中交产业投资控股有限公司

CCCC INDUSTRIAL INVESTMENT HOLDING COMPANY LTD.

No. CIHC/POCPEC/201723

Date: 18 August 2017

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

Subject: Re: Application of China Communications Construction Company Limited for Grant of Generation License in Respect of 300 MW Thermal Power Project, Gwadar, Balochistan

I, Xu Jun, being the duly authorized representative of CIHC Pak Power Company Limited ("CPPCL") by virtue of Board Resolution dated 28th April 2017, hereby apply to the National Electric Power Regulatory Authority for the grant of a Generation License to CPPCL pursuant to section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.

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

A Bank Draft No. 00000424 dated 12-07-2017 drawn on Bank Alfalah in the sum of Rupees 747,880, being the non-refundable licence application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

Date: 18 August 2017

We look forward to your facilitation in this regard

Xu Jun

CEO of CIHC PAK POWER CO.Ltd

Wu Ping

Director

Liu Jinsong

Director

A028101

SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

SECP

COMPANY REGISTRATION OFFICE, KARACHI

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No. 0107593

I hereby certify that CIHC PAK POWER COMPANY 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 Karachi this Ninteenth day of April, Two Thousand and Seventeen.

Incorporation fee Rs. 1,000/= only

(Kashif Mahmood)
Deputy Registrar of Companies

100/773

Certified to be True Copy

Deputy Registrar of Companies

THE COMPANIES ORDINANCE, 1984

(A COMPANY LIMITED SHARES)

ARTICLES OF ASSOCIATION

OF

CIHC PAK POWER COMPANY LIMITED

1. The regulations contained in Table "A" in the First Schedule to The Companies Ordinance, 1984 shall not apply to the Company except in so far as the same are expressly made applicable by the said Ordinance, or these Articles.

INTERPRETATION

2. In the interpretation of these Articles the following expressions shall have the following meanings, unless repugnant to or inconsistent with the subject Articles.

2.1: "Central Depository" means a central depository as defined in clause (cc) of section 2 of the Securities and Exchange Ordinance, 1969 and registered with the Authority under section 32 A of the Ordinance.

2.2: "The Articles" or "These Articles" mean these Articles of Association as originally framed or altered from time to time by Special Resolution;

2.3: "The Ordinance" means the Companies Ordinance, 1984, or any statutory modification or re-enactment thereof for the time being in force in Pakistan;

2.4: "The Company" or "This Company" means **CIHC PAK POWER COMPANY LIMITED**;

2.5: "The Chairman" means the Chairman of the Board appointed from time to time pursuant to these Articles;

2.6: "The Chief Executive Officer" shall mean the Chief Executive Officer appointed from time to time;

2.7: "Board" means a Board of the Directors, elected by the shareholders, to act on their behalf in the management of the Company affairs;

2.8: "The Directors" means the Directors and Alternate Directors for the time being of the Company, or as the case may be, the Directors and Alternate Directors assembled at a Board;

2.9: "Dividend" means the distribution of profits of the Company to its Members and includes bonus shares;

2.10: "Special Resolution" means a special resolution as defined in the Ordinance;

2.11: "Members" means a person whose name is for the time being entered in the Register of Members by virtue of his being a subscribers to the Memorandum of Association of the Company or of his holding by allotment or otherwise any share, scrip or other security which gives him a voting right in the Company.

2.12. "Proxy" includes an attorney duly constituted under a power of attorney;

2.13: "The Memorandum of Association" means the Memorandum of Association of the Company as originally framed or as altered from time to time in accordance with the provisions of the Ordinance.

2.14: "Secretary" shall include a temporary or assistant Secretary and any person appointed by the Directors to perform any of the duties of the Secretary.

2.15: "The Seal" means the common seal adopted by the Company:

2.16: "Month(s)" means a calendar month;

2.17: "The Registered Office" means the Registered Office for the time being of the Company;

2.18: "Persons" includes corporation as well as individuals;

2.19: "The Register" means the Register of Members to be kept pursuant to section 147 of the Ordinance;

2.20: "In Writing" means written or printed or partly written and partly printed or lithographed or typewritten or other substitute for writing:

2.21: Words importing singular number include the plural number and vice versa;

2.22: Words importing masculine gender include the feminine gender;

2.23: Words importing persons shall include corporations.

2.24: "Year" means a calendar year.

