography, main power house was located in the northwest of land area with the highest elevation; BOP workshop was located in the east area with lower elevation; in the southern seawater area, the coal yard was located. Besides, the geological survey for detailed design would be carried out accordingly.

1.5 Project Overview

1.5.1 Location

1.5.1.1 Pakistan Profile

Islamic Republic of Pakistan is South Asia, Pakistan has coastline along the Arabian Sea in the south and is bordered by India to the east, Afghanistan to the west and north, Iran to the southwest and China in the far northeast.

1.5.1.2 City profile

Karachi, where the project is located, is the largest city of Pakistan and the capital city of Sindh. It is the largest seaport and naval port, the center of national industry, commerce, trade and finance, and also the international airport for the travel to Southeast Asia, the Middle East, Africa and Europe.

1.5.2 Study Basis

- *Preliminary Feasibility Study for Pakistan Qasim 2x660MW Coal-fired Power Plant Project* (final copy) (18 December, 2013) confirmed by SHR and SEPCO III.
- *Authorization Letter for Survey and Design of Pakistan Qasim 2x660MW Coal-fired Power Plant* (27 December, 2013) issued by SHR.
- *Registered Letter concerning Qasim 2x660MW Project* issued by Pakistan PPIB on December 4, 2013.
- Chinese *Regulation for Content and Depth of Feasibility Study Report of Fossil Fuel Power Plant* and Chinese laws, regulations, policies and design regulations and specifications, etc.
- *Guidelines on Foreign Investment Cooperation Country (Area) : Pakistan* (2012) issued by Ministry of Commerce of the People's Republic of China
- Pakistan *National Power Policy 2013.*
- Pakistan *Policy for Power Generation Projects Year 2002* and *SALIENT FEATURES OF THE POWER POLICY 2002-1.*

- *Guidelines for setting up of Private Power Projects Under Short Term Capacity Addition Initiative August 2010*
- *Brief Report of Electric Power Development* presented by PPIB to WAPDA (June 11, 2013).
- *Electricity Demand Forecast Period 2011 to 2035* by NTDC.
- *NEPRA Grid Code 2005* issued and published by Pakistan National Electric Power Regulation Agency.
- *Description of 500/220kV Power Grid Protection System 2009.*
- NTDC's reply regarding electric power system in early March, 2013.
- *Grid Interconnection Study for Dispersal of Power from 2x660 MW Coal-Fired Power Plant at Port Qasim* prepared by NTDC.
- *Pakistan EIA Guidelines TPS Oct, 1997.*
- *RO549 I2000-NEQS and SRO-2010-NEQS Air-Water-Noise* —Pakistan national environmental quality legal notices.
- *Environmental Impact Assessment Report EIA* prepared by HBP.
- *Tariff Guidelines for IPP 2005 for* Pakistan private power stations and *Notification in Respect of NEPRA, Upfront Tariff for Project of Imported Coal 2013.*
- The relevant provisions of the tax law in Pakistan.
- *Technical Clarification Response and Site Boundary Map confirmed by PQA on 14 November, 2014.*
- *Parameters of design coal quality* confirmed by SHR. on 16 January, 2014.
- *Boundary map of leased land for power plant* confirmed by SHR. on 6 March, 2014.
- Unit cost of leased land at plant site, leased jetty, manpower, material and machinery collected at the project site by SHR.
- *Limestone characteristics for Power Plant FGD issued by SHR on 4 May, 2014.*
- *Financial Evaluation confirmed by SHR on 4 May, 2014*

1.5.3 Plant Site, Scale and External Conditions

1.5.3.1 Plant site

SEPCO III and HBED started site survey and plant site selection on 23rd October, 2013 under the guidance of Power China. PQA provided four plant sites. No.2 plant site was ultimately selected with the comparison of the four sites by site location, coal unloading jetty, and seawater quality and environment analysis.

The plant site is located in North Coast of Arabian Sea, in Port Qasim Industrial Area in the south-east of Karachi. It is about 37 kilometers from Karachi downtown and about 45

kilometers from the highway.

The area between site plant and Arabian Sea is tidal-flat area. Seaways are separated by mangrove forest. South of the plant site is connected with the Port Qasim Seaway which is on the north of tidal-flat area. North of the plant site is adjacent to the main road of the industrial park. There are spare bushes. weeds and mangroves. and some bare sand land in the site and there is no building. The plant site is flat. the north-west part is high and south-east part is low. Some southeast area is submerged in seawater.

1.5.3.2 Power Plant Scale

The project is a 2 × 660MW power plant and shall be completed in one phase without extension due to limitation of the site size.

1.5.3.3 External conditions

1）Electric Power Demand

According to the forecast of electric power demand, there will be still adequate power demand in Pakistan for this power plant in 2015-2030. Most thermal units in Pakistan now are oil-fired and gas-fired units with high cost. This project is coal-fired power plant; the coal price lower than oil and gas price. So the project is competitive in on-grid tariff.

2）Production Material Supply

The plant site is close to the port and the coal is imported by cargo ship from countries with abundant coal resource around India Ocean, such as Indonesia, South Africa, Botswana and Australia. At mid-long-term the good quality coal of indigenous Thar Coal Mine also can be considered, therefore the coal supply is guaranteed.

Light fuel will be used for unit startup. The fuel oil can be unloaded in Port Qasim and then sent to the power plant by road.

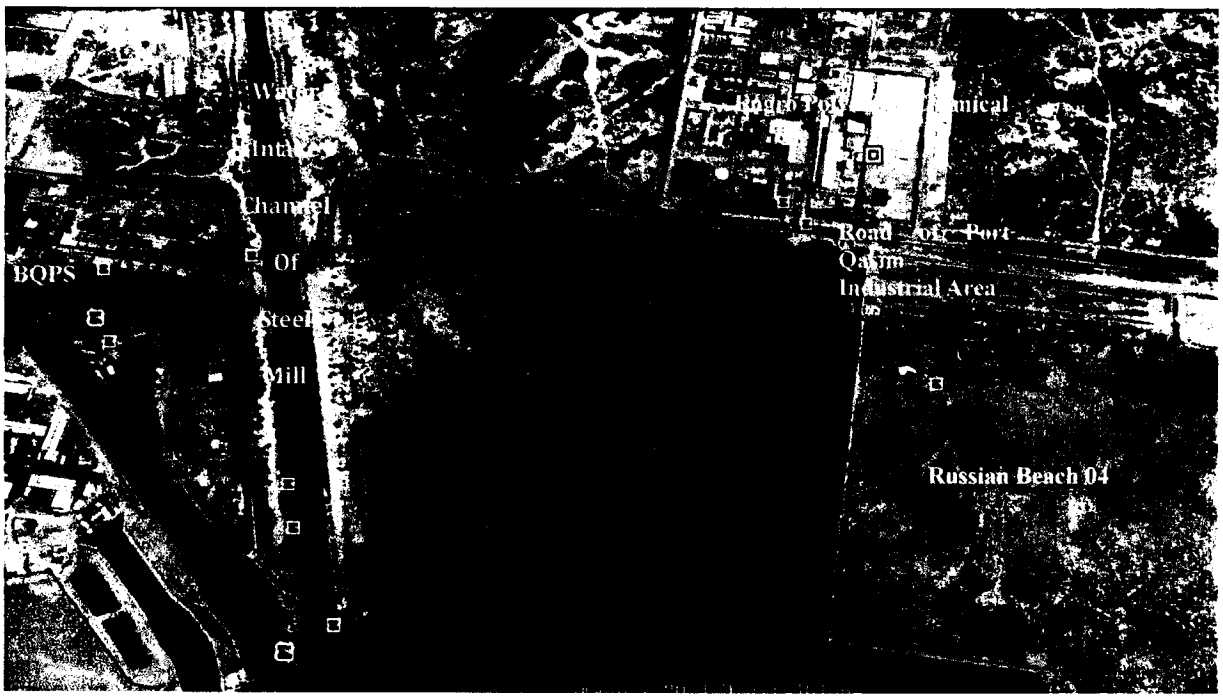
Service and potable water for Power Plant use can adopt desalinated seawater. The ash yard is at the plant site, fly ash and bottom ash which can not be comprehensively utilized will be stored in ash yard.

The limestone storage yard in Northwest Karachi can meet the desulfurization demand of the power plant, since it is about 100 kilometers away from the power plant, the limestone can be transported along the highway to the power plant by trucks. The quality of limestone can meet the desulphurization requirement.

The Bin Qasim Power Station on the west of the power plant has been operating for several years. After surveying the chemicals required by the power plant production can be obtained from the local market and can be transported to the power plant by truck.

3）Plant site

The surroundings of the power plant are shown in the following picture. The area on the east of the plant site is Russian Beach 04. Only backfilling was conducted and no construction was conducted in Russian Beach 04. The area on the north of the plant site is Engro Polymer&Chemical Ltd. and the area on the west of the plant site is Bin Qasim Power Station (BQPS) with water intake channel of Steel Mill passes through. The plant site is 200m away from the water intake channel. The south of the plant site is adjacent to Port Qasim shipping lane leading to Arabian Sea. The north side of the plant site is closed to Port Qasim Industrial Area main road: the site is in the Industrial Area and is suitable for power plant construction.



The plant site is in tidal-flat area at present, with most sections at tidal flat and a small section in the south in shallow sea. The site slops down from northwest to southeast. A north-to-south natural gulley runs through the middle of the plant site, the gulley is wide and shallow and forms swamp. The service wastewater of the steel mill on the northwest of the site and the chemical company on the northeast of the site are discharged through this gulley. Most of the site surface is bare; part of the surface is covered by vegetation. There are mangrove in the north and middle and thorns and weeds in the west. There is an underground natural gas pipeline with the diameter of 760mm stretches from east to the southwest in the plant site. Plant site condition can meet the requirement of power plant construction, also the underground gas pipeline shall be changed the route for the collision avoidance of the plant. .

4）Transportation

Karachi has a favorable transportation condition. There is a concrete road with width of about 15m in favorable condition from the urban to the PQA Industrial Area. The north of plant site is closed to the Industrial Area main road with 7.5m in width. The plant site is about 4 kilometers away from the PQA port with three bridges on the way. The transportation can meet the construction requirements.

Three bridges and turning radius, can not meet the requirement for large and heavy cargo conveyance, therefore, a construction jetty shall be constructed on the south of the power plant. The construction material will be carried by cargo ship with the load of 8000t and there shall be two master cranes with the capacity of 200t on the cargo ship. The large cargo shall be hoisted by master crane and put on the flat truck in the jetty and then be sent to the plant site.

Part of the new-built coal unloaded jetty shall be able to bear large dimensions and weight cargoes. If the plan of PQA port berth reconstruction is adopted, the construction jetty with load of 8000t shall be constructed in the plant site.

5）Hydrology and meteorology

The climate of the plant site area is subtropical monsoon climate, with the extreme maximum temperature of 46 ℃, the minimum temperature of 1.3 ℃, the annual average temperature of 26.4 ℃. The annual average rainfall is about 176mm, and mostly in July and August. The largest rainfall in 24 hours is 278mm in August, 1953. In winter, affected by northeast monsoon from inland, there is more northeast wind, the weather is dry and there is little rain. In summer, the wind has variable direction. Affected by southwest monsoon, the west wind and southwest wind are strong. The climate changes from October to November every year and tropical storm from the Arabian Sea will affect this area.

6）Water source

The south of the plant site is adjacent to the channel leading to Arabian Sea. The water source of the power plant shall be taken from the Qasim bay. The seawater tide level, water quantity, temperature, intake and discharge conditions can meet the requirement of seawater secondary circulating cooling.

7）Ash yard

There shall be on-site emergency ash yard in the plant site, the capacity of which could meet the requirement of the power plant operation for 1.5 years. The off-site ash yard could be built to the northeast of plant site, about 10 km away and outside the Port Qasim Industrial Area. However, the supposed off-site ash yard was preliminarily selected and the relative land

acquisition and environmental impact assessment were in process.

8) Seismic geological condition

According to geological report, the plant site is flat and there is no landslide, collapse, debris flow, adverse geologic actions, goaf and mine in the plant site. The site is stable and is suitable for construction.

There is liquefiable soil layer in the plant site, which unfavorable for earthquake resistance. The plant site is soft soil and the site classification is II. The basic seismic intensity of site is 7 degree and the seismic peak acceleration is 0.16g.

The stratums, within depth of 40.00m in plant site, composed of Quaternary artificial accumulation layer (Q_4^{ml}), Quaternary paralic sedimentary layer (Q_4^{mc}), Quaternary slope eluvium (Q_4^{dl+el}) and Triassic conglomerate (T) on the basis of geological investigation on site.

For the site ground, the upper stratum is weak and poor mechanical properties, and the lower stratum is solid and good physical and mechanical properties, which belongs to the typical dual stratum structure of soft upper and hard lower. Therefore the important building and general building cannot use shallow foundation, the pile or other artificial foundation shall be used.

Main geotechnical engineering issues in proposed site cover ground settlement and deformation of the backfilled area after reclamation and leveling, negative friction resistance upon file foundation acted by backfilling soil and weak layer, and seismic liquefaction of saturated sand, and corrosion of groundwater and ground soil, and shallow groundwater, etc.. In general the overall site seismic geological conditions is not very good, those problems should be solved by engineering means, but needs to increase the project investment.

1.5.4 Main Design Principles

1) Standard: Chinese Codes and Standards are applied for the Project; Environmental protection shall meet the Pakistan standard and Word Bank Standard; Fire fighting and power grid interconnection shall meet Pakistan regulation and standard.

2) Units: 2x660MW supercritical coal-fired wet cooling units; supercritical PC boilers with condensing steam turbine generators;

3) Grid interconnection: the power shall be interconnected to Matiari 500kV substation which is about 180km away from the power plant, with two-circuit of 500kV outgoing lines.

4) Coal supply: Subbituminous coal imported from Indonesia and other countries.

5) Coal unloading jetty: New-built coal unloading jetty or reconstructed coal unloading jetty

of Qasim Port berth with the load of 30,000t, 50,000t and 70,000t are analyzed and 70,000t load of new-built pile type jetty is recommended within the south boundary of the site area.

6) Cooling type: Sufficient comparison and demonstration from such as the environmental impact, project implementation, operation and maintenance, whole life period cost are analyzed and seawater secondary circulating cooling tower of one tower per unit is recommended.

7) Make-up water source: The make-up water for secondary circulating cooling water adopts pretreated seawater; Service water, potable water and fire fighting water adopt desalinated seawater.

8) Flue gas desulfurization(FGD): FGD shall be built together with the power plant; limestone-gypsum wet FGD processing is adopted.

9) Ash yard: There shall be on-site emergency ash yard in the plant site, the capacity of which could meet the requirement of the power plant operation for 1.5 years. The off-site ash yard could be built to the northeast of plant site, about 10 km away and outside the Port Qasim Industrial Area. The initial capacity of off-site ash yard could maintain the power plant operation for 5 years and have enough space to be expanded for hold the operation for 20 years.

10) Startup and Standby power supply: The startup and standby power supply of the units shall connected by 500kV bus in the power plant.

11) Units utilization (power plant factor): The operation period of the power plant is 30 years. The annual utilization hours of the power plant shall be 7200 hrs.

1.5.5 Primary Technical and Economic Data

Plant land occupation: 39.81hm^2

Gross Power plant efficiency: 42.03%

Rate of standard coal consumption for power generation: 292.3g/kW.h

Auxiliary power rate: 8.00%

Number of staff of power plant: 298

Annual power generating capacity: 9504GWh

1.5.6 Technology Selection and Design Standards

1.5.6.1 Technology Selection

(1) Supercritical and Subcritical Technology

The terms "subcritical" and "supercritical" refer to main steam operation conditions being

either below or above the critical pressure of water (221.255 bars). The significance of the critical point is the difference in density between steam and water. Above the critical pressure, the density of water and steam is the same.

The efficiency of supercritical units is higher than that of the subcritical units. The heat rate of the subcritical units with the primary pressure of 173.8 bars is 2% lower than that of the supercritical units with the primary pressure of 248 bar.

As for unit parameters, the increase of initial steam parameters not only involves improvement of thermal efficiency, but also involves overall economic efficiency. Of which, the most important is the amount of investment. The increased investment on increasing initial steam parameters can reduce power generation cost and the increased investment can be recovered within reasonable period. With the increase of fuel cost, the supercritical technology will be more competitive. Therefore, supercritical units will be adopted in this project for higher efficiency and benefit and the reduction of fuel cost.

In China, the supercritical technology was introduced in the 1980s and experienced three generation, the parameters of which were as follows: 24.2MPa,538℃/566℃, 24.2MPa,566℃ /566℃ and 25 (or 26.25) MPa, 600℃/600℃. So far, the quantity of 600MW units adopted the supercritical technology which has been put into service is more than one hundred. Therefore, the supercritical technology has been proven to be more safe and reliable.

（2）Unit Capacity

The unit capacity is 660MW. The unit capacity of the project only takes up a small proportion of the total installed capacity of the system, stability and safety can be assured. For more details, please refer to attached special report, Appendix L.2: Unit Capacity Analysis.

（3）FGD

Limestone-gypsum wet FGD will be adopted in this project. The efficiency shall be not less than 92%.

For more details, please refer to Chapter VI: Flue Gas Desulphurization.

（4）Water Supply

The seawater will be the water source of the power plant. Some seawater taken into the power plant will be used for the make-up water of the C.W. system, the others, after aeration, clarification, ultra filtration (UF) and seawater desalination system treatment, will be used for boiler make-up water treatment, or as service water, potable water, fire fighting water, etc. For more details, please refer to section 5.9 and 5.13.

1.5.6.2 Design Codes and Standards

《Technical Code for Designing Fossil Fuel Power Plant》 GB 50660-2011

《Technical Code for General Plan Transportation Design of Fossil Fuel Power Plant》 DL 5032-2005

《Technical Code for Design of Civil Structure of Fossil-fired Power Plant》 DL 5022-2012

《Technical Code for Design of Waste Water Treatment of Fossil Fuel Power Plant》 DL/T 5046-2006

《Code for Hydraulic Design of Fossil Fuel Power Plant》 DL/T 5339-2006

1.5.7 Heat Balance and Water Balance

The Thermal Flow Diagram for the proposed supercritical units shall refer to the attached Thermal Flow Diagram (F06221K-J01-01). The information on steam driven feedwater pumps, turbine heat rate and steam flow on TMCR condition is included.

Water balance shall refer to the attached Water Balance Diagram (F06221K-S01-02). The water consumption includes: boiler make-up water, coal yard spray water, potable and service water etc.

1.6 Conclusion

With the analysis of the project from the aspect of construction condition, technical scheme, environmental protection, economic benefits and technical and economic risks, the project is feasible. However, there are still potential risks in tariff policy, power consumption and dispatching in a long run, thus, solutions shall be taken in PPA.

CHAPTER II ELECTRIC POWER SYSTEM

2.1 Pakistan Power Grid Overview

2.1.1 Installed Capacity

By the end of 2011, there are 37 main power plants (stations) with the installed capacity of 20,921MW in Pakistan. Among them, there are 31 thermal power plants (29 oil-fired and gas-oiled power plants and 2 coal-fired power plants) with the installed capacity of 13,978MW. These power plants are mainly in the South-Central Pakistan. There are 4 large-sized hydropower stations with the installed capacity of 6,481MW and several small hydropower stations with the total installed capacity of 108MW. These hydropower stations are mainly in the North Pakistan. Tarbela hydropower station with the installed capacity of 3,478MW is the largest hydropower station in Pakistan. There are 2 nuclear power stations with the installed capacity of 462MW. The utilization of wind energy develops fast recently, other renewable energy like wind energy, solar energy and biomass haven't been widely utilized.

In 2013, Pakistan's total installed capacity was 23,663MW, 28.85% were hydropower with the installed capacity of 6,826MW; 67.62% were thermal power with the installed capacity of 16,000MW; 3.33% were nuclear power with the installed capacity of 787MW; 0.21% were wind power with the installed capacity of 50MW.

2.1.2 Power Grid

The design, construction and maintenance of substations, and transmission lines are conducted by NTDC and KESC in Pakistan. At present, power grid has covered all the large cities.

The voltage level of Pakistan power grid includes 500kV, 220kV, 132kV, 66kV, 33kV and 11kV.

By the end of 2013, there were 16 500kV substations with the total capacity of 15750MVA; 29 220kV substations with the total capacity of 18231MVA.

By the end of 2013, the total length of 500kV and 220kV transmission lines are 5143km and 8309km separately.