2.25: Subject as aforesaid any words or expressions defined in the Ordinance; shall except where the subject or context forbids bear the same meaning in these Articles.

BUSINESS

3. The Company is entitled to commence business from the date of receiving the certificate for commencement of business. The business of the Company shall include all or any of the objects enumerated in the Memorandum of Association.

SHARES AND CAPITAL

4. The authorized capital of the Company is PKR 100,000 (Pak Rupees One Hundred Thousand Only) divided into Ten Thousand (10,000) ordinary shares of PKR 10 (Pak Rupees Ten Only) each with the rights, privileges and conditions attaching thereto as provided by regulations of the Company for the time being with power to increase or reduce its capital and to divide the shares in the capital for the time being into several classes.

5. The shares shall be under the control of the Board of Directors who may allot or otherwise dispose off, the same to such Persons, on such terms and conditions and at such times, as the Board of Directors think fit. Shares may also be allotted in consideration other than cash.

6. Fully paid shares shall be allotted to all subscribers in the first instance and the Company shall not be bound to recognize any equitable, contingent, future or partial claim to or interest in a share on the part of any person other than the registered shareholder, save as herein provided or save as ordered by some Court of competent jurisdiction.

7. The certificate of title to shares shall be issued under the Seal of the Company.

8. Every Member shall be entitled to one certificate for the shares registered in his name, or at the discretion of the Directors to several certificates, each for one or more of such shares.

ALTERATION OF CAPITAL

9. The company may from time to time in a General Meeting by Ordinary Resolution, increase the share capital by such sum, to be divided into shares of such amount, as the resolution shall prescribe.

10. Subject to the provisions of the Ordinance, all new shares shall, before issue be offered to such persons as at the date of the offer are entitled to receive notices from the company of general meetings in proportion, as nearly as the circumstances admit, to the amount of the existing shares to which they are entitled. The offer shall be made by notice specifying the number of shares offered, and limiting a time within which the offer, if not accepted, will be deemed to be declined, and after the expiration of that time, or on the receipt of an intimation from the person to whom the offer is made that he declines to accept the shares offered, the Directors may dispose of the same in such manner as they think most beneficial to the company. The Directors may likewise so dispose of any new shares which (by reason of the ratio which the new shares bear to shares held by person entitled to an offer of new shares) cannot, in the opinion of the Directors, be conveniently offered under this regulation.

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

12. 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 Memorandum of Association, subject, nevertheless, to the provisions of clause (d) of subsection (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.

13. The company may, by Special Resolution, reduce its share capital in any manner and with, and subject to, any incident authorized and consent required, by law.

14. A share premium account may be applied by the Company:

    a) in writing off the preliminary expenses of the Company;

    b) in writing off the expenses of or the commission paid or discount allowed on any issue of shares or debentures of the Company;

    c) in providing for the premium payable on the redemption of any redeemable preference shares or debentures of the Company; or

    d) in paying up un-issued shares of the Company to be issued as fully paid up bonus shares.

CERTIFICATES

15. Every person whose name is entered, as a Member in the Register of Members shall without payment, be entitled to a certificate under the common Seal of the Company specifying the shares held by several Persons. The Company shall not be bound to issue more than one certificate and delivery of a share certificate to any one of several joint holders shall be sufficient delivery to all.

16. Unless the conditions of the issue of any shares, debentures or debentures of stock of the Company otherwise provide, the Company shall within ninety days after the allotment and within forty-five days (or where the transferee is a Central Depository with five days) after receipt by the Company of the application for transfer of any shares, debentures or debenture stock complete and have ready for delivery the certificate of all shares, the debentures, the certificate of all debenture stock allotted or transferred, and unless sent by post or delivered to the person entitled thereto within the period aforesaid the Company shall immediately thereafter give notice to that person in the manner prescribed in these Articles for the giving of notices to Members that the certificate is ready for delivery.

17. If a certificate of shares, debentures or debenture stock is proved to have been lost or destroyed to the satisfaction of the Company, and the Company is requested to issue a new certificate, the Company shall issue a new certificate to the applicant within forty-five days from the date of application.

TRANSFER AND TRANSMISSION OF SHARES

18. All transfers of shares may be affected by transfer in writing in the usual common form under hand only. Whenever shares of different classes have been issued a separate instrument of transfer shall be required for each class of shares unless the Directors resolve otherwise.