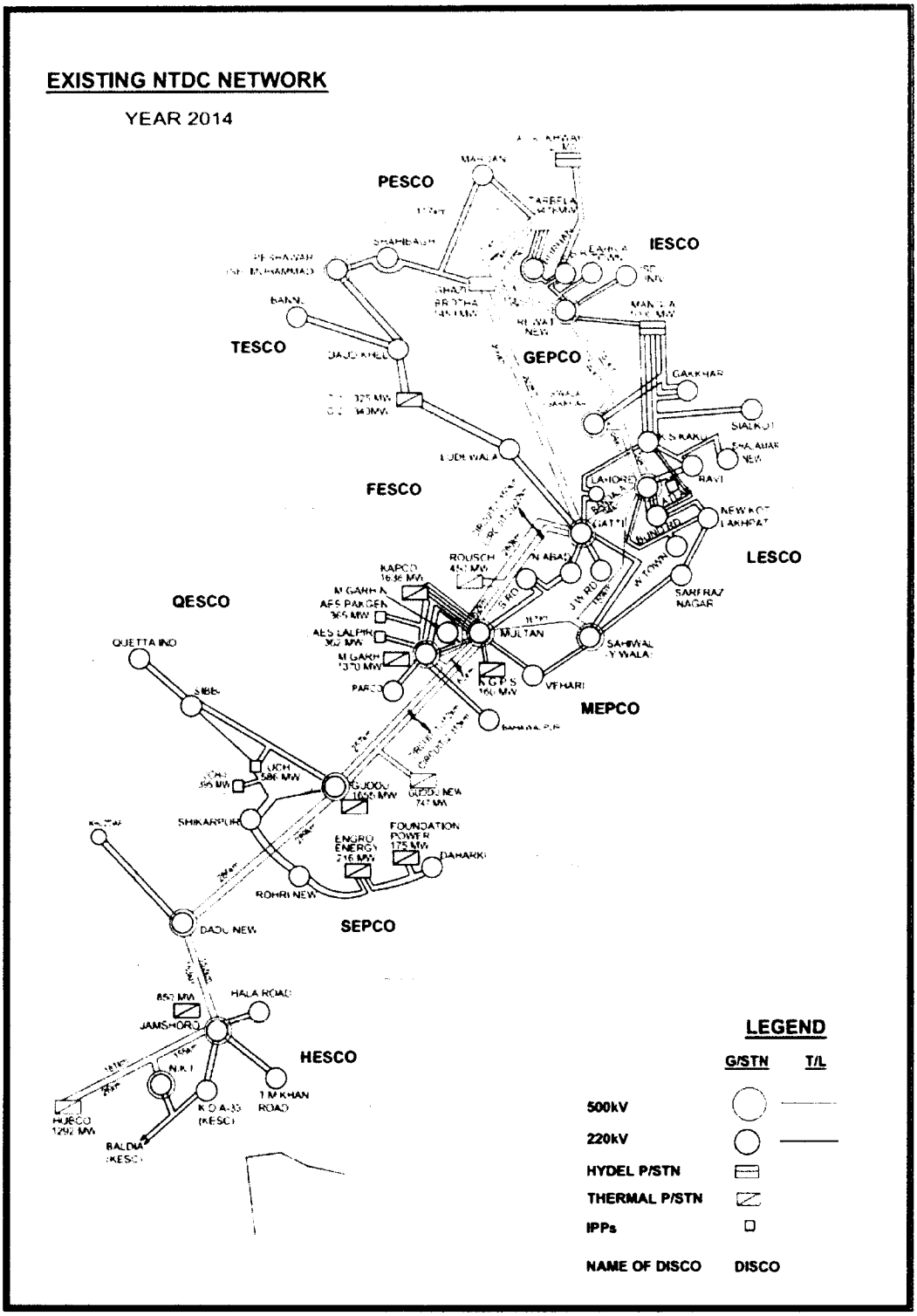


Figure 2.1-1 Pakistan Power Grid

2.1.3 Deficiency of Pakistan Power Grid

(1) Large transmission loss. Most hydropower stations in Pakistan are located in northern area. The electricity loads are mainly in large and medium-sized cities located in the south of the

northern mountainous area. The power loss rate is 20 ~25% due to the long transmission distance, various voltage level of transmission lines, overload operation of power system, aging equipment and electricity stealing.

(2) Inappropriate constitution of power system. There are abundant water resources in Pakistan, while there are few large hydropower projects except those constructed in 1960s-1970s. Most new constructed projects are thermal power projects. At present, the proved reserves of petroleum, natural gas are limited in Pakistan. With the continuous rise in oil and gas prices, the power generation cost rises and the raw materials are in short supply.

(3) Inappropriate tariff, the government has a heavy burden. Thermal power generation is dominant in Pakistan's power supply (67.4%). Most of them are oil-fired and gas-fired. In recent years, with the continuous rise in international oil and gas prices, the power generation cost has increased rapidly. The fuel oil and gas cost takes 40% of power generation cost. In order to minimize the impact from the rising tariff on enterprise operation and people's living; the government has to pay huge financial subsidies every year. In the fiscal year of 2006~2007, subsidies for the electric power sector were 1 billion US dollars.

2.1.4 Analysis of Electric Power Demand

In 2013, the effective capacity of thermal power units and nuclear power units were 14,357MW and 750MW respectively.

In 2013, the maximum load of PEPSO/NTDC is 18,827MW. Supoose thet the maximum load of K-Electic maintain the level of 2012 which is 2,596MW. With the coefficient of 0.93, the maximum load of Pakistan is 19,923MW.

In 2012, gas-fired power generation accounted for 44.78% of the whole thermal power generation in Pakistan, oil-fired power generation accounted for 55.12%, and coal-fired power generation accounted for 0.17%. The low-cost coal-fired power generation took small proportion. It can be expected until 2013 that the above data remain the basic level without obvious development.

The insufficient power supply is mainly caused by two factors: Firstly, the Pakistan lags behind in power grid construction; the large transmission loss and electricity stealing take nearly 25% of the total power supply; Secondly, the existing oil-fired and gas-fired power plants cannot be fully utilized due to the oil and gas shortage. In 2012, 2,221MW cannot be fully utilized due to the energy shortage.

As per *Demand and Supply Study 2011*, statistics of Pakistan power supply and power consumption of 2000~2010 are shown in Table 2.1-1 and Table 2.1-2, average annual growth rate of power consumption was about 4.9% , the average annual economic growth rate of the

same period was 6.5% and elastic coefficient was 0.754.

Table 2.1-3 shows the change of per capita power consumption. In 2000 ~2010, the per capita power consumption fluctuated due to the unstable economic development, and the growth rate of per capita power consumption was only 0.7%.

Table 2.1-1 Statistics of 2000~2010 Pakistan Power Supply Unit: GWh

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
67319	70132	72975	76656	82486	87113	96725	102075	101458	99645	104981

Table 2.1-2 Statistics of 2000~2010 Pakistan Power Consumption Unit: GWh

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
45500	48496	50594	52595	57468	61278	67629	71942	72519	69669	73596

Table 2.1-3 Statistics of 2000~2010 Pakistan Per Capita Power Consumption Unit: kWh

2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
389	399	394	413	391	324	431	452	395	388	391

According to the economic status and development planning of Pakistan, the GDP was 179 billion US dollars in 2012 and was planned to achieve 700 billion US dollars in 2030.. The average growth rate of GDP is expected to be 7.84% in 2012 ~2030. With the elastic coefficient of 0.754, the growth rate of annual power consumption of Pakistan is 5.91% in 2012 ~2030.

In Demand and Supply Study 2011, forecasts of power demand and peak load have been developed. The average annual growth rate of power consumption in high, normal and low scenarios are 8.62%, 7.68% and 6.43% respectively to the year of 2030, and the average annual growth rate of peak load in high, normal and low scenario are 8.87%, 7.92% and 6.67% respectively to the year of 2030.

In this project, the growth rate of peak load and power consumption is 6.43%, 5.91% and 4.9% in high, normal and low scenario.

The Pakistan power forecasts in high, normal and low levels are shown in Table 2.1-4a, Table 2.1-4b, and Table 2.1-4c.

Table 2.1-4a 2013~2030 Pakistan Power Consumption Forecast (High) Unit: MW, GWh

	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Load	19923	21252	22669	24181	25794	27515	29350	31308	43238	59714
Power Consumption	118630	126543	134983	143986	153590	163835	174763	186419	257455	355561

Table2.1-4b 2013~2030 Pakistan Power Consumption Forecast (Normal) Unit: MW, GWh

	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030
Load	19923	21100	22347	23668	25067	26548	28117	29779	39682	52879
Power Consumption	118630	125641	133066	140931	149260	158081	167423	177318	236286	314864

Table 2.1-4c 2013~2030 Pakistan Power Consumption Forecast (Low) Unit: MW, GWh

	2013	2014	2015	2016	2017	2018	2019	2020	2025	2030

Load	19923	20899	21923	22998	24124	25307	26547	27847	35389	44952
Power Consumption	118630	124443	130541	136937	143647	150686	158069	165815	210620	267533

2.2 Plan of Pakistan Power Supply Construction

The Pakistan Government made short-term, medium-term and long-term plans based on *National Power Policy 2013* and current power system. .

The short-term plan: 1. Increase the supply of oil and gas to improve the units performance, so as to increase 700MW generated output; 2. Settle the debt and put the current power plant project into operation, so as to increase 1700MW generated output; 3. Import electricity from countries like India and Iran; 4. Make new power policy such as new power transmission policy and give space to private investors to change the status of power transmission and decrease power transmission loss.

The medium-term plan: provide fund for investors and meantime accelerate the feasibility study and analysis of thermal and hydropower projects.

The long-term plan: 1. Build thermal power base with the units capacity of 1000MW in the southern coastal area of the country, the base will be supported by the imported coal; 2. Build 1000MW thermal power base in Sindh; 3.Build liquefied natural gas thermal power base; 4. Build hydropower base with the units capacity of 1000MW in Indus River basin; 5. Suppressing high energy consumption units.

The coal-fired units installation plan: build 4 coal-fired power plants with the total installed capacity of 1240MW in 2015, among which 1000MW will be imported coal-fired units in Karachi and 4274MW will be coal-fired units replacing the oil-fired units; build 17 coal-fired power plants with the total installed capacity of 18727MW in 2016~2020, among which 6480MW will be imported coal-fired units in Karachi and 3800MW will be Tal Coal-fired units; build Sindh coal-fired power plant with the installed capacity of 5280MW relying on Sindh Coal Mine in 2025; In 2021 ~2030, the new increased total installed capacity of Tal coal-fired units will be 15000MW

The planned gas-fired installed units: build 5 new power plants with the total installed capacity of 1285MW in 2013 ~2015 and 3 new power stations with the total installed capacity of 2260MW in 2016 ~2020.

The planned cogeneration installed units: build 2 new power plants with the total installed capacity of 160MW in 2015 and 3 new power plants with the total installed capacity of 285MW in 2016.

The hydropower units installation plan: build 8 new hydropower stations with the total

installed capacity of 602MW in 2013~2015. 25 new hydropower stations with the total installed capacity of 20458MW in 2016~2020. 3 new hydropower stations with the total installed capacity of 7890MW in 2021~2025. and 4 new hydropower stations with the total installed capacity of 6170MW in 2026~2030.

The planned nuclear power installed units : build one new nuclear power station with the installed capacity of 1100MW in Karachi in 2018 ~2019. and one new nuclear power station with the installed capacity of 1100MW in Karachi in 2019 ~2020.

The planned wind and solar power installed units: increase 1600MW wind power generating capacity and 1000MW photovoltaic power generating capacity in 2013 ~2020. Currently. some of the feasibility study is in progress.

Details of Pakistan power supply installation plan are shown in Table2.2-1. Table 2.2-2. Table 2.2-3 and Table 2.2-4.

Table 2.2-1 Part of Planned Pakistan Gas-fired Units Unit: MW

Gas-fired Power Plants	Installed capacity	Commissioning Time	Status
UCH-II	404	2014	In progress
Guddu(1)	243	2014	None
Guddu Steam(2)	243	2014	None
Guddu Steam(3)	261	2014	None
Star Thermal	134	2015	Financial closing
Kandra	120	2016	Tariff Determination/negotiation
Odean	140	2020	Registered/approved for processing
1000MW Gas-fired Power Plants	2000	2020	None
Total	3545		

Table 2.2-2 Part of Planned Pakistan Coal-fired Units Unit: MW

Coal-fired Power Projects	Installed capacity	Commissioning Time	Status
JDW	80	2015	Tariff Determination/negotiation
Ramzan	100	2015	Tariff Determination/negotiation
Janpur	60	2015	Tariff Determination/negotiation
Karachi (Public Sector)	1000	2015	None
Fatima	100	2016	Tariff Determination/negotiation
Tal（IPP）	1200	2016	None
Chishtia	65	2016	Tariff Determination/negotiation

Dewan	120	2016	Tariff Determination/negotiation
Coal Plant at Sahiwal	1200	2017	None
Oracle Coalfields Thar	600	2017	None
Green Field Coal Thar(Phase-1)	660	2017	None
China Power International Holding	1200	2017	None
Engri Thar Coal	600	2017	None
Bin Qasim PP	1200	2016	Be related to this project
Tal（IPPs）	2600	2018	None
Gadani(1)	1322	2017	Negotiation
Gadani(2)	5280	2018	Negotiation
TPS Jamshoro (Unit Add.)Phase-1	660	2018	None
TPS Jamshoro (Unit Add.)Phase-2	660	2019	None
Green Field Coal Thar(Phase-2)	660	2019	None
Engro Thar Coal	600	2019	None
Gadani	5280	2020	None
Sindh	5280	2025	None
Long-term Planned Project	15000	2030	None
Total	40247		

Table 2.2-3 Planned Pakistan Cogeneration Units Unit: MW

Cogeneration Projects	Installed capacity	Commissioning Time	Status
Janpur Energy Ltd.	60	2015	Registered
Ramzan Energy Ltd.	100	2015	Registered
Chishtia Power	65	2016	Registered
Fatima Energy Ltd	100	2016	Registered
Dewan Energy Ltd.	120	2016	Registered
Total	445		

Table 2.2-4 Part of Planned Pakistan Hydropower Units (Unit: MW)

Hydropower Projects	Installed capacity	Commissioning Time	Status
NEWBONG HPP	84	2014	In progress
DUBER khwar HPP	130	2014	None
New Hydroelpower Projects(6 projects)	388	2015	None
PATRIND HPP	147	2016	In progress
Neelum Jhelum Hydel	969	2016	None
Golen Col HPP	106	2016	None
Rajdhani	132	2017	Financialclosed
GULPUR HPP	100	2017	Financial closed
Phandar Hydro	80	2017	None

Hydropower Projects	Installed capacity	Commissioning Time	Status
Extension of Tarbela	1910	2017	None
Kotli	100	2017	Financial closed
Sehra	130	2017	Tariff Determination /negotiation
Chakothi-Hattian	500	2017	Tariff Determination /negotiation
KAROT HPP	720	2017	Tariff Determination /negotiation
Keyal Khwar	122	2017	None
Gulpurpoonch river	100	2017	None
SUKI KINARI	840	2018	Financing closed
Madian	157	2018	Tariff Determination /negotiation
Asrit-Kedam	215	2018	Tariff Determination /negotiation
Azad Patan	640	2018	Tariff Determination /negotiation
KOHALA	1100	2018	Tariff Determination /negotiation
Kaigah	548	2019	Feasibility study
Dasu	2160	2019	None
Lower Pallas Valley	665	2019	None
Bunji	7360	2020	Feasibility study finished
SPATGAH	496	2020	Feasibility study finished
PALASVALLEY	665	2020	Feasibility study finished
Lower Spat Gah	496	2020	None
Mahl	590	2025	Preliminary work
Diamer-Bhasha	4500	2025	None
Dasu	2160	2025	None
Patan	2800	2025	None
Thakot	2800	2030	None
Yulbo	2200	2030	None
Tungus	500	2030	None
Rakhiot Yugo	670	2030	None

Hydropower Projects	Installed capacity	Commissioning Time	Status
Total	35120		

If all the planned projects are taken into consideration, it is shown in Table 2.2-5 and Table 2.2-6 that the thermal power units capacity (49.6% are coal-fired units capacity and 4.4% are gas-fired units capacity) accounts for the most (54%) in the new increased installed capacity in 2014~2030. Hydropower units and nuclear power units account for 43.3% and 2.7% respectively.

If only considering the projects which are in progress, finical closed and negotiating, Hydropower units capacity accounts for 38.8% in the new increased installed capacity, coal-fired units capacity accounts for 38.3%, gas-fired units capacity accounts for 5.3% and nuclear units capacity accounts for 17.6%.

Table 2.2-5 New Increased Capacity in Pakistan (Considering All the Planned Projects)

Unit: MW, %

Item	New Increased Installed Capacity in 2014~2030	
	Capacity	Percentage
Coal-fired	40247	49.6
Gas-fired	3545	4.4
Oil-fired	0	0
Nuclear power	2200	2.7
Hydropower	35120	43.3
Total	81112	100

Table 2.2-6 New Increased Capacity in Pakistan (Projects in progress, Tariff Determined and Negotiating) **Unit: MW, %**

Item	New increase of capacity in 2014~2030	
	Capacity	Percentage
Coal-fired	4799（including 4274 of replacing oil with coal）	38.3
Gas-fired	658	5.3
Oil-fired	0	0
Nuclear power	2200	17.6
Hydropower	4865	38.8
Total	12522	100

2.3 Power Load Forecast and Electric Power Market Demand

2.3.1 Forecast of Electric Power Demand

(1) Electric power demand is forecasted based on the load level showed in Table 2.1-4. All the

wind power and solar power projects are excluded. Thermal and hydropower projects which are without status listed or in the status of preliminary work are excluded too. Details of power installations and schedule are shown in Table 2.2-1~2.2-4.

(2) Year 2015~2020, 2025 and 2030 are calculated: wet season (high rain period) and dry season (low water period) are considered.

(3) Load forecast value is taken for the load value in wet and dry season (Three scenarios of high, normal and low according to different growth rate). And 10% and 5% of the peak load are taken respectively as emergency load reserve value and maintenance load reserve value, both are hot reserve.

(4) In wet season, hydropower units operate with full installed capacity considering 10% as the proportion of auxiliary power and thermal power units operate in full output.

(5) In dry season, hydropower units operate with 55% of the installed capacity, and thermal power unit operate in full output.

2.3.2 Forecast of Electric Power Market Demand

Table 2.3-1a Pakistan Electric Power Demand Forecast (High) Unit: MW

	2013		2015		2016		2017		2018		2019		2020		2025		2030	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
I System gross demand	22911	22911	26070	26070	27809	27809	29663	29663	31642	31642	33753	33753	36004	36004	49723	49723	68671	68671
1) Peak load	19923	19923	22669	22669	24181	24181	25794	25794	27515	27515	29350	29350	31308	31308	43238	43238	59714	59714
2) System reserve capacity	2988	2988	3400	3400	3627	3627	3869	3869	4127	4127	4403	4403	4696	4696	6486	6486	8957	8957
II Planned power supply installed capacity	21993	21993	22855	22855	23545	23545	25227	25227	28179	28179	29279	29279	31540	31540	32130	32130	32130	32130
1) Hydropower	6826	6826	6910	6910	7195	7195	8877	8877	11829	11829	11829	11829	12990	12990	13580	13580	13580	13580
2) Thermal power	14417	14417	15195	15195	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600
3) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
III Accessible capacity	21327	18921	22164	19746	22826	20307	24339	21232	26996	22856	28096	23956	30241	25695	30772	26019	30772	26019
1) Hydropower	6160	3754	6219	3801	6476	3957	7989	4882	10646	6506	10646	6506	11691	7145	12222	7469	12222	7469
2) Thermal power	14417	14417	15195	15195	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600
3) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
IV Electricity profit and loss (+profit, -loss)	-1585	-3990	-3906	-6324	-4983	-7501	-5324	-8431	-4646	-8786	-5656	-9797	-5763	-10309	-18951	-23704	-37899	-42652

Table 2.3-1b Pakistan Electric Power Demand Forecast (Normal) Unit: MW

	2013		2015		2016		2017		2018		2019		2020		2025		2030	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
I System gross demand	22911	22911	25700	25700	27218	27218	28827	28827	30531	30531	32335	32335	34246	34246	45635	45635	60811	60811
1) Peak. load	19923	19923	22347	22347	23668	23668	25067	25067	26548	26548	28117	28117	29779	29779	39682	39682	52879	52879
2) System reserve capacity	2988	2988	3352	3352	3550	3550	3760	3760	3982	3982	4218	4218	4467	4467	5952	5952	7932	7932
II Planned power supply installed capacity	21993	21993	22855	22855	23545	23545	25227	25227	28179	28179	29279	29279	31540	31540	32130	32130	32130	32130
1) Hydropower	6826	6826	6910	6910	7195	7195	8877	8877	11829	11829	11829	11829	12990	12990	13580	13580	13580	13580
2) Thermal power	14417	14417	15195	15195	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600
3) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
III Accessible capacity	21327	18921	22164	19746	22826	20307	24339	21232	26996	22856	28096	23956	30241	25695	30772	26019	30772	26019
1) Hydropower	6160	3754	6219	3801	6476	3957	7989	4882	10646	6506	10646	6506	11691	7145	12222	7469	12222	7469
2) Thermal power	14417	14417	15195	15195	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600
3) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
IV Electricity profit and loss (+profit. -loss)	-1585	-3990	-3536	-5954	-4393	-6911	-4488	-7595	-3535	-7675	-4239	-8379	-4005	-8552	-14863	-19616	-30039	-34792

Table 2.3-1c Pakistan Electric Power Demand Forecast (Low) Unit: MW

	2013		2015		2016		2017		2018		2019		2020		2025		2030	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
I System gross demand	22911	22911	25212	25212	26447	26447	27743	27743	29102	29102	30529	30529	32024	32024	40697	40697	51694	51694
1) Peak. load	19923	19923	21923	21923	22998	22998	24124	24124	25307	25307	26547	26547	27847	27847	35389	35389	44952	44952
2) System reserve capacity	2988	2988	3288	3288	3450	3450	3619	3619	3796	3796	3982	3982	4177	4177	5308	5308	6743	6743
II Planned power supply installed capacity	21993	21993	22855	22855	23545	23545	25227	25227	28179	28179	29279	29279	31540	31540	32130	32130	32130	32130
1) Hydropower	6826	6826	6910	6910	7195	7195	8877	8877	11829	11829	11829	11829	12990	12990	13580	13580	13580	13580
2) Thermal power	14417	14417	15195	15195	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600
3) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
III Accessible capacity	21327	18921	22164	19746	22826	20307	24339	21232	26996	22856	28096	23956	30241	25695	30772	26019	30772	26019
1) Hydropower	6160	3754	6219	3801	6476	3957	7989	4882	10646	6506	10646	6506	11691	7145	12222	7469	12222	7469
2) Thermal power	14417	14417	15195	15195	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600	15600
3) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
IV Electricity profit and loss (+profit, -loss)	-1585	-3990	-3048	-5466	-3622	-6140	-3404	-6511	-2106	-6247	-2432	-6573	-1783	-6330	-9925	-14678	-20922	-25675

Table 2.3-1 shows that if only consider the projects which are in process, financial closed and in negotiating, when load average annual growth rate is 6.43% (high scenario), **Pakistan Electric Power Demand will be 8431MW in 2017**. When load average annual growth rate is 5.91% (normal scenario), **Pakistan Electric Power Demand will be 7595MW in 2017**. When load average annual growth rate is 4.9% (low scenario), **Pakistan Electric Power Demand will be 6511MW in 2017**.

Therefore, in the year of 2017 when this project is put into operation, there will be adequate electricity market demand in Pakistan.

2.3.3 Electric Power and Energy Balance

Annual utilization hours of this power plant can be forecasted by electric power and energy balance.

(1) Electric power and energy balance is carried out in normal scenario.

(2) Since the preliminary work of most planned projects haven't been conducted, the electric power and energy balance is based on 2.3-1b with reasonable assumption of planned power supply project progress. Details of the new increased power installed capacity during 2015~2030 are shown in Table 2.3-2.

(3) Year 2015~2020, 2025 and 2030 are calculated; wet season (high rain period) and dry season (low water period) are considered.

(4) Load forecast value is taken for the load value in wet and dry season (Three scenarios of high, normal and low according to different growth rate). And 10% and 5% of the peak load are taken respectively as emergency load reserve value and maintenance load reserve value, both are hot reserve.

(5) In wet season, hydropower units operate with full installed capacity considering 10% as the proportion of auxiliary power and thermal power units operate in full output.

(6) In dry season, hydropower units operate with 55% of the installed capacity, and thermal power unit operate in full output.

表 2.3-2 Increased Power Installation Based on Forecast of Electricity Market Demand : MW

Item	2015	2016	2017	2018	2019	2020	2025	2030
Coal-fired	5900	1050	700	150	700	150	8300	14800
Gas-fired	0	0	0	0	0	0	0	0
Oil-fired	0	0	0	0	0	0	0	0
Nuclear power	0	0	0	0	0	0	0	0
Hydropower	0	0	0	0	0	1161	5000	1000
Total	**5900**	**1050**	**700**	**150**	**700**	**1311**	**13300**	**15800**

2.3.4 Result of Electric Power and Energy Balance

Table 2.3-3 Pakistan Electric Power and Energy Balance Unit: MW

	2013		2015		2016		2017		2018		2019		2020		2025		2030	
	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season	Wet season	Dry season
I System gross demand	22911	22911	25700	25700	27218	27218	28827	28827	30531	30531	32335	32335	34246	34246	45635	45635	60811	60811
1) Peak. load	19923	19923	22347	22347	23668	23668	25067	25067	26548	26548	28117	28117	29779	29779	39682	39682	52879	52879
2) System reserve capacity	2988	2988	3352	3352	3550	3550	3760	3760	3982	3982	4218	4218	4467	4467	5952	5952	7932	7932
II Planned power supply installed capacity	21993	21993	28755	28755	30357	30357	32739	32739	35841	35841	37641	37641	40052	40052	53942	53942	69742	69742
1) Hydropower	6826	6826	6910	6910	7057	7057	8739	8739	11691	11691	11691	11691	12852	12852	18442	18442	19442	19442
2) Coal-fired	150	150	10564	10564	11899	11899	12599	12599	12749	12749	13449	13449	13599	13599	21899	21899	36699	36699
3) Gas-fired and oil-fired	14267	14267	10531	10531	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651
4) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
III Accessible capacity	21327	18863	28064	25646	29651	27181	31865	28806	34672	30580	36472	32380	38767	34269	52098	45643	67798	60993
1) Hydropower	6160	3696	6219	3801	6351	3881	7865	4806	10522	6430	10522	6430	11567	7069	16598	10143	17498	10693
2) Coal-fired	150	150	10564	10564	11899	11899	12599	12599	12749	12749	13449	13449	13599	13599	21899	21899	36699	36699
3) Gas-fired and oil-fired	14267	14267	10531	10531	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651	10651
4) Nuclear power	750	750	750	750	750	750	750	750	750	750	1850	1850	2950	2950	2950	2950	2950	2950
IV Electricity profit and loss (+profit, -loss)	-1585	-4049	2364	-54	2433	-37	3038	-21	4141	49	4137	45	4521	22	6463	8	6987	182

Table 2.3-4 Pakistan Energy Balance Unit: GWh

Year	2012	2015	2016	2017	2018	2019	2020	2025	2030
I Total Electricity Consumption	118630	133066	140931	149260	158081	167423	177318	236286	314864
II Generating capacity of coal-fired units	1045	66565	73451	74716	71139	74439	71757	107247	181625
III Generating capacity of hydropower	30047	29098	29715	36779	49178	49178	54054	77532	81732
IV Generating capacity of nuclear power	5507	5507	5507	5507	5507	11550	19250	19250	19250
V Generating capacity of oil and gas fired units	81727	31593	31953	31953	31953	31953	31953	31953	31953
VI Generating capacity of new energy	8	8	8	8	8	8	8	8	8
VII Electric power from foreign countries	296	296	296	296	296	296	296	296	296
VIII Installed capacity of coal-fired units	150	10564	11899	12599	12749	13449	13599	21899	36699
IX Utilization hours of coal-fired units	6966	6301	6173	5930	5580	5535	5277	4897	4949

According to Table 2.3-3、2.3-4, annual utilization hours of coal-fired units will be 5930 hours in 2017, 4897 hours in 2025 and 4949 hours in 2030.

Therefore, the utilization hours of coal-fired units will be about 5500h in 2017~2030 when the power demand-supply is balanced in Pakistan grid.

2.4 Pakistan Grid Planning

According to *National Power Policy 2013*, the plan of grid development is concentrated on reducing transmission loss. Firstly, updating SCADA software and optimizing current transmission structure; Secondly, take transmission loss into consideration in the process of power dispatching; thirdly, construct small and medium power plants in the area with large load demand; fourthly, strengthen 220kV loops in major cities of the country; fifthly, extend the national HV grid northward.

In 2013~2020, Pakistan will build 69 circuits of 500kV lines (7480km), 500kV/220kV main transformers with the capacity of 18150MVA , 7 circuits of ±600kV HVDC lines (5100km in total), 1 circuit of ±500kV HVDC lines(100km).

Pakistan will make new policies to encourage private investment in transmission grid construction and change the current management to break monopoly and raise efficiency through competition.

According to the collected data from other consulting companies, in 2030, Pakistan will build hydropower bases in the north, and coal-fired thermal power bases in the south. 500kV AC

power grid covers the whole country, and an AC&DC interconnected grid, in which the coal-fired thermal power base will deliver power to the middle and north areas through EHV DC lines.

Details are shown in Figure 2.4-1.

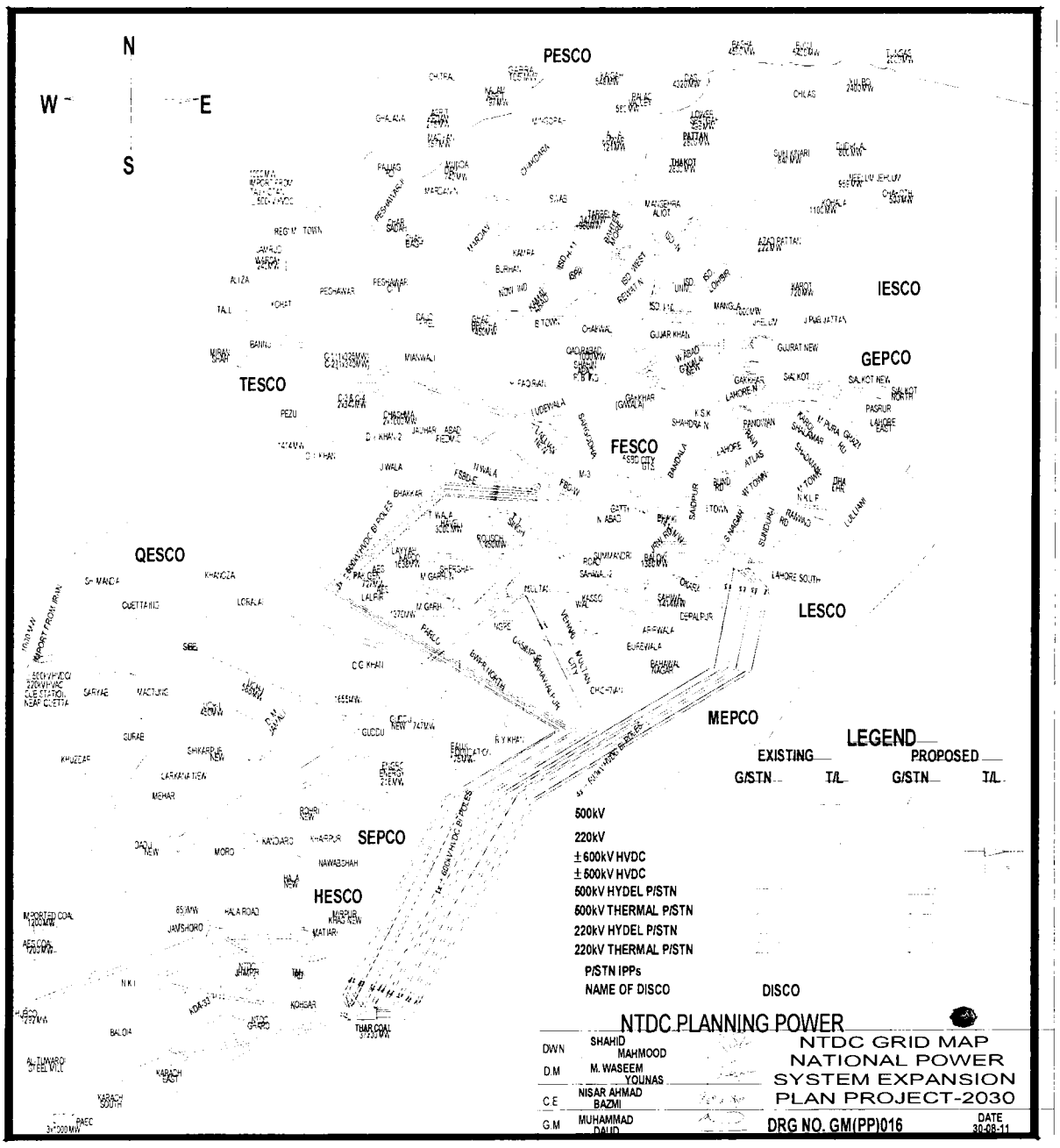


Figure 2.4-1 Pakistan Grid Planning in 2030

2.5 Unit Capacity

2.5.1 Current Maximum Unit Capacity

In the current units in Pakistan, the maximum capacity of single thermal unit is 365MW, the maximum capacity of single hydropower unit is 432MW, and the maximum capacity of single

nuclear power is 300MW.

2.5.2 Current Unit Capacity Selection

According to *1000–1200 MW Imported Coal based Integrated Power Project near Karachi Feasibility Study* written by Sargent&Lundy in 2008, WAPDA and NTDC determined the maximum unit capacity for Pakistan grid is 660MW (exclusive of auxiliary power).

2.5.3 General Requirement from Power Grid to the Unit Capacity

According to *NPRA National Code*, the rated frequency of Pakistan grid is 50Hz and allowable frequency fluctuation is ±0.2~±0.5Hz, this is the same as in China. The unit capacity selection could refer to related Chinese regulation, i.e., the maximum unit capacity do not exceeds 8%~10% of the total system capacity.

2.5.4 Unit Capacity of This Project and the Impact to the Grid Stability

The unit capacity of is this project 660MW.The total installed capacity of the whole country is 23663MW with effective capacity of 19000MW or above in 2013. The unit capacity of is this project accounts for 3.5% of the total installed capacity of the whole country.

The negative influence to the local power system caused by this plant is low. But due to various factors involved in grid stability analysis, further analysis shall be done to decide whether it can meet the requirement for stability in fault condition.

According to Appendix L.2 *The Special Report of Single Unit Capacity*, based on the related calculation conditions, the single unit capacity of 660MW is feasible and can meet the standard of *Grid Code 2005*. In the case of single unit is tripping operation while in fault, the frequency is above 49.8Hz, which can meet the power grid safety requirement.

2.6 Role of the Power Plant

The plant is in the south of Qasim industrial park on the southeast of Karachi in Pakistan. The power plant is near Arabian Sea and is about 45km from Karachi.

A 2×660MW coal-fired power plant is proposed to be built in this project, which could be the thermal power base in the south of Pakistan in the future. The units can be directly interconnected with 500kV main grid and could supply power to the middle and north areas.

This project can relieve the power shortage by replacing oil by coal and reduce power generation cost of Pakistan.

2.7 Interconnection Scheme

The power plant will be interconnected to the planned Matiari 500kV switchgear which through two-circuit 500kV lines with the length of 180km. The conductor type is quadrifid GREELEY. The maximum transmit capacity of the conductor is 2200MVA (40℃). The short-term and long-term interconnection scheme is shown in Figure 2.9-1 and 2.9-2

separately.

ANNEX-4

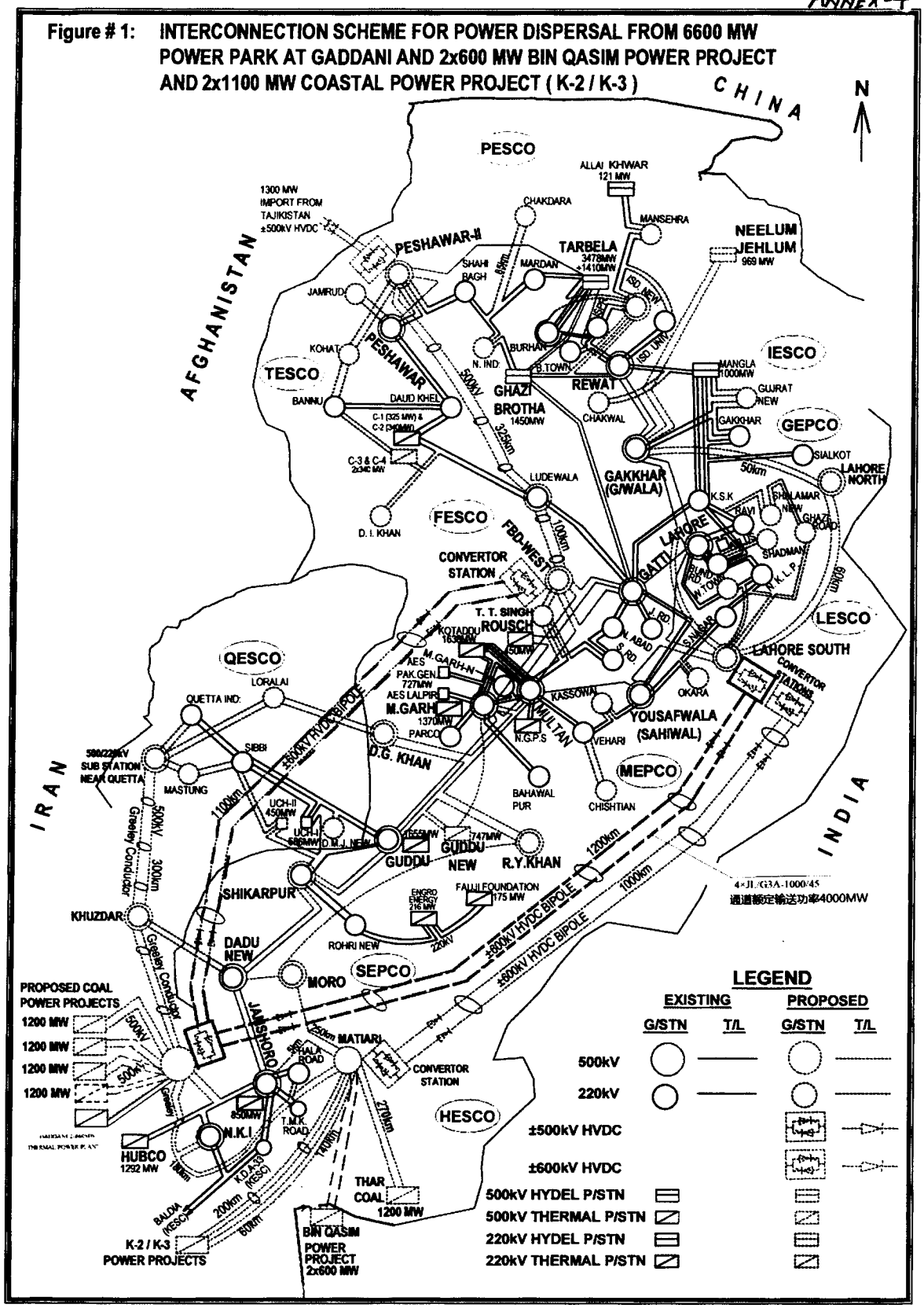


Figure 2.9-1 Short-Term Interconnection Scheme of Qasim Coal-fired Power Plant

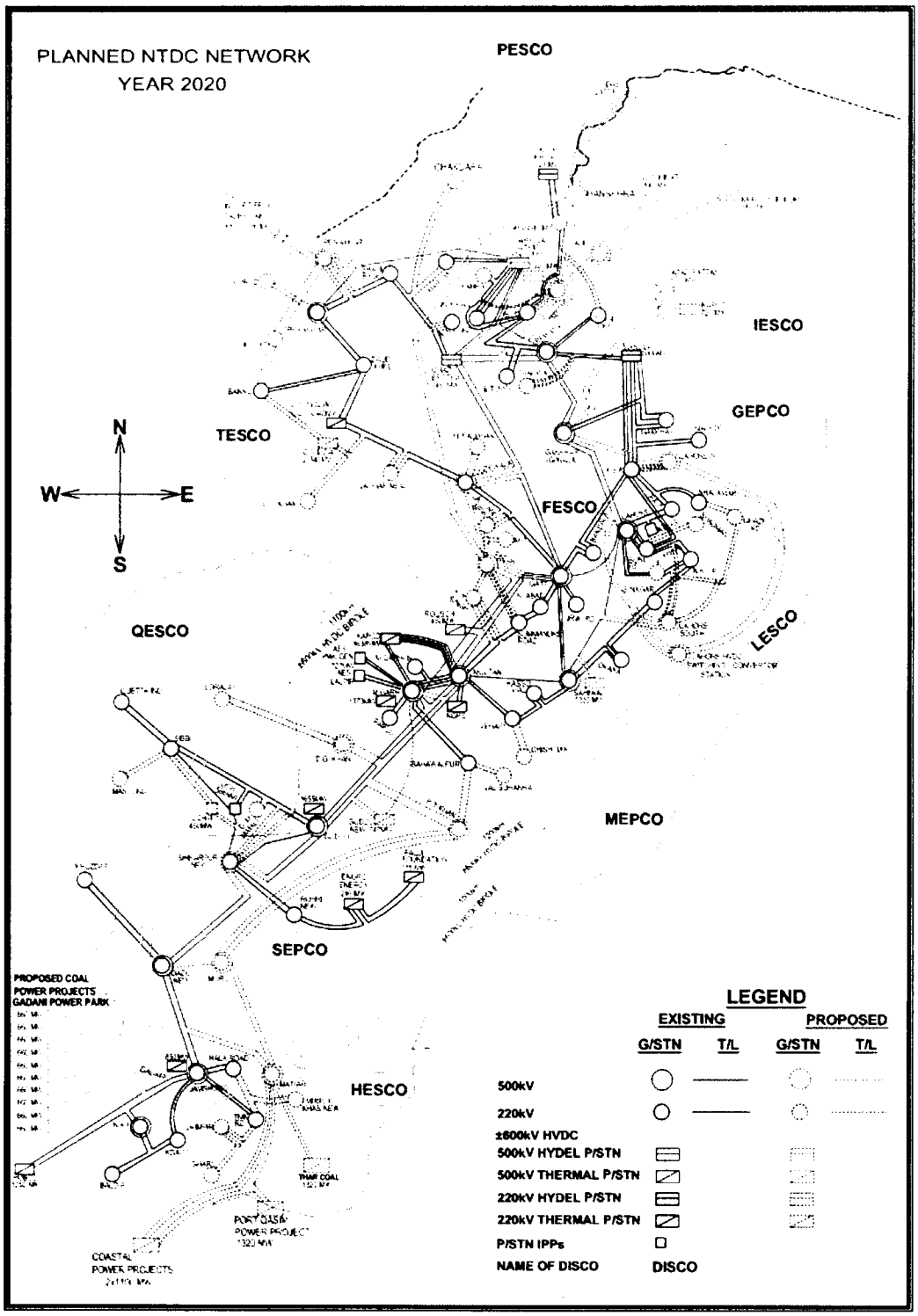


Figure 2.9-2 Long-Term Interconnection Scheme of Qasim Coal-fired Power Plant

2.8 Requirement for the Power Plant

(1) Units of this project

2×660MW units will be built in this project and will be interconnected to 500kV grid .