19. The transferor shall be deemed to remain the holder of the share until the name of the transferee is entered in the Register in respect thereof. Each signature to such a transfer shall be duly attested by the signature of one credible witness.

20. The directors may decline to register any transfer of shares to transferee of whom they do not approve and shall be bound to show any reasons for exercising their discretion subject to the provisions of Section 77 and 78 of the Ordinance.

21. The Directors may on giving seven days previous notice by advertisement, close the transfer books and Register during such time as the Directors think fit, provided that the closing does not exceed thirty (30) consecutive days.

22. The legal heirs, executors or administrators of a deceased holder shall be the only Persons to be recognised by the Directors as having title to the shares. In case of shares registered in the name of two or more holders, the survivors and the executors of the deceased shall be the only Persons to be recognised by the Company as having any title to the shares.

23. No share can be mortgaged, pledged, sold, hypothecated, transferred or disposed off, by any Member to a non-Member without the previous sanction of the Board of Directors.

BORROWING POWERS

24. Subject to the provision of the Ordinance, the Directors may from time to time at their absolute discretion raise or borrow any sum, or sums of money for the purpose of the Company from banks, firms or companies, particularly a person holding the office of the director, and may secure the payment of money in such manner and upon such terms, and conditions in all respects as they think fit particularly by the issue of debentures of the Company or by making, drawing, accepting or endorsing on behalf of the Company any promissory note or bills of exchange or giving or issuing any other security of the Company.

25. Debentures and other securities may be made assignable free from any equities between the Company and the Persons to whom the same may be issued.

26. Any debentures or other security may be issued at a discount, premium or otherwise and with any special privilege as to redemption, surrender, drawing, allotment of shares, attending and voting at general meeting of the Company or subject to compliance of the provisions of the Ordinance.

RESERVES

27. The Directors may from time to time before recommending any Dividend set aside out of the profit of the Company such sums as they think fit as a reserve for redemption of debentures or to meet contingencies for equalization of or for special Dividends or for rebuilding, repairing, restoring replacing, improving, maintaining or altering any of the property of the Company or for such other purpose as the Directors may in their absolute discretion think conducive to the interest of the Company.

GENERAL MEETINGS

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

29. The Directors may, whenever, they think fit, call an extra ordinary general meeting, and extra ordinary general meetings shall also be called on such requisition, or in default, may be called by such requisitions, as is provided by section 159 of the Ordinance.

30. Where special business is to be transacted at a general meeting, a statement setting out the all such facts, as may be material for the consideration of such business, shall be annexed to the notice of such meeting.

31. The notice of such every general meeting shall prominently specify that a Proxy may be appointed to attend in demanding a poll and vote on a poll in place of the Member appointing him.

STATUTORY MEETING

32. The Company shall hold a statutory meeting as laid down in section 157 of the Ordinance not less than three months and not more than six months from the date that the Company is entitled to commence business.

33. The Directors shall cause the appropriate number of copies certified and delivered to the registrar for registration forthwith after sending the report to the members as per section 157 (5).

NOTICE AND PROCEEDINGS OF GENERAL MEETING

34. Twenty-One 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 manner provided by the Ordinance for the general meeting, to such Persons as are, under the Ordinance or the regulation of the Company, entitled to receive such notice from the Company, but the accidental omission to give notice to, or the non-receipt or notice by, any Member shall not invalidate the proceedings at any general meeting.

35. All business shall be deemed special that is transacted at an extraordinary general meeting, and also all that is transacted at annual general meeting with the exception of declaring Dividend, the consideration of the accounts, balance sheet and the reports of the Directors and auditors, the election of the Directors, the appointment of, and the fixing of the remuneration of, the auditors.

QUORUM

36. No business shall be transacted at any general meeting unless a quorum of Members is present at that time when the meeting proceeds to business; save as herein otherwise provided, Members having twenty-five percent of the voting power present in person or through Proxy and two Members personally present will be quorum of the Company's meeting.

37. 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, and, if at the adjourned meeting quorum is not present within half an hour from the time appointed for the meeting, the Members present being not less than two, shall be a quorum.

38. The Chairman of the Board of Directors, if any, 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 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 Directors is present, or willing to act as Chairman, the Members present shall choose one of their number to be Chairman.