(2) Interconnection Scheme

Two circuit 500kV outgoing lines and only outgoing bays will be built. The maximum transmit capacity is 2000MVA(40℃). The type of conductor is quadrifid GREELEY (AAAC).

(3) Main electrical wiring

500kV main wiring: 3/2 wiring.

bus penetration power : not less than 2000MVA(40℃).

The unit shall connect to 500kV power distribution unit through generator-transformer unit set.

(4) Selection of main transformer

The 500kV step-up main transformer capacity shall be determined based on the maximum continuous generated output of the unit. The voltage regulation model is off-load. The connection group is Yn/d11 and the voltage class is 525±2×2.5%/UekV. Neutral point direct grounding. Transformer Impedance is 14%.

(5) Equipment short-circuit current

Short-circuit current of 500kV electrical equipment is not less than 50kA.

(6) Requirement of system peak load regulating for the units

Peak load regulating of single 660MW unit shall be not less than 60% of the unit rated capacity.

(7) Generator power factor

The generator rated power factor is 0.85, with operation capability in 0.95 leading phase.

(8) Generator excitation

Static Exciter.

(9) Startup and standby power supply

The startup and standby power supply of the units shall connected by 500kV bus in the power plant.

(10) Annual utilization hours

7200~7446hours.

(11) Reactive power configuration

500kV shunt reactors are configured at the side of 500kV transmission line connected with the plant. The total capacity of shunt reactors is tentatively 2×111Mvar.

2.9 Conclusion

1) Pakistan has electric power demand and competitive on-grid tariff of this project

(1) Electric Power Demand

Due to the uncertainty of those planned power supply projects of which the preliminary work haven't been done, only the projects which are in progress and with financing closed phase and in negotiation phase are taken into consideration. Even in low scenario, there will be still adequate power demand in Pakistan to for this power plant.

(2) Competitive On-grid Tariff

According to PPA, the pricing of on-grid tariff in Pakistan is mainly Cost + Profit, i.e., the sponsors and Pakistan government reach the agreement of the electricity cost price, and then Pakistan government determines the on-grid tariff ensuring certain profit for the sponsors based on the cost price.

Most thermal units in Pakistan are oil-fired and gas-fired units with high cost. This project is coal-fired power plant; the coal price is lower than oil and gas price. So on-grid tariff of this project will be competitive

2) The project complies with the electric power development plan of Pakistan and is supported by the local government

(1) Promote the energy development in Pakistan

Currently, oil and natural gas are insufficient in Pakistan, and coal will be developed to meet the energy demand. The project, with local coal as standby fuel, will promote the coal development. So this project is supported by the local government.

(2) Optimize the local power supply constitution

In current power supply installed capacity of Pakistan, Hydropower accounts for 29.1%, thermal power accounts for 67.4% (most are oil -fired and gas-fired power plants) and nuclear power accounts for 3.5%. According to the power supply planning of Pakistan, hydropower, coal-fired thermal power, gas-fired thermal power, and nuclear power will account for 43.6%, 49.6%, 4.4% and 2.7% respectively of the new increased installations to the year of 2030.

The project will increase the proportion of coal-fired thermal power installation, optimizes the local power supply constitution. So it is supported by the local government.

(3) Improve local power supply reliability and reduce power generation cost

Most of the current thermal power units of Pakistan are oil -fired and gas-fired units. The power generation cost is high and the disabled capacity is large due to the shortage and price fluctuation of gas and oil.

This coal-fired power plant will reduce the power generation cost and improve the reliability of power output and power supply. So it is supported by the local government.

3) Uncertainties

(1) Uncertainty in electricity transmission

The power plant will be interconnected to the planned 500kV switchgear in the northeast of Pakistan through two-circuit 500kV lines. The construction transmission and transformation projects associated with this power plant can not be confirmed now.

(2) Uncertainty in on-grid tariff

Firstly, the pricing of on-grid tariff in Pakistan is mainly Cost + Profit, the specific policy of profit can not be determined. Secondly, due to the factors like government financial revolving, it may take more time than the expected for the sponsors to get the profit. Therefore, there are uncertainties in on-grid tariff.

Moreover, uncertainty exists in electric power system reform in Karachi. It is hard to know whether the electric power system reform for KESC is based on power market. If it is not a marketable reform, the power plant cannot give a full play of its competitiveness in power generation cost.

(3) Uncertainty in annual utilization hours

According to the power and energy balance, if the demand-supply gap is filled by coal-fired power plants in 2015~2020, there will be a competition between coal-fired and gas-fired power plants power generation. In the long term, with the production of large hydropower stations, the power demand in Pakistan can be met. Then the annual utilization hours of coal-fired power plants will be reduced. Therefore, there is uncertainties in annul utilization hours.

(4) Uncertainty in electric power dispatching

Electric power dispatching of Pakistan is an independent agency. Due to the power shortage in the country, there is no man intervention in electric power dispatching or limit for the plant on-grid energy as long as the power grid transmission capability is allowed, thus uncertainties in power dispatching is less.

With the continuous development of large hydropower stations in Pakistan, electricity surplus is possible in wet season. Besides, line loss will be considered in electric power dispatching, there is a possibility that the government-owned power plants is dispatched prior to others. Thus, long-term potential risk exists in electric power dispatching.

4) Solutions

Based on PPA and current negotiating progress, the sponsor and Pakistan government will make an agreement on annual utilization hours of power plant, and the government will purchase all electricity involved in the agreement. Moreover, electricity payment agreement will be assured by Pakistan Ministry of Finance and Chinese ECI (export credit insurance).

During the term of the agreement, Pakistan Government shall undertake the uncertainties in

power utilization, transmission, dispatching and on-grid tariff.

Policies ensuring certain profit for the sponsors made by the Pakistan government are to meet the power demand of the country. When the electric power supply and demand is balanced, the government will push forward marketable reform in the electric power industry. Then there will be a possibility of change for the current tariff polices. Thus, there are long-term potential policy risks in the current measures.

5) Conclusions and Suggestions

With the current measures, risks in power transmission, dispatching and on-grid tariff of this project can be avoided to some extent. But there are still long-term potential policy risks.

Uncertainties in plant power transmission shall be focused and the power loss caused by remission shall be reduced to the least.

Firstly, negotiate the investment of the associated power transmission & transformation projects of this power plant; secondly, clearly define the rights and liabilities of how to transmit the electric and respond the potential risks.

CHAPTER Ⅲ FUEL SUPPLY

3.1 Coal Source

Annual coal consumption of the 2×660MW units will be 4,660,000t. It's proposed to select cheap and reliable commercial coal from international coal market. The background and tendency of coal market, as well as coal quality, price, current and future production capacity, and transportation expense will be analyzed in this chapter. It's recommended that coal of Indonesia be as the main coal and coal of South Africa and Australia be an effective supplement. The coal boilers are designed to mix two or three kinds of coal from different countries according to coal price in different periods.

3.1.1 Imported Coal

3.1.1.1 Indonesia Coal

According to the statistical data from National Energy and Mineral Resources Department in 2013, the coal reserves in Indonesia are 58 billion tons. The proved reserves are 19.3 billion tons and 5.4 billion in them can be used for being exploited for commercial purpose. The coal reserves in many places have not been proved, the total reserves are estimated more than 90 billion tons. In Indonesia, the anthracite takes up 0.36%, bitumite 14.38%, subbituminous 26.63%, and lignite 58.63%. The Indonesia coal has the following characteristic: high moisture, low ash content, low sulfur content, and high volatile matter. The subbituminous's calorific value is 5700~7200kcal/kg, volatile matter 37~42.15%, and sulfur content 0.1~0.85%. The lignite's calorific value is 4345~5830kcal/kg, volatile matter 24.1~48.8%, and sulfur content 0.1~0.75%. Based on distribution area: South Sumatra(39%), East Kalimantan(30%), South Kalimantan(13%) and some in West Java, Sulawesi, Irian.

Generally, coal-bearing stratums are smooth with low burying depth and easy to be explored in Indonesia coalmines. The present exploring coalmines are open-pit mines. Indonesia coalmines are explored in scale and centralized way. Five large coal producers' production capability takes up more than 75% of the whole national coal production. Each producer's coal production capacity is from 15000000 ton to 35000000 ton. Indonesia coal production has been developing rapidly in recent 20 years from less than 100,000,000 ton in 2000 to 386,000,000 ton in 2012. Indonesia domestic demands for coal are very low with only 20% of

the producing coal. Thus about 300,000,000 ton coal needs to be exported so that the credibility of the coal source can be guaranteed.

Indonesia mainly produces lignite. The percentages of production capacity for lignite, sub-bituminous and soft coal are 59%, 27% and 14%, there is only 0.5% soft coal. The main index of the coal like water content, volatile component, ash content, calorific value and etc. are nearly the same as the coal type designed for the boilers of this project.

Indonesia coal mines are mainly located near the costal area or inland areas near water system. Several exclusive wharfs for coal exporting in some port have been established surrounding the coal production areas. Coal from the coal districts are firstly transported from coal districts to the commodity storage yard or inland river wharfs by land way, then shipped to the loading port(or coal wharf) or the anchorage for large vessel shipping. The tonnage of the outbound vessel can reach 50000 ton. The shipping distance is 3900 miles from main ports of Indonesia to Qasim Port of Pakistan which is the shortest distance from the coal supplying port.

3.1.1.2 Australia Coal

Australian hard coal mainly distributed in Queensland and New South Wales, the indicated coal reserve is 7,640,000,000 ton in which there is 37,100,000,000 ton soft coal and anthracite, 39,300,000,000 ton sub-bituminous and lignite.

Coal production in Australia takes up 7% of the global production, only after India. Australia the fourth largest coal producing country and the largest coal exporting country in the world. The annual exporting capacity is about 300,000,000 ton and half of it is coking coal and half is thermal coal.

Coal production in Australia takes up 7% of the global production, only after India. Australia the fourth largest coal producing country and the largest coal exporting country in the world. The annual exporting capacity is about 300,000,000 ton and half of it is coking coal and half is thermal coal. 53,300,000 Australian dollars.

There are 16 main coal producers, 37 important coal mines and production of these coal mines takes up 73% of the total production.

In recent 13 years, Australian coal production has been increasing from 312,000,000 ton to 43,100,000 ton. The compound annual growth rate is 2.7%. The coal consumption is from 65,380,000 ton to 69,020,000 ton with the compound annual growth rate of 0.5%. The consumption growth is far less than production growth and about 350,000,000 ton coal can be exported every year and 51% of it is thermal coal.

Australia mainly produces high-quality thermal coal. The calorific value of lignite, sub-bituminous and anthracite is higher than those from other countries. According to the analysis index of the recommended quality of the source coal, The main index of the coal like water content, volatile component, ash content, calorific value and etc. are nearly the same as the coal type designed for boiler using super-critical pulverized coal, so it can be mixed with Indonesia low-calories coal and also burned by itself.

Australian ports available for coal shipping mainly locate in the 6 ports like northeastern Newcastle Port, southeastern Burnie Port and etc. The natural resource is very redundant in the Hunter Valley of Newcastle which is the economic and trading center of the northern and northwestern New South Wales. The coal exporting takes up more than 90% of the port throughput. There are various shore cranes, floating crane, coal loader, grain feeder and roll on and off facilities. 100,000 ton cargo ship at maximum can be stopped in the dock. The distance from Newcastle to Qasim of Pakistan is about 6,500 miles which is the largest distance from the source coal country. However, this shipping line is safe and reliable.

3.1.1.3 South Africa Coal

According to data from World Energy Council, the indicated reserves of soft coal, anthracite, sub-anthracite and lignite are 30,156,000,000 ton in South Africa (in which 81.5% low rank bitumite, 13.1% high rank bitumite and 5.4% soft coal), ranking the 6th after US, Russia, China, India and Australia. It takes up 10.6% of the global measured reserves. Nineteen coalfields of South Africa distributed in the area of 700km from north to south and 500m from east to west. 12.9 million ton of the measured reserves are in Witbank, Highveld, Ermelo, South Rand, Natal and Waterburg coalfield. Witbank Coal mine has the largest coal production capacity, and the secondary is Highveld coalmine and the total coal production of these two coal fields takes up more than 80% of the total production.

As the main coal producing country, South Africa ranks the 5th after US, China, Russia and Australia. The coal resource centralized in the eastern area: Mpumalanga's coal production takes up 83% and Limpopo is the secondary. As shown in the following picture, 39% of South Africa's coal is used for power generation, and nearly 20% for manufacturing synthetic fuel. South Africa is the only country which produces liquid fuel by coal commercially in the world.

Since 2000, coal production capacity is keeping stable with 220,000,000 ton to 260,000,000 ton in South Africa and 100,000,000 to 120,000,000 ton is used for chemical material and industrial fuel consumption. In recent years, South Africa's exporting coal is about more than 70,000,000 ton and takes up about 27% of the whole production. More than 97% of the coal

was exported from Richard Port and coal exporting to Asian area is increasing while to other areas is decreasing.

From the credibility of the coal supplying, coal production from main exporting enterprises of South Africa can completely meet the demands for thermal coal of coal power plant in this project. The coal transportation, especially the exporting coal is mainly by the way of Transnet railway transportation and the transportation capacity is 68,000,000 ton. Now the exclusive coal transportation railway is expanded and the capacity will rise to 81,000,000 ton per year, the throughput of Richard Port will expand to 105,000,000 ton and these infrastructure and logistical lines can guarantee the coal transportation channels.

3.1.1.4 Other Countries' Coal

Vietnam Coal:

Hongji anthracite is the main export product in Vietnam, which is mainly produced in the northeast of Guangning province, Vietnam.

According to the design parameters of coal-fired boiler, this project mainly takes the high-quality lignite or bituminous coal as fuel. Different coal mixing will lead to low combustion efficiency and affect the operation quality. In result, it is difficult to mix the Vietnam anthracite with thermal coal of other countries, along with its high heat and expensive price, which contributes us to refuse taking Vietnam as a source of coal in this project.

Botswana Coal:

Botswana is a landlocked country, it has limited coal exploration because of limitation of geographical location. Now, African Energy Company tries to transport coal by Botswana railways via Zimbabwe and finally arrived at Maputo in Mozambique, then sell coal to overseas market. Botswana is planning to build south network of railways for transnational transportation to avoid high cost. The network is to be finished in five to seven years. Compared with the same quality of coal of South Africa, the recent export volume of Botswana is up to one million tons whose cost is above $30. Botswana is not considered to be coal supplier.

By expounding the condition of coal source countries such as Indonesia, Australia, South Africa, Vietnam and Botswana, it's recommended that Indonesia coal be as the main coal of this project and South Africa coal and Australia coal be supplement.

3.1.2 Indigenous Coal

Pakistan coal resource spread in Sind province, Balochistan Province, Punjab Province and northwestern provinces. According to estimation from Geological Survey of Pakistan-GSP,

coal resource volume in Pakistan is about 186,200,000,000 ton of which 184,000,000,000 ton was in Sind Province (176,000,000,000 ton in Thar, 1300,000,000 ton in Lakhra, 3,700,000,000 ton in Sonda Thatta and etc.), in addition, Balochistan 217,000,000 ton, Punjab Province 235,000,000 ton, northwest provinces 90,000,000 ton.

The coal include lignite and sub-bituminous, and the calorific value is from 2,780 to 7,227 kilo calories. In Thar region in the south of Sind province, there is the largest fair lignite mine in the world.

Thar Coal Field is the largest coal area that has been found so far in Pakistan with area of 9000 km^2. it is a low-sulfur coal mine in the Thar Desert, southeast of Sind Province that is 380km away from the port city of Karachi. The coal reserve is 176,000,000,000 ton. The coalfield is divided into 10 sections and Shenhua Group invests coal pithead coal power plant in Block IV.

There are coal production enterprises in Pakistan like Thar Coal Co., Ltd, Lakhara coal development Coal Co. and Coal Import Corporation.

Local Pakistan Coal include lignite and sub-bituminous with great difference about the physical specialties and chemical composition. They contain so much sulfur and lime that it is difficult for these kind of coal to meet the quality standards from the industrial clients. Coal supply is insufficient. At present, 98% of the coal is produced in Thar Coal Mine in Sind Province. According to the open data and investigation from on-site investigators supplied by German M/s Rheinbraun Engineering Consultant, Thar Coal Mine is now on the phase of planning establishment and supplementary geology exploration without reaching the production phase. According to the data of pithead power plant invested by Shenhua. The production planning of Thur Coal Mine is mainly for supporting the power generation project and surrounding chemical projects without too much commercial coal for marketing in 5 years. In addition, the economic exploration and present production of lignite from Punjab and Balochistan is quite low with only 300000 ton per year in spite of high heat of the lignite, and 90% is used for the brick manufacturing in the brick manufacturing factories of the surrounding area. The lignite heat from Thar Coal Mine is from 3213 to 6062 kilo, but 90% with low heat and contain more than 1% sulfur. Besides coal from Thar, coal from other areas contain too much sulfur and lime most of which is used in the brick factories and power generation by the technology of "liquid burning technology". So the coal is unfit for using as the dynamic coal for burning.

In this project, the burning coal electricity power plant locates in the Qasim Port of Karachi in

Pakistan. 415（35+380）km away from Thar Coal Mine in Sind Province which is the source place for coal. Thar coal mine is 380 km away from Karachi city which is 35 km away from Qasim Port. The logistic mainly depends on the road transportation and the expense is about 33 US dollars per ton based on cost standards about transportation for the local staple commodity and handling charge. The freight is nearly the same with the pithead price of the coal.

In addition. referring to the burning specialty (like burning. burning ash. coking property and etc.) of the dynamic coal from the importing countries. if these coals are burnt together with Pakistan lignite. it not only decreases heat of importing coal. but also influences the burning safety of the boiler. Moreover. after taking the coal dust on the road of coal transportation and freight. the local Pakistan lignite will not be recommended in short-term and indigenous dynamic coal of good quality will be considered for mix burning in mid-long-term based on the coal supply conditions.

3.2 Coal Quality

According to the analysis of last section. the coal for the power plant is recommended to be from Indonesia. South Africa and Australia. The analysis about coal quality and the ash content is tentatively as follows:

Coal Quality Data Sheet

No.	Item	Unit	Design coal	Remark
1	total moisture （M_t）	%	30	
2	volatile matter （dry ash-free basis）（V_{daf}）	%	40.71	
3	Proximate Analysis（Air Dried）			
3.1	Moisture（M_{ad}）	%	15	
3.2	Ash （A_{ad}）	%	15	
3.3	Volatile Matter（V_{ad}）	%	28.5	
3.4	Fixed Carbon（FC_{ad}）	%	41.5	
4	Air Dried HHV（$Q_{gr,ad}$）	kcal/kg	5650	
5	As Received LHV（$Q_{net,ar}$）	kcal/kg	4340	
6	Hardgrove Gindability Index（HGI）		49	
7	As Received Ultimate Analysis			
7.1	Carbon Car	%	43.30	
7.2	Hydrogen Har	%	3.50	
7.3	Nitrogen Nar	%	1.0	
7.4	Sulphur Sar	%	0.85	
7.5	Oxygen Oar	%	9.0	
7.6	Ash Aar	%	12.35	

No.	Item	Unit	Design coal	Remark
7.7	Moisture Mar	%	30	
8	Ash Fusion Temperature (reducing)			
8.1	deformation temperature	℃	1210	
8.2	softening temperature	℃	1240	
8.3	Hemispherical temperature	℃	1280	
8.4	Flow temperature	℃	1300	
9	Ash Analysis			
9.1	SiO_2	%d	45.1	
9.2	Al_2O_3	%d	25.6	
9.3	Fe_2O_3	%d	13.31	
9.4	CaO	%d	3.0	
9.5	MgO	%d	5.3	
9.6	TiO_2	%d	0.9	
9.7	Na_2O	%d	0.97	
9.8	K_2O	%d	1.50	
9.9	P_2O_5	%d	1.20	
9.10	SO_3	%d	3.12	

3.3 Coal Consumption

Installed capacity / Coal consumption	1×660MW		2×660MW	
	Design coal	Check coal	Design coal	Check coal
Hourly coal consumption t/h	323.6		647.2	
Daily coal consumption t/d	6472		12944	
Annual coal consumption 10^4t/a	232.99		465.98	

Note: 1) Daily operation hours are taken as 20.

2) Annual operation hours are taken as 7200.

3.4 Fuel for Ignition and Combustion Support

Light fuel oil from free international fuel oil market will be mainly used for the project. In power plant area, the waterway and highway traffic conditions are good to ensure fuel oil supply. When unloaded in the jetty, the fuel oil will be transported into the plant by highway.

3.5 Coal Transportation

The coal for the power plant may be from Indonesia, South Africa and Australia, and will be transported by ship.

According to the port situation of the export countries which was selected, the coal loading port also can be decided initially.

The shipment ports are separately Tanjung Bara port in Indonesia. New Castle port in Australia and Richards Bay port in South Africa.

The distance between the national coal loading ports and Pakistan Qasim port is shown in this table as follows:

SN	SHIPMENT PORT	UNSHIP PORT	SEA MILE
1	Tanjung Bara Port	Qasim Port	3900
2	New Castle Port	Qasim Port	6500
3	Richards Bay Port	Qasim Port	4300

According to the analysis of the route of voyage. the distance from Richard Bay of South Africa to Qasim of Pakistan is about 4200-4300 nm, about 17 days at sea; the distance is about 3900nm from Tanjung Bara port of Indonesia to Qasim of Pakistan, about 16 days at sea; it is about 6500nm from Newcastle port of Australia to Qasim of Pakistan, about 25 days at sea.

According to the analysis of the sailing routes, from these import countries' ports, eg. Indonesia Tanjung Bara port, Australia Newcastle port, South Africa Richards Bay to Pakistan Qasim port, and the comparison of shipping situation from ship type, quantity, distance, shipment, freight and other data, we can get that the cheapest transportation cost is the 70000-ton panamax bulk carrier, in addition, the logistics cost importing coal from South Africa and Indonesia is more advantaged, because of the longer distance and sailing date from Australia, about 8~9 days longer, the rent becomes more expensive. The detail analysis sees Appendix L.1 *Report of Coal feasibility*.

3.6 Supply of Desulfurization Absorbent

The installed capacity of the project is 2×660MW, and wet desulphurization device will be installed for the project. 115,800 tons of limestone will be used as FGD absorbent for the 2×660MW units every year.

According to the document provided by the Owner, the quality of the limestone for this project is as follows:

No.	Parameter	Method	Unit	Test Results
1	Silica(SiO2)	Based on ASTM-C25-06	%	01.56
2	Alumina(Al2O3)	Based on ASTM-C25-06	%	00.08
3	Iron(Fe2O3)	Based on ASTM-C25-06	%	00.87
4	Calcium Oxid (CaO)	Based on ASTM-C25-06	%	53.89
5	Magnesium Oxid (MgO)	Based on ASTM-C25-06	%	00.39

There are large amounts of high quality limestone in NWFP Province, Punjab Province, Sindh

Province, Balochistan Province, and Northern area of Pakistan. They are widely used in road construction, building construction, sanitation and hygiene, and water treatment. Currently, the limestone output in Pakistan is about 8700,000 t, which is mainly used in cement production, road construction, building construction, and chemical industry. For this project, the required 115,800 tons of limestone every year can be purchased locally, and then transported to the power plant by truck.

FGD Absorbent （Limestone）Consumption:

Item	Unit	1×660MW		2×660MW		Remark
		Design coal	Check coal	Design coal	Check coal	
Hourly consumption	t/h	8.045		16.09		Hourly limestone consumption is calculated as the hourly consumption under BMCR.
Daily consumption	t/d	160.9		321.8		Daily limestone consumption is calculated as 20 hours.
Annual consumption	10^4t/a	5.79		11.58		Annual utilization hour is considered as 7200 hours

3.7 Jetty and coal unloading facilities

For Jetty and coal unloading facilities, please refer to *Feasibility Study Report of Coal Unloading Jetty*.

CHAPTER Ⅳ PLANT SITE CONDITIONS

4.1 Site Overview

4.1.1 Site Location

The power plant, consisting 2×660MW coal-fired power generating units, under planning, is located in PQA industrial area, southwest Pakistan, about 37km away from Karachi city.

Once as the capital of Pakistan in 1947-1959, Karachi is now the provincial capital of Sindh province, the country's capital and chief city, largest seaport and naval port, industry and commerce center, trade and finance center, as well as an international air station in Southeast Asia between Middle East, Africa and Europe, with an area of 1,448km^2 (591 km^2 of the urban area) and population of 9,300,000 (the census taken in 1998) in urban area. Situated in northwest of Indus River delta and bordered by Arabian Sea to the south, the climate is pleasant in most time in Karachi, with mean lowest temperature of 13℃ in winter (January and February), mean highest temperature of 34℃in summer (May and June), and with slight annual mean rainfall of 200mm only.

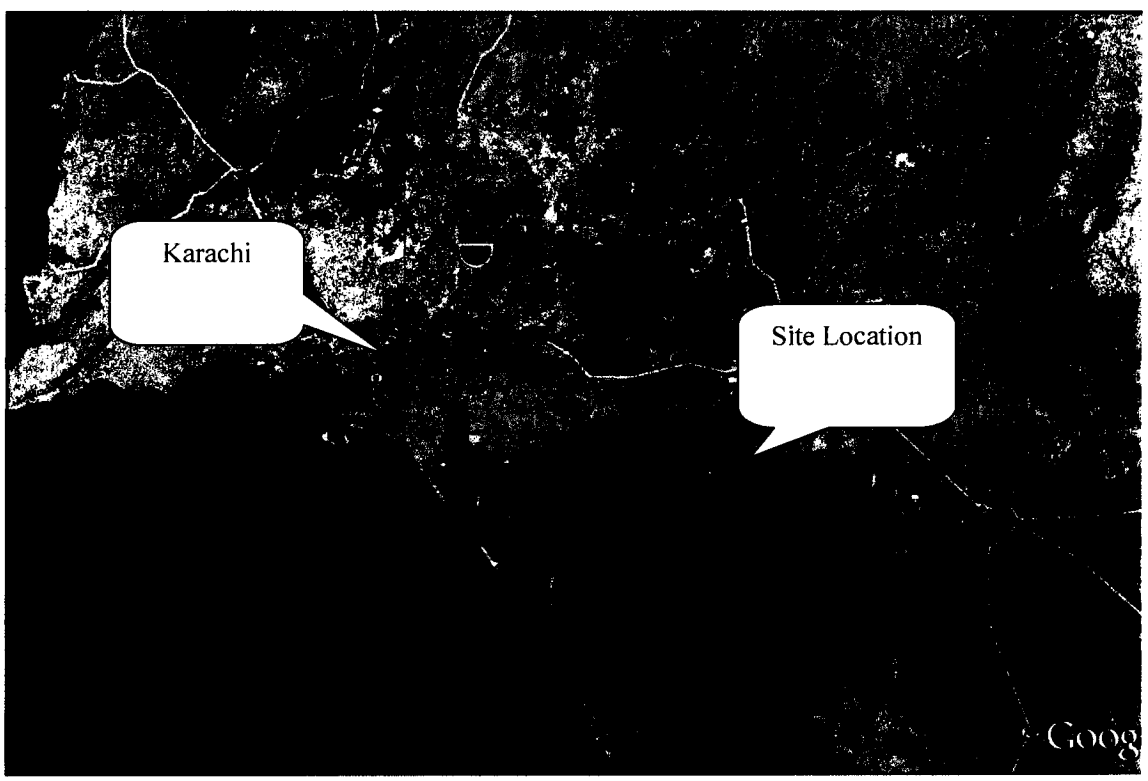


Figure 4.1-1 Geological Location of Plant Site

4.1.2 Site Conditions

The topography of the plant site is relatively flat and north high low-lying south. The south side is adjacent to the channel of Arabian Sea, the ground elevation is between -7m—4.3m.

There is a north-to-south gulley at site southwards to the channel and one natural gas pipeline at both sides of the road to the north of plant site.

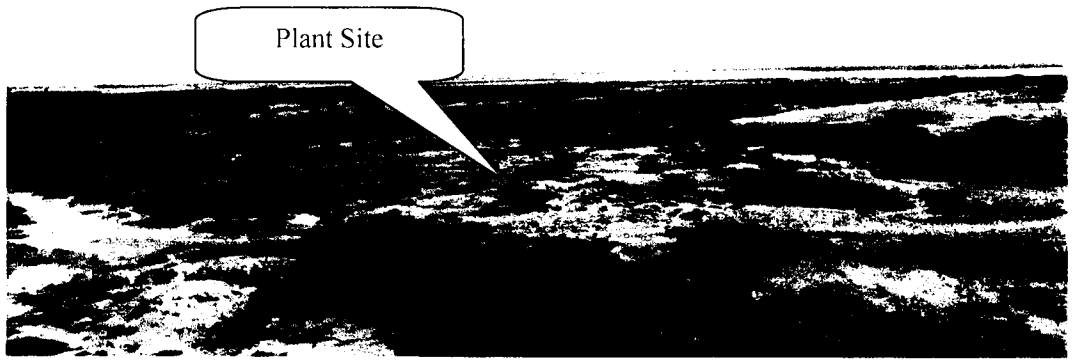


Figure 4.1-2 Plant Site

4.2 Transportation

Port Qasim geographically adjacent to main shipping routes, has favorable internal traffic conditions, only 15 km from the Pakistan highway, 14 km from the national railway lines, and only 22 km Jinnah International Airport.

Based on the field survey, currently, there is a fifteen-meter-wide concrete road in good condition from Karachi to the site. The north side of the site is adjacent to the concrete road of the Industrial Area, about 7.5m in width.

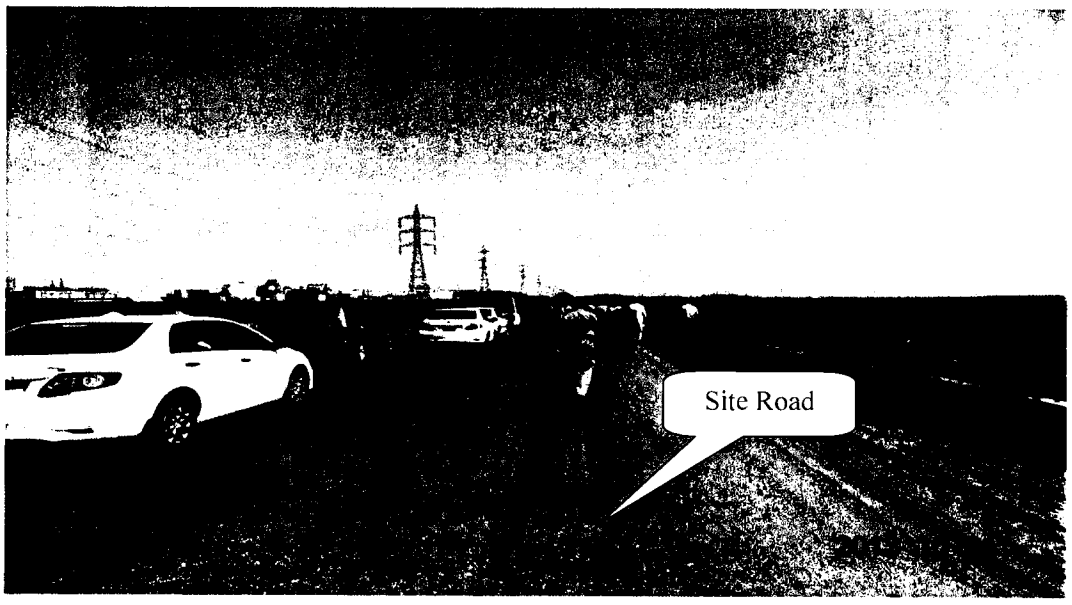


Figure 4.2-1 Site Road

4.3 Hydrometeorology

4.3.1 Tidal Wave

4.3.1.1 Design Tide Level

The characteristic values of tide at Pipri observation station on Port Qasim are shown in Table4.3-1 and Table 4.3-2.

Table 4.3-1 Characteristic value of tide at Pipri station

No.	Item	Value
1	Tidal types	0.45（mixed tide）
2	Shallow water effect	0.16
3	Highest tide level	4.16m
4	Lowest tide level	-0.79m
5	Maximum tide range	4.52m
6	Average rising tide duration	6Hr44Min
7	Average ebb tide duration	5Hr40Min
8	Quickest rising tide duration	4Hr16Min
9	Highest astronomical tide level	4.01m
10	Average higher high tide level	3.45m
11	Average lower high tide level	2.66m
12	Average sea water level	2.03m
13	Average higher low tide level	1.40m
14	Average lower low tide level	0.62m
15	Lowest astronomical tide level	-0.57m
Note: Height datum adopts Port Qasim Chart datum（PQA datum）.		

Table 4.3-2 2004-2013 Annual and monthly characteristic value of tide at Pipri station

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Full-year
Highest tide level (m)	4.03	4.12	3.98	3.88	3.90	4.00	4.01	4.02	3.92	3.96	4.04	3.86	4.12
Lowest tide level (m)	-0.54	-0.56	-0.66	-0.68	-0.72	-0.54	-0.48	-0.44	-0.68	-0.79	-0.65	-0.56	-0.79
Average highest tide level (m)	3.75	3.83	3.80	3.71	3.75	3.84	3.80	3.83	3.76	3.73	3.76	3.69	3.77
Average lowest tide level (m)	-0.36	-0.31	-0.37	-0.55	-0.47	-0.34	-0.27	-0.25	-0.42	-0.47	-0.50	-0.36	-0.39
Note: Height datum adopts Port Qasim Chart datum（PQA datum）.													

Lacking observation datum in Port Qasim Authority, the year sequence of actual tide level recorded in original files is less than the requirement of 20 years in succession. Therefore, the frequency statistics analysis is inapplicable for working out the design value for tide level. The highest and lowest astronomical tide level at Pipri station is respectively 4.01m and -0.57m. The greatest storm tide recorded in Karachi in almost one century happened in 1907, causing an elevation 1.2m higher than the highest astronomical tide level. The recurrence

interval is nearly one century. The storm tide has a space scale from dozens to hundreds of kilometers and a time scale about 1~100h. Area influenced by the storm tide can shift with the movement of atmospheric disturbance factors. thus one storm tide course sometimes will influence a coast of 1000~2000km for days. Though the project is at inland sea area. the impact from storm tide elevation shall be taken into account due to the tremendous hazard.

Considering that the highest astronomical tide and maximum historical storm surge elevation is 5.21m. the highest tide level at 1% frequency in site is designed as 5.21m and lowest tide level at 97% guaranteed frequency in site as -1.50m.

4.3.1.2 Design Wave

The generating area with the dominant wind direction from project site to the opposite bank is 1.5km and is with mean water depth of 12m. Once-in-fifty-year wind speed at 10m height in 10minutes is designed as 25.3m/s; the average wave height is calculated in wave equation as 0.47m. When the recurrence interval is fifty-year, the depth of water in the south coast of plant site is about 4m, and once-in-fifty-year wave height at 1% accumulative frequency is 1.04m based on conversions of wave heights at various accumulative frequencies.

Having raising the sea area of the plant, the boundary wall in the south of site is beyond 150m distant from the seawater and from the boundary of backfilling area. The east of the plant site connects to the acquired land of steel mill. which has been backfilled up to 4.5m; hence. the regions east and south of plant are unaffected by waves. The boundary in the west of plant site is close to the water intake channel of steel mill. running parallel with the water intake channel, and between them there is a 200m coastal beach. In the event of once-in-a-hundred-year tide under existing condition, the area outside the boundary wall in the west of plant will be submerged. The main direction of incoming wave in this sea area is southwest, consequently wave protection measures shall be considered for the west region of plant site.

4.3.2 Flood Water logging

The water level in the water diversion channel of the steel mill west of the plant site is the same as the tide level. If the project is designed with a protection for once-a-hundred-year tide level, the seawater inside the intake channel will have no impact on the plant site, where there is no perennial flood water logging existing.

According to Harbor Bureau, the incident that ships fail to approach the port due to natural disasters, especially severe weather, has never happened in recently 30 years.

There are two drainage gulleys going through the east part of proposed ash yard and plant site. Once-a-hundred-year flood shall be taken into consideration. In the topographic map, the east

and west gulleys are with a catchment area about 56.17km^2 and 3.63km^2 respectively. Thus the total catchment area is 59.8km^2. A steel mill, built at small watershed upstream of west gulley, cuts off the catchment channel at upstream, thus the catchment area at present is small. As the upstream ash yard is in small size, in lack of actual data, the small watershed is calculated on the basis of flood formation principle, and the designed value of peak flow for the gulleys north of ash yard is derived from generalizations, experimental parameter processing and the rainstorm data, with results shown in Table 4.3-3.

Table 4.3-3 Design flood of small watershed

Recurrence interval	Ash yard small watershed	Eastern small watershed	Western small watershed
Once-in-a-hundred-year peak flow (m^3/s)	299	275	31.4
Once-in-fifty-year peak flow (m^3/s)	201	185	21.2
Once-in-twenty-year peak flow (m^3/s)	98.0	90.2	10.3
Note: the small watershed at ash yard upstream consists of the eastern and western small watershed.			

Due to lack of data, substitution method is partially used in calculating the small watershed flood, and the result shall be confirmed through investigation. The result and flood investigation outcome are analyzed to get the final result. Based on field survey on historical flood, no flood has overflowed the gulley over the past 30 years. The gulley in the west and east of the highway bridge close to the north of plant site is with perennial flood water level of 4.4m and 4.2m respectively. The recurrence interval is once-in-ten~twenty-year.

The peak flow in hydrologic section is calculated by using Manning formula based on channel roughness, flood level in investigation, rive gradient, and hydrologic sectional area at the highway bridge close to the north of plant site. The result shows that the perennial peak flow of east and west gulley is respectively 56.6m^3/s and 44.4m^3/s.

According to field survey and investigation, the eastern and western gulley interlinks in east-west direction at the place about 250m north of the highway bridge, and the two streams can link into integration in case of flood. Therefore the peak flow summation of the two gulleys shall be compared and analyzed with the flood result of upstream small watershed. The peak flow of the two gulleys in whole for years is about 101m^3/s.

From above, it is concluded that the once-in-twenty-year peak flow of small watershed at ash yard upstream is 98.0m^3/s, and the total peak flow of two gulleys by inversion calculation is 101m^3/s. The two values are close. Considering the perennial flood water in recurrence

interval of once-in-ten~twenty-year, the peak flow value of small watershed is reasonable. The design peak flow of gulleys at both sides of upstream and of the whole catchment area is shown in Table 4.3-4.

Table 4.3-4 Design Peak Flow

Location	Once-in-a-hundred-year peak flow(m^3/s)
The east gulley north of ash yard upstream	275
The west gulley north of ash yard upstream	31.4
Whole ash yard upstream	299

Once-in-a-hundred-year flood hygrograph in whole catchment area at ash yard upstream is calculated by the method of generalized triangle flood hydrograph, shown in Table 4.3-5.

Table 4.3-5 Flood Hydrograph at Ash Yard Upstream

Duration (h)	Flow(m^3/s)
0	0
2.2	47.8
4.4	299
8.2	33.8
15.6	0

The design flood of two gulleys north of ash yard is shown in Table 4.3-6.

Table 4.3-6 Design peak flow and flood level

Location	Once-in-a-hundred-year peak flow(m^3/s)	Once-in-a-hundred-year flood level(m)
The east gulley north of ash yard upstream	275	7.63
The west gulley north of ash yard upstream	34.6	5.65

4.3.3 Regular Meteorology

Regular meteorological elements for the project are shown in Table 4.3-7.

Table 4.3-7 Regular meteorological elements

Meteorological item	Statistical value	Unit	Occurrence time	Year
Mean air pressure for years	1005.7	hpa		1981-2010
Mean air pressure for years (sea level)	1008.3	hpa		1981-2010
Mean relative humidity for years	66.0	%		1981-2010
Mean temperature for years	26.4	℃		1981-2010
Maximum wind speed by actual measurement and corresponding wind direction	23.7(W)	m/s	2010	1981-2010

Mean wind speed for years	3.5	m/s		1981-2010
Prevailing wind direction for years	SW			1981-2010
Mean precipitation for years	176	mm		1981-2010
Maximum annual precipitation	481.5	mm	1994	1981-2010
Minimum annual precipitation	0.0	mm	1987	1981-2010
Maximum daily precipitation	142.6	mm	2009.07.19	1981-2010
Mean precipitation days for years	18.7	d		1981-2010
Mean thunderstorm days for years	5.6	d		1981-2010
Maximum thunderstorm days for	18	d	1994	1981-2010
Mean foggy days for years	0.6	d		1981-2010
Maximum foggy days for years	7	d	1990	1981-2010
Mean sandstorm days for years	0.5	d		1981-2010
Maximum sandstorm days for years	3	d	2005/2003	1981-2010
Mean sunshine duration for years	2775.4	h		1981-2010
Mean cloud amount for years	2.8	Oktas		1981-2010

Meteorological items such as monthly and annual mean air pressure, mean temperature, mean relative air humidity and mean precipitation at Karachi airport are in Table 4.3-8.