39. The Chairman may, with the consent of any meeting at which the quorum is present (and shall if so directed by the meeting), adjourn the meeting from time to time 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 the meeting is adjourned for ten days or more, notice of the adjourned meeting shall be given as in the case of an original meeting. Save as aforesaid, it shall not be necessary to give any notice of an adjournment of the business to be transacted at an adjourned meeting.

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

41. A poll may be demanded only in accordance with the provisions of section 167 of the Ordinance.

42. If a poll is duly demanded, it shall be taken in accordance with the manner laid down in section168 of the Ordinance and the result of the poll shall be deemed to be the resolution of the meeting at which the poll was demanded.

43. A poll demanded on the election of Chairman or on a question of adjournment shall be taken at once.

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

45. If any votes shall be counted which ought not to have been counted, or might have been rejected, the error shall not vitiate the result of voting unless the error is pointed out at the same meeting and is of sufficient magnitude to vitiate the resolution.

46. The demand for a poll shall not prevent the continuance of a meeting for the transaction of any business other than the question on which the poll has been demanded.

VOTES OF MEMBERS

47. Subject to any rights or restrictions for the time being attached to any class or classes of shares, on a show of hands every Member present in person shall have one vote except for election of Directors in which case, the provisions of section 178 of the Ordinance shall apply. On a poll every Member shall have voting rights as laid down in section 160 of the Ordinance.

48. In the case of joint holders of a share, the vote of the senior who tenders the vote shall be accepted to the exclusion of the votes of the other joint holders, and for such purpose, the seniority of shall be determined by the order in which the names stand in the Register.

49. 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.

50. No objection shall be raised to the qualification of any voter except at the meeting or adjourned meeting at which the vote objected to is given or tendered, any every vote not disallowed at such meeting shall be valid for all purposes. Any objection made under the provisions of this Article shall be referred to the Chairman of the meeting whose decision shall be final and conclusive.

51. On a poll votes may be given either personally or by Proxy.

52. The instrument appointing a Proxy shall be in writing under the hand of the appointer or of his attorney duly authorized in writing. A Proxy must be a Member.

53. The instrument appointing a Proxy and the power of attorney or other authority (if any) under which it is signed, or a notarial certified copy of that power or authority, shall be deposited at the Registered Office of the Company not less than forty-eight 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.

54. An instrument appointing a Proxy may be in the following form, or a form, as near thereto as may be:-

CIHC PAK POWER COMPANY LIMITED

We.. ....of..in the district of .... being Members of **CIHC PAK POWER COMPANY LIMITED** hereby appoint... of.. as our Proxy to vote for us and on our behalf at the (annual, extraordinary, as the case may be) general meeting of the Company to be held on the ....day of .... and at any adjournment thereof.

55. A vote given in accordance with the terms of an instrument of Proxy shall be valid notwithstanding the death or insanity of the principal or revocation of the Proxy, provided that no intimation in writing of such death, insanity or revocation of transfer shall have been received by the Company at least twenty-four hours before the commencement of the meeting or adjourned meeting at which the Proxy is used.

DIRECTORS

56. The number of directors shall not be less than three. The following persons shall be the first directors of the Company and shall hold the office up to the date of the First Annual General Meeting:

1. Mr. Xu Jun;
2. Mr. Wu Ping; and
3. Liu Jinsong.

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

58. Save as provided in Section 187 of the Ordinance, no person shall be appointed as a Director unless he is a Member of the Company.

POWERS AND DUTIES OF DIRECTORS

59. 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 any statutory modification thereof for the time being in force, 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 regulations 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.

60. The Directors shall appoint a Chief Executive Officer in accordance with the provisions of sections 198 and 199 of the Ordinance.

61. The amount, for the time being remaining which has not been discharged, of moneys borrowed or raised by the Directors for the purposes of the Company (other than by the issue of share capital) shall not at any time without the sanction of the Company in general meeting, exceed the issued share capital of the Company.

62. The Directors shall cause minutes to be made in books provided for the purpose:-

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

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

c) of all resolutions and proceedings at all meetings of the Company and of the Directors and of committees of Directors.

DISQUALIFICATION OF DIRECTORS

63. No person shall become the Director of a Company if he suffers from any of the disabilities or disqualifications mentioned in section 187 of the Ordinance and, if already a Director, shall cease to hold such office from the date he so becomes disqualified or disabled.

64. Provided, however, that no Director shall vacate, his office by reason only of his being a Member of any Company which had entered into contracts with, or done any work for, the Company of which he is Director, but such Director shall not vote in respect of any such contract or work, and if he does so vote his vote shall not be counted.