Table 4.3-8 Monthly meteorological conditions from year 1981 to 2010 at Pipri station

Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Full-year
Mean temperature （℃）	18.6	21.2	25.4	28.9	31.1	31.9	30.5	29.2	29.5	28.9	24.6	20.4	26.4
Extreme maximum temperature（℃）	32.3	36.1	42.2	43.4	46.0	46.0	40.0	41.6	42.1	42.6	38.5	34.5	46.0
Extreme minimum temperature（℃）	2.3	3.8	11.0	13.8	17.7	22.1	22.3	20.0	18.0	11.7	7.4	1.3	1.3
Mean maximum temperature（℃）	26.3	28.4	32.2	34.7	35.5	35.4	33.3	32.1	33.2	35.5	32.5	28.2	32.0
Mean minimum temperature（℃）	11.5	14.0	18.6	23.0	26.6	28.3	27.6	26.3	25.6	21.9	16.8	12.7	20.7
Mean air pressure（hPa）	1013.6	1011.5	1008.4	1005.1	1001.5	997.1	996.4	998.6	1002.8	1007.6	1011.5	1013.8	1005.7
Monthly maximum mean air pressure（hPa）	1019.5	1018.0	1014.5	1011.1	1007.8	1002.8	1001.5	1003.3	1008.5	1015.0	1017.4	1019.6	1019.6
Monthly minimum mean air pressure（hPa）	1013.7	1005.1	1005.9	1005.0	1000.7	995.8	991.1	998.5	1001.9	1006.7	1011.0	1010.8	991.1
Mean relative humidity（%）	54.0	57.4	61.7	65.5	70.8	72.6	75.6	77.8	74.0	64.4	57.3	54.1	66.0
Monthly maximum mean relative humidity（%）	78	80	83	87	86	85	88	90	89	88	84	75	90
Monthly minimum mean relative humidity（%）	24	27	26	35	47	59	63	61	54	30	28	25	24
Mean wind speed(m/s)	2.4	2.6	2.9	3.7	4.7	5.0	5.0	4.7	4.1	2.4	2.0	2.2	2.4
Maximum wind speed(m/s)	18.0	23.7	17.0	16.0	19.5	20.0	20.0	18.0	18.0	18.5	15.4	18.0	18.0
Mean precipitation（mm）	8.4	7.4	5.3	3.0	0.1	10.8	60.0	60.9	11.0	2.6	0.4	4.8	176.0
Maximum precipitation（mm）	89.3	33.2	73.4	47.6	5.0	110.2	270.4	250.4	68.9	39.3	8.3	61.3	481.5
Minimum precipitation（mm）	0	0	0	0	0	0	0	0	0	0	0	0	0

Meteorological conditions in three month with the highest temperature (10% wet bulb temperature is 27.6 ℃) in the recent five years are shown in Table 4.3-9.

Table 4.3-9 10% wet bulb temperature and meteorological conditions in recent five years measured in Karachi airport meteorological station

Year	Month	Day	Mean wet bulb temperature(℃)	Mean dry bulb temperature (℃)	Mean relative humidity (%)	Mean air pressure (hPa)	Mean wind speed (m/s)
2011	6	19	27.6	31.8	72.3	996.5	4.1

The design wind speed at the height of 10m in ten minutes once-fifty-year and once-a-hundred-year is respectively 25.3m/sand 26.8m/s for this project. The basic wind pressure in once-a-fifty-year is 0.400 kN/m^2.

Wind direction frequency in full year, winter and summer observed at Karachi airport meteorological station in year 1996-2010 are shown in Table 4.3-10, and that observed at Port Qasim in year 1980-1985 are shown in Table 4.3-11.

Table 4.3-10 Wind direction frequency in full year, winter and summer at Karachi airport meteorological station

Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	C
Full year	2	0	10	0	2	0	1	0	2	1	41	3	22	0	2	0	15
Summer	0	0	1	0	0	0	1	0	1	1	54	5	32	0	1	0	4
Winter	4	0	28	0	5	0	3	0	3	1	22	0	7	0	4	0	24

Table 4.3-11 Wind direction frequency in full year, winter and summer at Port Qasim

Wind direction	N	NE	E	SE	S	SW	W	NW	C
Full year	3.3	10.6	4.7	0.9	2.4	25.2	43.8	5.7	3.4
Summer	0.4	0.5	0.6	0.3	4.4	45.4	42.2	5.3	0.9
Winter	7.1	28.3	13.2	2.2	2.1	9.0	25.8	6.2	6.1

4.4 Water Source

4.4.1 Water supply

The plant site is classified as semi-arid without fresh water source, and the seawater is the only reliable water source. Therefore, desalinated seawater is proposed for the project.

The seawater for the project is from Bay of Qasim. The seawater intake pump house locates at south of the power plant. The seawater flows through intake channel into the fore-bay of the seawater intake pump station and is pumped into the seawater pre-treatment system.

SWRO effluent will be used as boiler make-up water, service water, potable water and fire fighting water, etc.

According to the water source condition, seawater secondary circulating cooling supply system is planned. One natural draft cooling tower will be built for each unit.

4.4.2 Tides, Waves and Currents

Refer to Section 4.3 for seawater tide level and wave data.

The offshore tide on Arabian Sea normally heads towards west during the northeast monsoon period (November~ March) and towards east during the southwest monsoon period (May~ September). Approach channel is a deep groove in the Delta, near which there are lots of sand bank and shoal. Under the influence of islands, coastline and topography, the currents in the channel region are obviously reversing with small waves. The current velocity changes in a certain range, with mean tide rising and ebb velocity about 0.6m/s, and the maximum velocity in 1.0~1.8m/s. The velocity of tide ebb is normally faster than that of tide rising in the approach channel, in a flow direction parallel with the ship line.

4.4.3 Seawater Temperature

From the data observed at the port inside channel from January 1980 to March 1982, it is known that the minimum and maximum monthly mean temperature of sea surface was respectively 18 ℃and 32 ℃, and of 10m depth undersea were respectively 29 ℃ and 31.8℃. The sea surface was with maximum salinity of 40.3 ‰ and minimum salinity of 28.1 ‰. The tidal creek at Port Qasim belongs to the intertidal zone in lack of fresh water, with average salinity about 36 ‰.

The monthly mean temperature of sea surface in year 1989-1994 observed at the measured point (Figure 3-3) nearest the plant in Port Qasim is shown as below:

Table 4.4-1 Sea surface temperature

Year	Month	Mean temperature of sea surface (℃)
1989-1994	Jan-Mar	25.1
	Apr-Jun	30.2
	Jul-Sep	29.5
	Oct-Dec	26.3

4.4.4 Seawater Quality

The representative seawater collected from BQCS (power plant in Port Qasim) near the proposed project is with parameters as follows:

Table 4.4-2 Parameters of representative seawater quality

Item	Value	Unit
Acid and alkali（PH）	7.8	
Conductivity	49000	μs/cm^2
Total dissolved solids（TDS）	39000	mg/l
Turbidity	12	NTU
Total suspended solids（TSS）	30	mg/l
Total hardness（TH as $CaCO_3$）	7200	mg/l
Calcium as $CaCO_3$	1100	mg/l
Magnesium as $CaCO_3$	6100	mg/l
T-Alkalinity as $CaCO_3$	135	mg/l
CL^-	22700	mg/l
Biochemical oxygen demand（BOD）	27	mg/l
Chemical oxygen demand（COD）	256	mg/l
Fossil oil and animal oil	None	mg/l
Note: NUT is the unit of turbidity measurement.		

SEPCOIII conducted seawater sampling near the plant site and entrusted the testing to Pony Testing International Group, with results as below.

Table 4.4-3 Result of seawater sampling testing

Item	Value	Unit
Acid and alkali（PH）	7.71	
Chemical oxygen demand（COD_{Mn}）	2.11	mg/l
Biochemical oxygen demand（BOD_5）	1.6	mg/l
CL^-	20300	mg/l
Total organic carbon（TOC）	1.25	mg/l
Suspended solid matter（SS）	52	mg/l
Dissolved solid matter	26500	mg/l
Total solid matter	26500	mg/l
Total hardness（TH as $CaCO_3$）	6870	mg/l

According to observation datum of inside channel near the plant site from Jan 1980 to Mar 1982, the minimum and maximum suspended matter was respectively 0.015g/l in Jan and 0.20g/l in Aug. Due to the tide and wave disturbance to silt tide flat near the bottom of inside channel at the port, the suspended matter at 10m underwater was with higher concentration.

4.4.5 Channel Silt

The powder and fine sand deposited at port channel are mainly from:

1）The adjacent shallow bay （Korangi Bay，Gharo Bay，Isaro Bay and other smaller bays）；

2） The suspended substance brought from low places inside the channel by rising tides;

3）Water discharged by the rainstorm into the channel and neighboring bays;

4）Earth filling inside the channel;

5）Powder and fine sand brought by north and northeast wind in winter into the port channel area, especially in the channel area with scarce or no mangrove.

The silt size grading is shown as below:

Table 4.4-4 Silt Size Grading

No. of sampling points	Sampling point 20	Sampling point21	Sampling point 22
Latitude	N24°46′49.85″	N24°46′43.93″	N24°46′39.50″
Longitude	E67°22′31.64″	E67°22′28.95″	E67°22′26.94″
Grain size	Proportion	Proportion	Proportion
0mm	0%	0%	0%
0.005mm	16.0%	18.2%	13.5%
0.075mm	96.8%	94.2%	96.8%
0.090mm	98.2%	95.5%	98.0%
0.125mm	99.0%	97.8%	99.0%
0.250mm	99.2%	99.0%	99.2%
0.335mm	99.5%	99.4%	99.5%

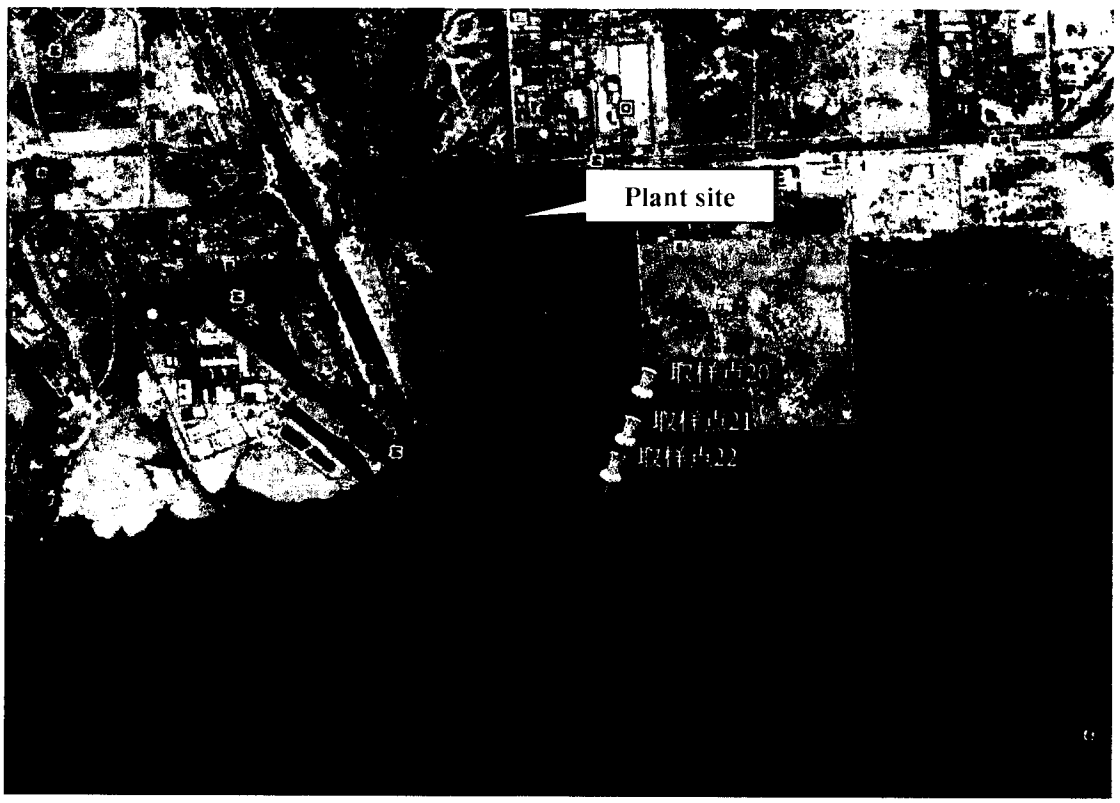


Figure 4.4-5 Sampling points for silt grain size analysis

4.4.6 Marine Organism

Seawater salinity is high in Qasim for most of the year (about 37~41%) except the non-monsoon season. High salinity is a key factor to affect the marine animal and algae. High

salinity, appropriate sediment and silt bed form environmental conditions for marine animal and algae, and hydrological condition at the seaport is much different from that at the bay. At present, organic biological filtration absorption is lacking inside the bay. The algas in this region are mainly tropical and subtropical species.

As the main plant species, mangrove in this region is sparser than that in other regions, since there is no fresh water injection in this region. There are just a few algae in this region, as the silt in water is lack of hard substances and is with high salinity.

Pelagic species like fish, shrimp and crab are common, as well as lots of juvenile prawn and fish populations. The most common fishes are Terapon jarbua, mudskipper and pony fishes, etc, and boleophthalmus dussumieri is the most common and suitable for growing here.

The commercial fishing is in ways of net throwing, beach purse-seining and net casting. The shrimp fishing is very simple with purse-seining in the port channel bed. The offshore bay usually is the fishing center, mainly with juvenile shrimps and a variety of fishes.

Zooplankton: known from samples collected in study period, there are rich seasonal planktonic animals in sea area near the project, such as ctenophore, chaetognath and juvenile fishes. From Mar to Aug, juvenile fishes are very common, with the maximum density of 125*125/m^3 in April, while in Jan, Mar, Apr and Jul, fish balls are in small quantity.

The zooplankton species nearby the port include: juvenile fishes, fish balls, crustaceans, annelids larvae, gastropod larvae, bivalve larvae, heterogastropoda, chaetognaths, pteropods, cysticerus, hydrozoans, jellyfishes, coscinodiscus, hemidiscus hardmannianus, ceratium, chaetoceros, pyrrhophyta, noctiluca scintillans, and the like.

Phytoplankton: centric diatom, flagellates and tintinds are the most common, while pennate diatoms, coccolithophorids, formanaiferan and radiolarians are the least common.

4.5 Ash Yard

Dry ash handling system will be adopted for two (2) 660MW units, with total capacity of 94.23×10^4 t/a, including fly ash and bottom ash of 72.99×10^4 t/a, rejects of 4.66×10^4 t/a, and desulphurization gypsum of 16.58×10^4 t/a.

To avoid the impact of the industrial park planning, set ash yard at the outside of industrial park, about 10 kilometers straight away from the northeast of power plant. There are no buildings (structures) in the ash yard. The ground surface is covered by sandy soil, with sparse shrubs and weeds growing. The topography slopes down from north to south, with average elevation of 39.0～42.0m,. The ash yard is about 10 kilometers straight away from the sea, so it can not be affected by seawater and flood. The maximum rainfall in 24 hours is 278mm, which is occurred in August 1953.

The ash yard will be designed as plain ash yard, the experience stacking height of fly ash and bottom ash is about 10m～15m by truck.

The initial ash yard is designed with five-year storage amount, covering an area of $49\times10^4m^2$ （700m×700m）. When the stacking height of fly ash and bottom ash reaches 13m, the storage capacity will be $492.94\times10^4m^3$, meeting five-year storage demand for 2×660MW units. The details are shown in Drawings F06221K-S02-02, F06221K-S02-03.

There are enough land surround the initial ash yard for further expansion, which can meet twenty-year storage demand for 2×660MW units. When covering an area of $169\times10^4m^2$ （1300m×1300m）, the stacking height of fly ash and bottom ash reaches 13m, the storage capacity will be $1920.89\times10^4m^3$, meeting twenty-year storage demand for 2×660MW units.

In addition, an on-site emergency ash yard of plain type will be located at the southeast of plant area, covering an area of approximately $18.20\times10^4m^2$, with due consideration of the optimum utilization of land acquisition and the uncertainty of offsite ash yard. When the stacking height of fly ash and bottom ash reaches 11m, the storage capacity will be $148.34\times10^4m^3$, meeting 1.5-year storage demand for 2×660MW units. The details are shown in Drawing F06221K-S02-04.

It is suggested to confirm the land acquisition of offsite ash yard and the comprehensive utilization of fly ash and bottom ash, so as to avoid risks and reduce investment on ash yard.

4.6 Seismic, Geology and Geotechnical Engineering

4.6.1 Geological Structure and Seismic Stability

4.6.1.1 Regional Geology

In geology, Karachi sag lies in the south of Kirther fold structure, which belongs to: marine terrestrial sediment, calcareous terrestrial sediment, oligocene sediment and late tertiary sediment. The fold structure in early tertiary and mesozoic sedimentary formation is covered by oligocene and late tertiary sedimentary formation.

Karachi sag includes Mor mountain, Pab mountain and western Bela ophiolite area, eastern and northern Kirther mountain, India Delta, southeastern and southern Arabian Sea. In the south, Karachi sage, nearly asymmetrical syncline, extends to Arabian Sea. Its eastern branch is wider and lager than its western branch. The significant stress of the sage fold makes its strike running toward south-north instead of southwest. The sag is divided into three main areas.

(1) **Northern relative rise area**

The area contains a series of anticlines in Thana, Bula, Khan and Karchat. It is shown in report that, in the east part of this region, Lakhra anticline continues to rise recently.

(2) **Southern sag area**

This part is mainly composed of Miocene Gaj stratum, occasionally covered by Manchar stratum and Quaternary sediment. Many small-scale linear propagation folds develop in partial sag area. An obvious ridge is formed in Gaj stratum that is mainly composed of limestone, in addition, a valley is created by earlier or older stratum mainly consisting of sandstone and shale. Manchar stratum is mainly composed of sandstone and shale also.

(3) **Western uniclinal structure**

It is formed by the action of nosing-like anticlines of Mangho Pir and Hub River (Cape Monze). Because the central axis extends toward southwest instead of south-north, it bears a considerable stretching effect. The fault in northeast-southwest direction together with the nosing-like anticline of Mangho Pir, inferred as Kutch fault, insert and stretch across the southern settlement area

4.6.1.2 Regional Structure

Pakistan's coastal areas, as a whole, can be divided into three tectonic belts: a group of east-west mountains in parallel in western Makran coastal area, Sindh southern plains in the east; the north-south fold belt which is regarded as the central dividing line formed during the collision period when Indian Plates undergone base division. The tectonic fracture of major structures in the vicinity of proposed plant is shown in Figure 4.6-1.

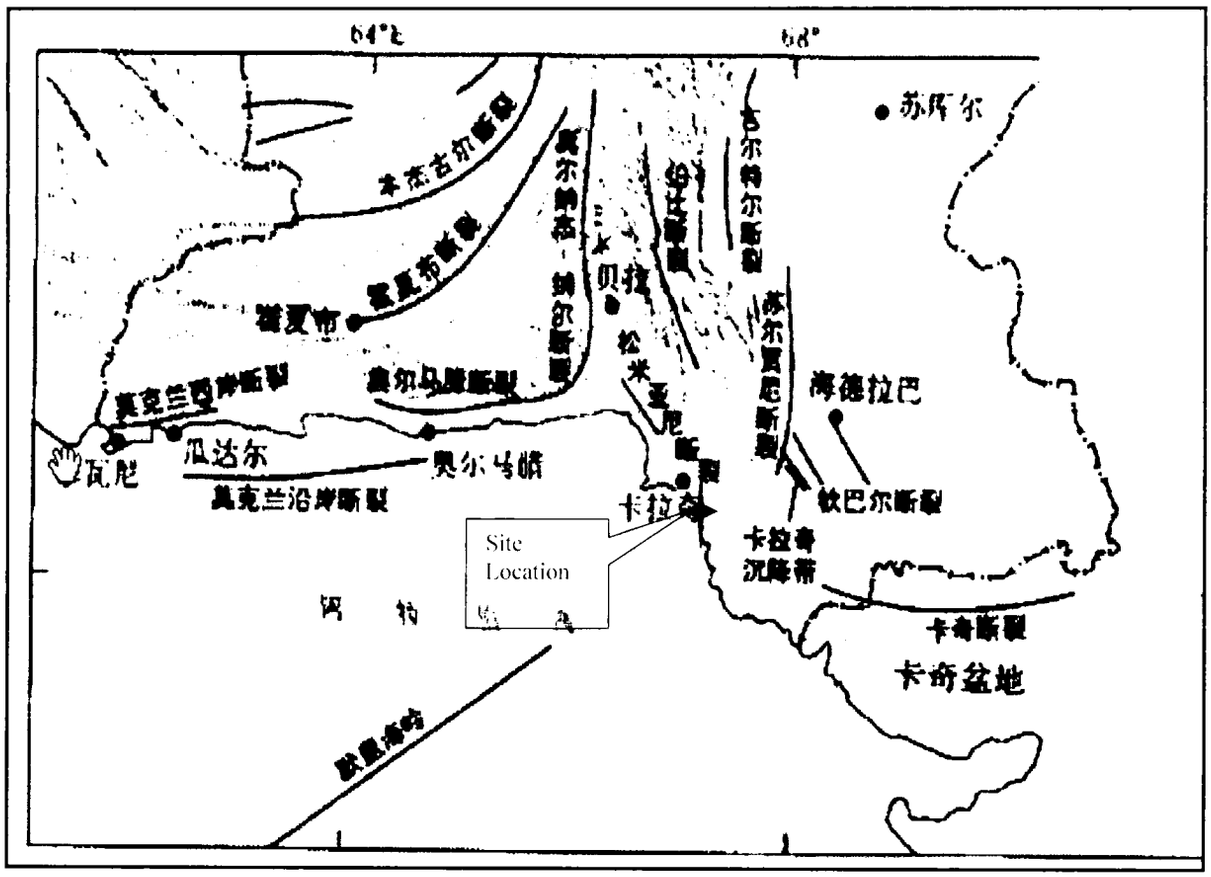


Figure 4.6-1 Tectonic Fracture of Major Structures in the Vicinity of Proposed Plant

The main fracture properties in the vicinity of the proposed plant are described as follows:

(1) Ornach-Nal fault: running north-south in 300km length, twists to left. Despite of tectonic movement, no strong earthquake is recorded. The main earthquake recently took place in the north and acted weakly. The proposed plant site is about 160km away from this fault.

(2) Pub fault: about 110km in length, lies to the east of Pub Mountains. Despite of no strong earthquake recorded, the seismic activity here is very frequent, and moderate earthquake occurred between Pub fault and Ornach-Nal fault, especially in the north. But it is difficult to connect it with geological structure. The proposed plant site is about 100km away from this fault.

(3) Kirthar fault: composed of several north-south sinistral faults twisting to left is situated to the east of Kirthar Mountains and the seismic activity belongs to medium type. The proposed plant site is about 210km away from this fault.

(4) Surjani-Tsimbal fault: 165-km-length Surjani fault, running north-south, is to the east of Larkanna, and cuts off Quaternary sediment along Surjani Mountain. It is a seismically active region. Tsimbal fault, to the south of Surjani fault, is composed of three northwest-southeast faults; the longest one is about 50km in length and destructive earthquake hit this region twice

historically The proposed plant site is about 100km away from this fault.

(5) Kachchh fault: is an east-west complex fault, according to aerial photograph and geological description, two strong earthquakes hit this region twice in the history. The intensity of earthquake occurred in 1819 reached VIII~IX, the area in size of 16km (width)×80km (length) suffered from land upheaval, the alluvial deposit on an east-west slope was lifted up to 7 m. Another strong earthquake took place again in 1845, with intensity of VII~VIII. The proposed plant site is about 150km away from this fault.

4.6.1.3 Earthquakes

Earthquakes hit Pakistan many times in history before, but rarely did tsunami. Northern Pakistan and Balochistan are hit by small earthquake every year. Pakistan's earthquake recorded is shown as below:

Table 4.6-1 Intensity of Main Earthquake in Pakistan

SN	Time	Epicentral Location	Death and Loss
1	In 894	An earthquake hit Shah Bundar, Sindh province	Killing 150,000 people
2	In 1668	An earthquake hit Shah Bundar once again.	Killing 50,000 people
3	In 1819	An earthquake hit Allahbun.	Killing 3,200 people
4	In 1827	An earthquake hit Lahore	Killing 1,000 people
5	In 1852	An earthquake hit a small city in Baluchistan.	/
6	In 1865	An earthquake occurred in Peshawar.	/
7	In 1889	An earthquake hit a remote area in Baluchistan.	/
8	From1892 to 1931	A series of earthquake hit Baluchistan.	/
9	1935	A 7.7-magnitude earthquake hit Baluchistan.	Killing 60,000 people
10	In 1945	An earthquake and tsunamis hit along the coast of Pakistan, the only tsunamis recorded in Pakistan's history.	Killing 4,000 people
11	In 1974	A 6.2-magnitude earthquake hit Hunza valley.	Killing 5,000 people
12	In 2005	A 7.8-magnitude earthquake hit Kashmir and Khyber.	Killing 80,000 people
13	In 2008	A 6.2-magnitude earthquake hit Baluchistan.	Killing200 people
14	In 2011	A 7.4-magnitude seismic hit Baluchistan. Pakistan, India and Dubai had obvious or strongly felt.	/

With reference to above data, the largest earthquake in Pakistan history hit Makran coast (Baluchistan) in November 28, 1945 21:56UTC (03:26IST), the epicenter was at Arabian sea 24.5 degrees north latitude, 63 degree east longitude, 100km away from the south of Karachi, 87km south southwest of Pakistan Churi (Baluchistan province). The seismic was measured 7.8 on the Richter scale and later revised as 8.0 with the help of seismographic stations in New Delhi, Calcutta and Kodaikanal. Followed by devastating tsunami in Arabian Sea and

Indian Ocean. it killed more than 4.000 people along Makran seashore in Pakistan as well as caused fatalities and considerable destruction to Iran. Amman and west coast of India.

According to seismic magnitude and location of coastal area (see Figure4.6-2) in Seismic Hazard Analysis Report of Pakistan Coastal Area. the project. geographically. is located in the Kachchh seashore saline soil plain seismic tectonic unit (VI zone).

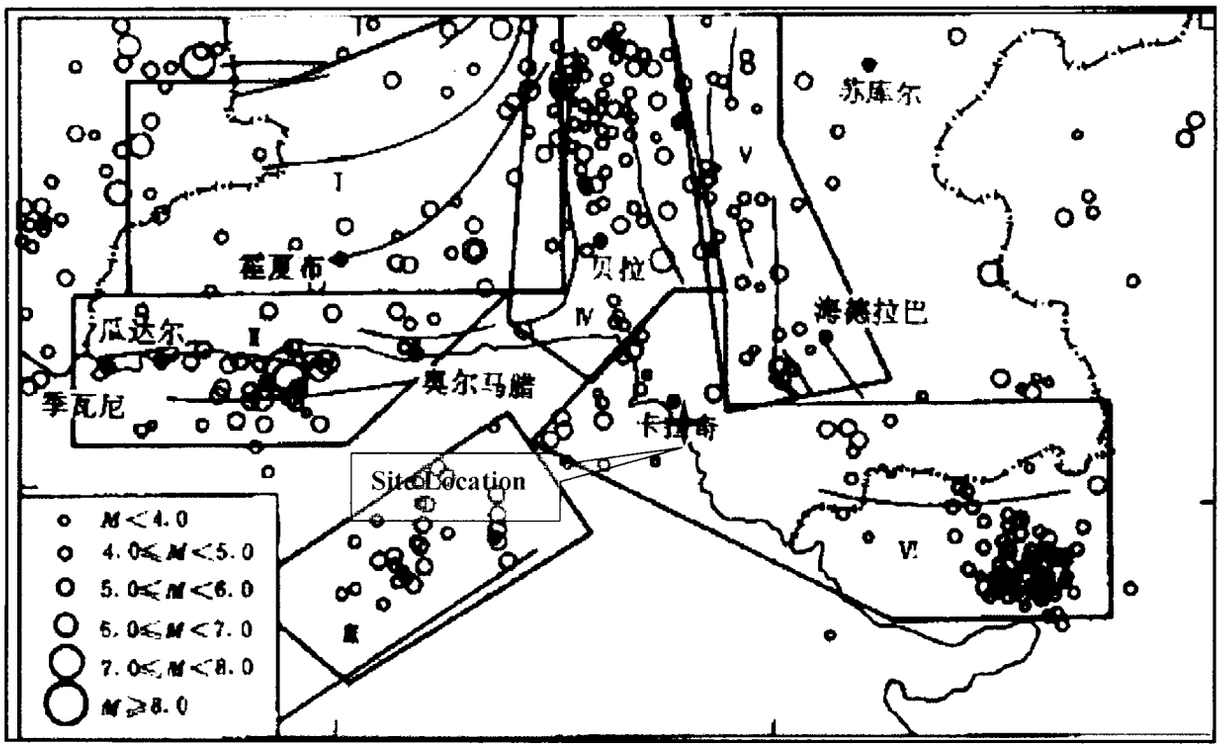


Figure 4.6-2 Seismic Magnitude and Location in the Vicinity of Proposed Plant

It is shown in figure 4.6-2 that Pakistan coastal area belongs to the seismic prone zone. but none of destructive strong seismic hit Karachi (in which the project is located) and its neighboring area. With reference to 1962~1998 seismic data provided by Sindh meteorological and seismological Bureau, all seismic magnitude in Karachi were of less than 5.00.

Table 4.6-2 Earthquakes Occurred Nearby Karachi

Year	Longitude	Latitude	Depth	Magnitude (Richter)	Intensity (mm)	Location
1962	24.70	66	0	4.50	-	Karachi
1965	25.03	67.76	40	4.50	-	Karachi
1966	25.0	68.0	-	5.00	VI-VII	Jhimpir
1968	24.61	66	19	4.10	-	Karachi
1970	25.28	66.65	33	4.90	V	Karachi
1971	25.00	68.00	-	4.50	V	
1972	25.35	66.71	33	4.50	V	Karachi
1973	25.48	66.33	57	4.90	V	Karachi
1975	25.50	66.80	-	4.50	V	Gadani
1976	24.96	70.38	14	4.70	V	Karachi
1984	25.86	66.41	33	4.70	VI	Karachi

Year	Longitude	Latitude	Depth	Magnitude (Richter)	Intensity (mm)	Location
1985	24.90	67.39	33	5.00	VI	Karachi
1986	25.34	66.60	33	4.60	V	Karachi
1998	25.69	66.46	33	4.40	V	Karachi
1998	24.85	66.35	33	4.50	V	Karachi

4.6.1.4 Site Seismic Stability

The fault structure and seismic data shows that the seismic activity in the neighboring is relatively strong, but the fractures is far away from proposed plant site, beyond the safety distance as specified in current seismic design code. No destructive strange seismic hit in the vicinity of plant site ever, hence it belongs to relatively stable area and is favorable for the construction of power plant.

4.6.2 Geological Conditions

The stratums, within depth of 40.00m in plant site, composed of Quaternary artificial accumulation layer (Q_4^{ml}), Quaternary paralic sedimentary layer (Q_4^{mc}), Quaternary slope eluvium (Q_4^{dl+cl}) and Triassic conglomerate (T) on the basis of geological investigation on site, are divided into four main stratums and several sub-stratums from top to bottom, with details described as follows:

1) Quaternary Artificial Accumulation Layer (Q_4^{ml})

①Plain fill layer (Q_4^{ml}) : in brownish yellow; with slight moisture; in medium density, with cohesive soil and gravel sand as the mains; distributed outside the newly-built power plant proposed; The plain fill for road embankment in port industrial area is in slight density with thickness of 4.0～9.0m.

2) Quaternary Paralic Sedimentary Layer (Q_4^{mc})

② Silty sand layer: in brownish gray; in slight density, in wet-saturated, with poor grain gradation and impure sand, mixed with clay about 5～15%, with quartz-feldspathic as mains, in form of fine sand in some districts.

As dominant components of paralic sedimentary layer, it has a good continuity in distribution and has been revealed in all drillings.

This layer is 1.50～7.50m in thickness. The base plate is with embedded depth of 3.00～9.00m and elevation of -5.20～-0.10m.

$②_1$ coarse sand layer: in brownish yellow and brownish grey; in wet-saturated, in slight ~medium density, with relatively pure sand and quartz-feldspathic as mains, is discontinuity distributed in ② silty sand layer in interlayer and lens form. It has been revealed in some

drillings

This layer is 1.30～3.50m in thickness. The base plate is with embedded depth of 1.30～3.50m and elevation of -2.40～2.30m.

②$_2$ Silty clay layer: in brownish yellow, grayish black; in slightly fishy smell, in plastic and soft plastic form; with knife cut mask of fine gloss, on less dry strength, mainly distributed in silty sand ②layer in interlayer form. It is widely distributed and belongs to weak layer.

This layer is 0.90～7.90m in thickness. The base plate is with embedded depth of 2.50～10.20m and elevation of -7.90～1.12m.

3）Quaternary Slope Eluvium（Q_4^{dl+el}）

③Gravel silty clay layer: in brownish yellow~brownish gray; in rigid plastic-solid form; with gravel sand content of 30～40%; partially mixed with a small quantity of pebble with difficulty in dry drilling due to calcitic cementation and solid stratum:

In standard penetration test (SPT), the drill rod reacts strongly; most of drillings with heavy thickness are revealed in such layer and widely distributed.

This layer is 1.50～18.70m in thickness. The base plate is with embedded depth of 7.50～26.50m and elevation of -22.90～-3.88m.

③$_1$ Coarse sand layer: in brownish yellow; in slight density~ density, in wet-saturated, with relatively pure sand and quartz-feldspathic as mains, mainly distributed above ③ gravel silty clay layer. Most drillings are revealed.

This layer is 1.50～6.40 m in thickness. The base plate is with embedded depth of 8.00～18.00 m and elevation of -14.20～-4.56.

4）Triassic Conglomerate Layer（T）

The underlying bedrock within the proposed site is the conglomerate layer, with heavy thickness and in stable position.

④$_1$ Conglomerate layer: in brownish yellow, brownish gray, and maroon; gravels are mainly consisted of sand stone, granite, and basalt in mosaic texture; with calcareous cementation, medium-thick formation and broken rock; rock cores are in form of fragment, gravel-cobble and sand stone, a few of them are in short column form. The rock mass index is RQD=0～15%; all drillings in field are revealed in such layer.

Such layer is underlying bedrock layer in a stable state, most parts are unrevealed, the revealed parts are with the minimum thickness of 1.50m and the maximum thickness of

19.5m.

④$_2$ Conglomerate layer: in brownish yellow, brownish gray; and maroon; gravels are mainly consisted of sand stone, granite, and basalt, in mosaic texture; with calcareous-siliceous cementation, medium-thick formation, medium weathering; rock cores are in form of fragment and short column; The rock mass index is RQD=20～40%. Part of drillings are revealed up to this layer with thickness of 1.90～20.50m.

Most parts are not drilled through and revealed parts are with max. thickness of 12.00m.

The physical and mechanical indexes of ground soil are shown in Table 4.6-3; the frozen soil has no impact on this region.

Table 4.6-3 Physical & Mechanical Parameters for Ground Soil at Site

No.	Stratum	Parameters	Natural water content ω (%)	Mass density ρ (g/cm³)	Dry density ρ_d (g/cm³)	Natural void ratio e	Liquid limit ω_L (%)	Liquid index IL	Direct shear		Compressibility factor	Compression modulus	Blow number of standard penetration N (blow/30cm)	Modified blow number of standard penetration N (blow/30cm)	The characteristic value of bearing capacity fak (kPa)
									Cohesion Cq (kPa) (direct shear)	Internal friction angle φq (degree) (direct shear)	α 0.1-0.2 (1/MPa)	Es 0.1-0.2 (MPa)			
①	Plain fill	Max. value													100~120
		Min. value													
		Average value													
		Variation coefficient													
		Proposed value		1.90					5.0	15.0		8.0			
		Quantity													
②	Silty sand	Max. value	23.1	1.99	1.71								22.0	21.4	120
		Min. value	13.1	1.98	1.68								3.0	2.8	
		Average value	16.6	1.99	1.69								10.3	10.0	
		Variation coefficient											0.510	0.512	
		Standard value	16.6	1.99	1.69				5.0	20.0		5.0	8.6	8.3	
		Quantity	3		2								28	28	
②1	Coarse sand	Max. value											23.0	23.0	140
		Min. value											3.0	3.0	
		Average value											9.8	9.7	
		Variation coefficient											0.709	0.712	
		Standard value		1.80					5.0	25.0		6.0	4.0	4.0	
		Quantity											6	6	

Continued Table 4.6-3 Physical & Mechanical Parameters for Ground Soil at Site

No.	Stratum	Parameters	Natural water content ω (%)	Mass density ρ (g/cm³)	Dry density ρ_d (g/cm³)	Natural void ratio e	Liquid limit ω_L (%)	Liquid index IL	Direct shear		Compressibility factor	Compression modulus	Blow number of standard penetration N (blow/30cm)	Modified blow number of standard penetration N (blow/30cm)	The characteristic value of bearing capacity fak (kPa)
									Cohesion Cq (kPa) (direct shear)	Internal friction angle φq (degree) (direct shear)	α 0.1-0.2 (1/MPa)	Es 0.1-0.2 (MPa)			
②₂	Silty clay	Max. value	41.64	1.99									14.0	14.0	90
		Min. value	14.20	1.81									3.0	2.6	
		Average value	24.32	1.90									5.9	5.5	
		Variation coefficient											0.547	0.567	
		Proposed value	24.32	1.90					15.0	10.0		3.0	4.8	4.4	
		Quantity	5	5									25	25	
③₁	Coarse sand	Max. value	24.2	1.83									70.0	61.6	220
		Min. value	8.8	1.83									10.0	8.4	
		Average value	16.5	1.83									34.2	29.3	
		Variation coefficient											0.583	0.602	
		Standard value	16.5	1.83					10.0	30.0		15.0	20.7	17.4	
		Quantity	2	1									8	8	
③	Gravel silty clay	Max. value	23.5	2.07									375.0	283.7	250
		Min. value	8.8	1.88									21.0	18.4	
		Average value	12.8	1.97									134.0	103.5	
		Variation coefficient											0.752	0.727	
		Standard value	12.8	1.97					25.0	30.0		25.0	98.9	77.3	
		Quantity	13	4									25	25	

Continued Table 4.6-3 Physical & Mechanical Parameters for Ground Soil at Site

No.	Stratum	Parameters	Natural water content ω (%)	Mass density ρ (g/cm³)	Dry density ρ_d (g/cm³)	Natural void ratio e	Liquid limit ω_L (%)	Liquid index IL	Direct shear		Compressibility factor	Compression modulus	Blow number of standard penetration N(blow/30cm)	Modified blow number of standard penetration N (blow/30cm)	The characteristic value of bearing capacity fak (kPa)
									Cohesion Cq (kPa)(direct shear)	Internal friction angle φq (degree) (direct shear)	α 0.1-0.2 (1/MPa)	Es 0.1-0.2 (MPa)			
④$_1$	Strong-weathered conglomerate	Max. value		2.15									77.0		300
		Min. value		2.05									50.0		
		Average value		2.10									62.8		
		Variation coefficient											0.198		
		Proposed value		2.20								30.0	50.9		
		Quantity		2									5		
④$_2$	Medium-weathered conglomerate	Max. value													500
		Min. value													
		Average value													
		Variation coefficient													
		Proposed value		2.40								60.0			
		Quantity													

4.6.3 Hydrogeology Conditions

4.6.3.1 Surface Water

The surface water mainly comes from the gulley in the middle part of plant area which is sourced from the sewage produced by the neighboring plant. As the gulley will be cut off after hydraulic reclamation, a channel shall be built for its dredge and to avoid the power plant being suffered from the scour in the flood period.

4.6.3.2 Underground Water

In investigation, the embedded depth of ground water observed in drillings is 0.00～0.70m. Ground water mainly consists of pore groundwater within Quaternary stratum and fissure water within bedrock. The ②silty sand layer and $②_1$ coarse sand layer are main aquifers of pore groundwater. Bedrock fissure water mainly exists within Triassic conglomerate.

Overall, the shallow stratum has good permeability. The groundwater level is affected by tide, causing frequent alternation of rising and decline. The embedded depth of groundwater in site may consider 0.0m given rising tide's impact upon the depth of groundwater level.

4.6.4 Water and Soil Corrosion

Considering Class I geological condition, in the alternation of drying and wetting, the groundwater (seawater) is strongly corrosive to concrete structure and the rebar of reinforced concrete structure; in the condition of long-term water immersion, the groundwater (seawater) is strongly corrosive to concrete structure and weakly to moderately corrosive to the rebar of reinforced concrete structure.

In the alternation of wetting and drying, the surface water (mainly refers to the sewage discharged by neighboring plants) is weakly corrosive to concrete structure and moderately corrosive to rebar in reinforced concrete structure. In the condition of long-term water immersion, it is slightly corrosive to concrete structure and the rebar in reinforced concrete structure.

The ground soil is strongly corrosive to concrete structure, rebar in reinforced concrete structure and steel structure.

Based on the evaluation of underground water and ground soil corrosion to construction materials, the foundation of buildings shall take anticorrosion measures in compliance with relevant provisions in *Code for Anticorrosion Design Industrial Constructions* GB50046-2008.