PROCEEDINGS OF DIRECTORS

65. The Directors may meet together for the dispatch of business, adjourn and otherwise regulate their meetings, as they think fit. Questions arising at any meeting shall be decided by a majority of votes. In case of an equality of votes, the Chairman shall have and exercise a second or casting vote. A Director may, and the Secretary on the requisition of a Director shall, at any time, summon a meeting of Directors. It shall not be necessary to give notice of a meeting of Directors to any Director for the time being absent from Pakistan.

66. The Directors may elect the Chairman of their meetings and determine the period for which he is to hold office; but, if no such Chairman is elected, or if at any meeting the Chairman is not present within ten 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.

67. A resolution in writing signed by all the Directors for the time being entitled to receive notice of a meeting of the Directors shall be as valid and effectual as if it had been passed at a meeting the directors duly convened and held.

FILLING OF VACANCIES

68. At the first annual general meeting of the Company, all the Directors shall stand retired from office, and Directors shall be elected in their place in accordance with section178 of the Ordinance for a term of three years.

69. A retiring Director shall be eligible for re-election.

70. The Directors shall comply with the provisions of sections 174 to 178 and sections 180 and 184 of the Ordinance relating to the election of Directors and matters anciliary thereto.

71. 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.

72. The Company may remove a Director but only in accordance with the provisions of the Ordinance.

SECRETARY

73. A Secretary may be appointed by the Directors for such term, at such remuneration and upon such conditions as they may think fit, and any Secretary so appointed may be removed by them, but without prejudice to any claim he may have for damages for breach of any contract of service between him and the Company.

DIVIDENDS

74. The Company in general meeting may declare Dividends but no Dividend shall exceed the amount recommended by the Directors. No Dividends shall be paid otherwise than out of the profits of the Company and in accordance with the Ordinance.

THE SEAL

75. The Directors shall provide for the safe custody of the Seal and the Seal shall not be affixed to any instrument except by the authority of a resolution of the Board of Directors or by a committee of Directors authorized in that behalf by the Directors and the presence of at least two Directors; and those two Directors shall sign every instrument to which the Seal of the Company is so affixed in their presence.

ACCOUNTS

76. The Directors shall cause to be kept proper books of account as required under section 230 of the Ordinance.

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

78. The Directors shall be required by sections 233 and 236 of the Ordinance, to prepare and lay before the Company in general meetings such profit and loss accounts or income and expenditure accounts and balance sheets duly audited and report as are referred to in those sections.

AUDIT

79. Once at least in every year the accounts of the Company shall be audited and the correctness of profit and loss accounts or income and expenditure accounts and balance sheet ascertained by an auditor or auditors and the provisions of the Ordinance in regard to audit and the appointment and qualification of auditors shall be observed.

80. Auditors shall be appointed and their duties regulated in accordance with sections 252 to 255 of the Ordinance.

AUTHENTICATION OF DOCUMENTS

81. Subject to the provision of section 241 of the Ordinance, any Director or the Secretary or any person appointed by the Directors for the purpose shall have power to authenticate any documents affecting the constitution of the Company.

WINDING UP

82. If the Company is wound up, whether voluntarily or otherwise the liquidator may, with the sanction of a Special Resolution, divide amongst the contributories in specie or kind, the whole or any part of the assets and liabilities of the Company, subject to the section 421 of the Ordinance and other provisions of the Ordinance as may be applicable.

INDEMNITY

83. Every Director and other officer or servant of the Company shall be indemnified by the Company against, and it shall be the duty of the Directors to pay out of the funds of the Company, all costs, losses and expenses which any such officer or servant may incur or become liable to by reason of any contract entered into or thing done by such officer or servant as such in any way in the discharge of the duties of such officer or servant including travelling expenses.

84. No Director or other officer of the Company shall be liable for the acts, receipts, neglect or default of any other Director or officer or for joining in any receipt or other act for conformity 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 Directors for or on behalf of the Company or for the insufficiency or deficiency of any security or investment in or upon which any of the money of the Company shall be invested or for any loss or damage arising from bankruptcy, insolvency or tortuous act 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 his office or in relation thereto unless the same happens through his dishonesty.