4.6.5 Seismic Effect of Site and Ground

4.6.5.1 Category of Construction Site and Seismic Parameters

It is comprehensively determined that the proposed plant site belongs to adverse seismic area

in accordance with the provision in *Code for Seismic Design of Buildings*（GB50011-2010）, with due consideration of its landform and stratum lithology.

Three wave velocity test holes are designed in survey and exploration for determining the category of construction site for proposed power plant. The result shows: the equivalent shear wave velocity of the stratum in the site is between 213.0 and 258.0m/s. the average equivalent shear wave velocity of ground soil values 234m/s.

According to regional stratigraphic data. the covering layer of proposed plant site is with thickness of 30.0~50.0m. The type of ground soil is determined as medium-soft soil and the category of site as Class II.

With reference to Seismic Zoning Map of Pakistan (Figure 4.6-3). the proposed plant site is in Seismic Zone 2B where the acceleration of the seismic peak value is 0.16~0.24g. According to Contour Map of Seismic Acceleration of Pakistan (Figure 4.6-4), the plant locates nearby the Zone with acceleration of 0.16g. the basic design acceleration above 10% probability in fifty years takes 0.16g. the corresponding seismic intensity is VII and the characteristic period of response spectra is 0.45s.

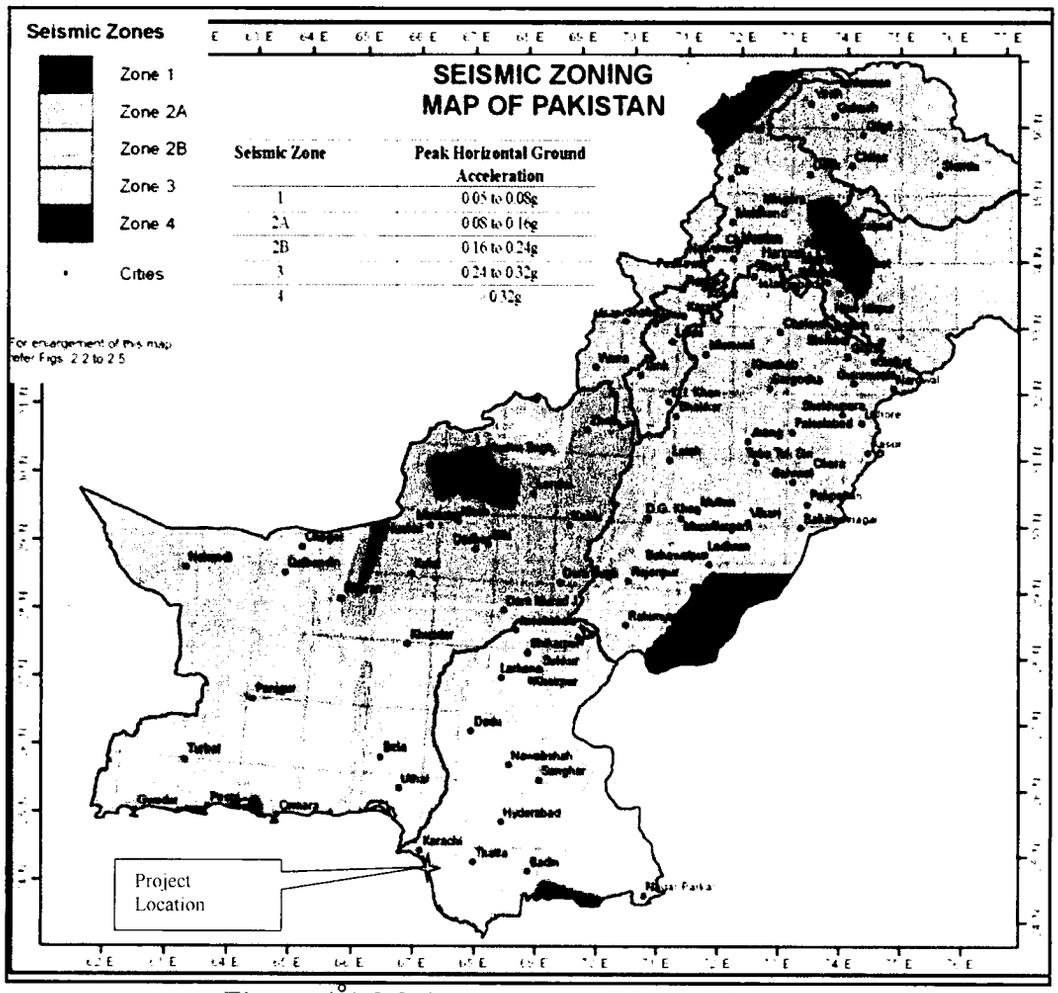


Figure 4.6-3 Seismic Zoning Map of Pakistan

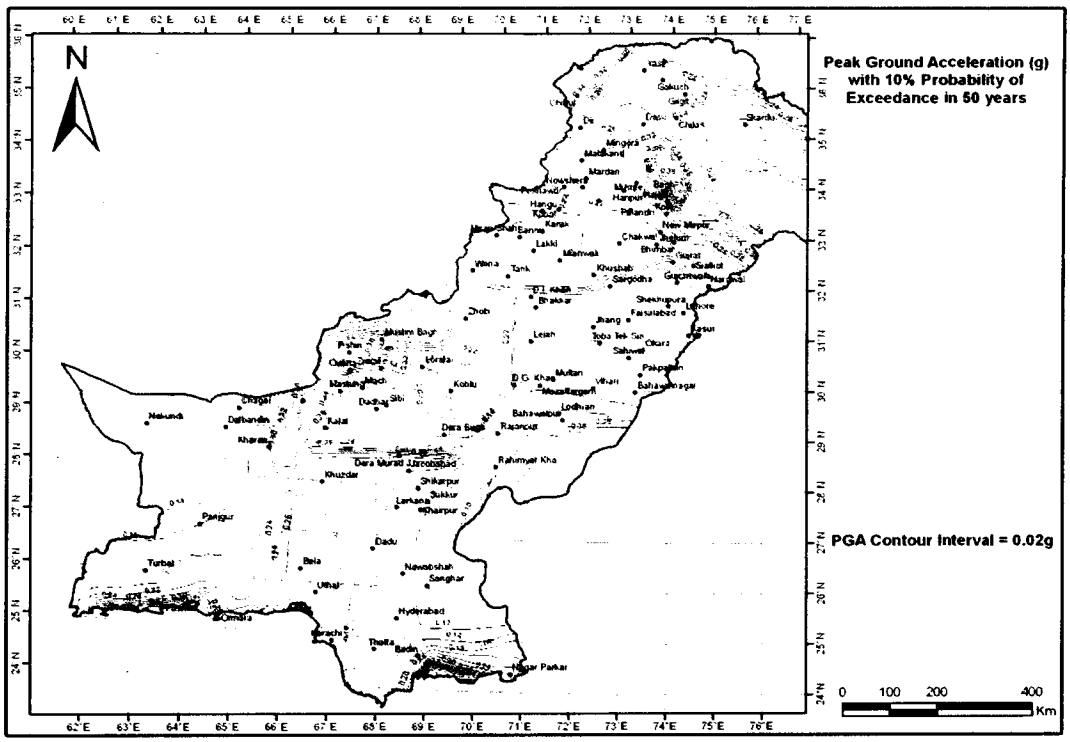


Figure4.6-4 Contour Map of Seismic Acceleration of Pakistan

4.6.5.2 Seismic Effect

When the intensity of seismic at site is considered as VII, most of the saturated sand stratum may suffer from medium liquefaction, a few stratums from slight liquefaction and very few stratums has no liquefaction, for detail plan of seismic liquefaction zones, refer to seismic liquefaction zones map attached with Geological Survey Report. The foundation design shall take the adverse effect of seismic liquefaction into account. The seismic liquefaction conditions of sandy soil in construction sections are shown as below:

Table 4.6-4 Seismic liquefaction

Construction Section	Liquefaction
Hydrogen generation station to be built (Plot Plan S22, same as below)	Non-liquefaction
Bottom ash bin (C01), condensating water polishing regeneration station (S28), ESP(J05), air compressor house and ESP building (J09), fuel oil pump house (J13), etc.	Slight-liquefaction
Others	Medium-liquefaction

4.6.6 Excavation and Dewatering of Foundation Pit

In plant area, the elevation of excavation slope is controlled between 3.0~5.0m. The main factors influencing the slope stability is the shear strength of slope soil and groundwater conditions. The site groundwater lies at a lesser depth; therefore, it is necessary to consider the impact of ground water to the stability of foundation pit slope, and to take necessary steps in the excavation of foundation pit. According to the characteristics of formation permeability,

it is suggested that foundation pit adopts dewatering well or other suitable means. The sandy soil predominates in the stratum, with poor slope stability, so the foundation pit needs to take corresponding measures in excavation. The foundation pit slope above underground water level shall take sloping measures, silt natural angle of repose should be considered as 30~34 °, coarse sand as 33~35 °, at the same time, vehicles and stacking shall be avoided near the pit edge. The permeability coefficient of main soil stratum within the depth of excavation is as shown in Table 4.6-5.

Table 4.6-5 Recommended Permeability Coefficient of Main Ground Soil

Number of Stratum	Stratigraphic lithology	Permeability Coefficient k(cm/s)
②	Fine sand	1.2×10^{-3}
$②_1$	Coarse sand	6.0×10^{-2}
$②_2$	Silty clay	1.2×10^{-5}
③	Coarse sand	2.4×10^{-2}
$③_1$	Gravel silty clay	6.0×10^{-5}

4.6.7 Adverse Geological Action and Geotechnical Engineering

Such adverse geological actions, as landslide, collapse, mud-rock flow, do not exist in proposed plant site. According to data available, the proposed plant site, free from mined-up region and unallowed exploiting region, are favorable for construction.

Main geotechnical engineering issues in proposed site cover ground settlement and deformation of the backfilled area after hydraulic reclamation and leveling, negative friction resistance upon file foundation acted by backfilling soil and weak layer, and seismic liquefaction of saturated sand.

(1) **Settlement and Deformation of Backfilled Ground**

The topography of site is low and its southern half region needs land reclamation backfilling. The reclamation thickness of the site is determined as 1.5-5.5m, based on the design elevation of 5.5m. The engineering geologic and hydrological conditions of the backfilled area in large size and heavy thickness that takes shape after the reclamation will change to some extent. Accordingly, to control fill body and fill ground is of great importance, the sandy soil that is with large grain size and high permeability shall be adopted as much as possible, if necessary, the heavy (dynamic) compaction is applied to reclamation soil.

(2) **Potential Negative Friction Resistance upon Pile Foundation Imposed by Backfilling Soil and Weak Layer**

When the ground is uplifted and leveled, the fill may produce self-weight consolidation

settlement in a long-term. The negative friction resistance is produced by the deformation of loose sand and weak silty clay under additional pressure of fill above, consequently, the resultant downward load will impact on the bearing capacity of pile foundation.

(3) **Seismic Liquefaction of Saturated Sandy Soil**

Because saturated sandy soil exists commonly in the site, when the intensity of seismic is VII, the medium liquefaction may take place in most regions and slight liquefaction may arise in a few regions. Necessary measures shall be taken to eliminate liquefaction settlement, considering the proposed coal-fired power plant belongs to important industrial facilities. Density method such as vibroflotation / broken stone compaction pile, etc. can be used for reinforcement in plant area. After that, inspection shall be carried out, and the blow number of SPT in soil between piles should not be less than the critical value of SPT blow in judging liquefaction. Turbo-generator set, the main power house, boiler house, chimney, cooling tower, and other important building (structure), as well as ordinary building (structure), all adopt the pile foundation and pile end shall enter the liquefaction layer and go into under the stable formation in enough depth to completely eliminate liquefaction effects.

(4) **Gulley Dredging**

By studying its thickness and rising and falling flood, removing all of silty clay layer $②_2$ of the gulley in the middle of plant area with heavy thickness will be in difficulty. Replace it after cleaning at a certain thickness, and use preloading technique or other measures to treat it together with leveled ground.

(5) **Corrosion of Underground Water**

The underground water is highly corrosive to concrete structure and the rebar in reinforced concrete structure, so does the ground soil to steel structure. The precautions in design shall confirm with provisions in *Anticorrosion Design of Industrial Constructions* （GB50046）.

(6) **Gulley Drainage**

It is suggest to build a drainage channel in upstream (northern site) and then divert the gulley in the middle of plant area toward east, then south, (bypass the site), and finally into the sea. It is helpful to eliminate the effects of drainage channel on the site, however, the length of such channel is relatively longer.

(7) **Gas Pipeline in North of Site**

There is a gas pipeline going through cooling tower and other sections in the north of proposed site. It has great impact on the safety in construction and operation of proposed power plant. Moving it southwards is strongly recommended.

4.6.8 Ground Foundation Treatment Scheme

The natural ground cannot meet the demand of design, in terms of high-rise buildings sensitive to settlement (such as main power house, chimney, cooling tower) or ancillary buildings, on account of the poor bearing capacity of ground soil within the range of embedded depth of buildings in plant area, as well as seismic liquefaction and weak subsoil. Building foundation shall adopt foundation treatment or pile foundation based on the actual geological condition of the site.

4.6.8.1 Vibration Crushed Stone Pile

The vibration crushed pile, conductive to increase the bearing capacity of ground soil and eliminating seismic liquefaction, can be used for ground treatment in ancillary building. Silty clay layer, in form of soft plastic-plastic with differing thickness of 1.0~4.0m, exists in the site within 4.0~7.0m depth. Despite the difficulty, pile forming is not unlikely when the undrained shear strength here is not less than 20kPa. In consideration of single-storey building with small load mainly involved in ancillary area, the foundation here shall take vibration crushed stone pile into consideration. The characteristic value of bearing capacity of composite ground is as shown in Table 4.6-6.

Table 4.6-6 Characteristic Value of Bearing Capacity of Vibration Crushed Stone Pile of Composite Ground

Pile diameter (m)	Pile spacing (m)	Characteristic value of bearing capacity of soil between piles fsk before treatment (kPa)	Characteristic value of bearing capacity of soil around pile after treatment fsk (kPa)	Area replacement ratio m	Pile-soil stress ratio of composite ground n	Characteristic value of bearing capacity of composite ground fsp(kPa)
1.1	2.2	120	180	0.226	2.5	241

On the basis of above and previous project experience: for the composite ground of vibration crushed stone pile, with diameter of 1.1m, at interval of 2.2m, shall consider the characteristic value of bearing capacity not less than 240kPa. Only viewed in the characteristic value of bearing capacity estimated, can the vibration crushed stone pile be used in ground treatment of buildings; however, considering the geological conditions of the site and the impact on the bearing capacity of vibration crushed stone pile, in-situ test shall be carried out to determine whether the scheme is doable. If vibration effect is satisfactory, it is possible to adopt vibration crushed stone pile for buildings with small load in main power house area.

4.6.8.2 Pile Foundation

From the perspective of ground soil conditions at site, the main power house area is under heavy load and natural ground scheme is not applicable for buildings sensitive to settlement. if using vibroflotation treatment is still not satisfactory, buildings in the plant area shall adopt the pile foundation scheme.

When the pile end bearing stratum is composed of high-density gravel silty clay and strong ~ moderately weathered conglomerate, for precast piles both of driven and static pressure type, their pile end are unable to enter the necessary depth of bearing stratum, producing effect on the horizontal bearing capacity and stability. The pile is shorter and the bearing capacity of single pile is lower, hence there are some limitations on the pile arrangement, the precast pile is not proper for the project.

Considering the geological conditions of the site, it is recommended to use bored cast-in-place (punching) pile, which has an advantage in proven technique and offers greater choice in pile diameter, and pile length. The groundwater and ground soil are highly corrosive to concrete structure and the rebar of reinforced concrete structure, so anticorrosion measures shall be taken in compliance with the regulations in *Code for Anticorrosion Design of Industrial Constructions* GB50046-2008

For the standard value (q_{sik}) of ultimate side resistance of bored cast-in-place pile and the standard value q_{sik} of ultimate end resistance. refer to Table 4.6-7.

Table 4.6-7 Recommended Value of Pile Foundation（on bored cast-in-place pile basis）

Number	Stratum	Standard value of ultimate side resistance q_{sik}(kPa)	Standard value of ultimate end resistance Q_{pk}(kPa)	Note
②	Silty sand	25	/	Take values with reference to Table 5.3.1 and Table 5.3.2 in *Technical Code for Building Pile Foundation* JGJ94-2008
$②_1$	Coarse sand	40	/	
$②_2$	Silty clay	25	/	
$③_1$	Coarse sand	80	/	
③	Gravel silty clay	90	1800	
$④_1$	Strong weathered conglomerate	140	2000	
$④_2$	Medium weathered conglomerate	180	2200	

Bored cast-in-place piles with diameter of 800mm and 1000mm are commonly used in China. The filed survey shows that the bored piles with diameter of 600mm, 750mm, 900mm and 1000mm are in common use in Pakistan. Therefore, it offers a range of options for the project. The bearing capacity of single pile with diameters above shall be estimated and calculated to optimize the design of the pile with appropriate diameter.

When loose fill, under consolidated soil, liquefied soil enter relatively hard stratum, the bearing capacity of pile foundation shall consider negative friction in accordance with Section 5.4.2 in *Technical Code for Building Pile Foundations (JGJ94-2008)*.

The standard values of vertical bearing capacity of single-pile with various diameters and the down load acted by negative friction of bored cast-in-place piles are shown in Table 10-4~10-13 of *Feasibility Study Report on Geotechnical Investigation*. The characteristic values of single bored cast-in-place piles can be founded in Table 4.6-8.

Table 4.6-8 The characteristic value for vertical bearing capacity of single bored cast-in-place pile

Pile dia.（mm）	Drilling No.	Effective length（m）	Standard value of vertical bearing capacity of single pile Q_{sk}（kN）	Standard value of down load Q_{gn}（kN）	Characteristic value of vertical bearing capacity of single pile R_a（kN）
D=600mm	S12	24.9	4131.6	213.0	1959.3
	S16	19.0	3148.2	188.4	1479.9
	S38	20.7	3215.9	277.9	1469.0
	S42	21.8	3572.1	230.8	1670.6
	S57	28.1	3654.9	315.6	1669.7
	S61	22.4	3654.9	308.6	1673.2
	S66	15.0	2445.4	308.6	1068.4
	S74	15.0	3172.7	180.1	1496.3
	S84	15.0	2294.7	255.3	1019.7
	S106	15.0	1902.8	339.4	781.7
D=750mm	S12	24.9	5302.2	266.3	2517.9
	S16	19.0	4083.3	235.5	1923.9
	S38	20.7	4167.3	347.4	1910.0
	S42	21.8	4608.7	288.5	2160.1
	S57	28.1	4711.4	394.5	2158.5
	S61	22.4	4711.4	385.8	2162.8
	S66	15.0	3212.3	385.8	1413.3
	S74	15.0	4113.6	225.1	1944.3
	S84	15.0	3025.5	319.1	1353.2
	S106	15.0	2539.9	424.3	1057.8
D=800mm	S12	24.9	5760.0	284.0	2738.0
	S16	19.0	4448.8	251.2	2098.8
	S38	20.7	4539.2	370.5	2084.3
	S42	21.8	5014.0	307.7	2353.1
	S57	28.1	5124.5	420.8	2351.9
	S61	22.4	5124.5	411.5	2356.5
	S66	15.0	3511.8	411.5	1550.2
	S74	15.0	4481.4	240.1	2120.7
	S84	15.0	3310.8	340.4	1485.2
	S106	15.0	2788.3	452.6	1167.9
D=900mm	S12	24.9	5678.5	319.5	2679.5
	S16	19.0	4561.2	282.6	2139.3
	S38	20.7	4556.4	416.8	2069.8

	S42	21.8	4992.8	346.2	2323.3
	S57	28.1	5302.7	473.4	2414.7
	S61	22.4	5302.7	462.9	2419.9
	S66	15.0	3932.7	462.9	1734.9
	S74	15.0	4907.8	270.1	2318.8
	S84	15.0	3605.6	383.0	1611.3
	S106	15.0	2952.8	509.1	1221.8
D=1000mm	S12	24.9	7123.0	355.0	3384.0
	S16	19.0	5539.0	313.9	2612.5
	S38	20.7	5664.1	463.2	2600.5
	S42	21.8	6231.4	384.7	2923.4
	S57	28.1	6322.4	526.0	2898.2
	S61	22.4	6322.4	514.3	2904.0
	S66	15.0	4365.1	514.3	1925.4
	S74	15.0	5489.8	300.1	2594.9
	S84	15.0	4155.7	425.5	1865.1
	S106	15.0	3568.6	565.7	1501.4

It is concluded that the pile with small length can meet the demand of upper load design. Therefore, it is doable for the project.

It is proposed to determine the appropriate pile diameter through studying the construction machinery, schedule, and costs, as well as the stratum differences and pile length, etc and conduct in-situ test pile work as the design basis.

4.7 Conclusions

Based upon the above analysis, it is quite evident that the general construction condition is feasible for the site. However. the geological conditions are not good, gulley diversion. mass backfill, and a lot of foundation treatment work is needed, which may result in a major increase in investment.