NOTICES

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

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

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

ARBITRATION

88. Whenever any difference arises between the Company on the one hand and any of the Members, their executors, administrators or assignees on the other hand touching the intent or construction or the incidence or consequences of these presents, or of the statute or touching anything then or thereafter done, executed, omitted, or suffered in pursuance of these presents or of the statute or touching breach or alleged breach or otherwise relating to the premises, or to any statute effecting the Company, or to any of the affairs of the Company, including the fixing of the fair value of the shares of the Company, every such difference shall be referred to the decision of an arbitrator to be appointed by the parties in difference or if they cannot agree upon a single arbitrator to the decision of two arbitrators of whom one shall be appointed by each of the parties in difference or any umpire to be appointed by the two arbitrators.

SECRECY CLAUSE

89. Every director, manager, member of the committee, officer, servant, accountant or other person employed in the business of the Company shall if so require by the Directors before entering upon his duties, sign a declaration pledging to observe a strict secrecy respecting all transactions of the Company with the customers and the state of accounts with individuals, matters relating thereto and shall by such declaration pledge himself not to reveal any of the matters which come to his knowledge in the discharge of his duties except when required to do so by the Directors or by a Court of Law and except so far as may be necessary in order to comply with any of the provisions in these presents contained.

90. We are several Persons whose names and addresses as subscribed below are desirous of being formed into a Company, in pursuance of this Articles of Association, and we respectively agree to take the number of shares in the capital of the Company as set out opposite to respective names:-

DISPUTE RESOLUTION

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

We are several Persons whose names and addresses as subscribed below are desirous of being formed into a Company, in pursuance of this Articles of Association, and we respectively agree to take the number of shares in the capital of the Company as set out opposite to respective names:-

Sr. No.	Name	Father's Name	Nationality / CNIC No.	Occupation	Residential Address	No. of shares taken by each subscriber	Signature
1.	Xu Jun	Xu Xiaosheng	People's Republic of China Passport # PE0110988	Director	Room A903, International Port Apartment, Wu No.2, North Road, East 3rd Ring Road, Beijing, China.	1 (One)	
2.	Wu Ping	Wu Qinglin	People's Republic of China Passport # PE0789815	Director	Room 102, Jinyuan No. 27 Building, No. 12 Chnagqing Garden Community, Dongxihu District, Wuhan, Hubei Province, China..	1 (One)	
3	Liu Jinsong	Liu Shoubao	People's Republic of China Passport # PE1076007	Director	Room 101, No.5 Building, No. 58 Yard, Qingta West Road, Fengtai District, Beijing, China.	1 (One)	
Total Number of Shares Taken						3 (Three)	

Dated: April 17, 2017

Certified to be True Copy

Deputy Registrar of Companies

THE COMPANIES ORDINANCE 1984

(A Company Limited by Shares)

MEMORANDUM OF ASSOCIATION

OF

CIHC PAK POWER COMPANY LIMITED

NAME

I. The name of the Company is "CIHC PAK POWER COMPANY LIMITED".

REGISTERED OFFICE

II. Registered Office of the Company will be situated in the Province of Sindh, Pakistan.

OBJECTS

III. The objects for which the Company is established are: -

1. The principal line of business of the company shall be to carry on all or any of the businesses of generating, purchasing, importing, transforming, converting, distributing, supplying, exporting and dealing in electricity and all other forms of energy and products or services associated therewith and of promoting the conservation and efficient use of electricity and to perform all other acts which are necessary or incidental to the business of electricity generation, transmission, distribution and supply, subject to permission of concerned authorities; and to locate, establish, construct, equip, operate, use, manage and maintain thermal power plants, coal fired power plants, hydal power plants, wind mills, power grid station, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, plant and equipment for combined heat and power schemes, offices, computer centres, shops and necessary devices, showrooms, depots, factories, workshops, plants and to provide transforming, switching, conversion and transmission facilities, subject to permission of relevant authorities.

2. To carry on, manage, supervise and control the business of transmitting, manufacturing, supplying, generating, distributing and dealing in electricity and all forms of energy and power generated by any source whether nuclear, steam, hydro or tidal, water, wind, solar, hydrocarbon fuel or any other form, kind or description.

3. To carry on in Pakistan or abroad the business of establishing, commissioning, setting up, operating and maintaining electric power transmission systems/networks, power systems, generating stations based on conventional/ non-conventional resources for evacuation, transmission, distribution, trading or supply of power through establishing or using stations, tie-lines, sub-stations and transmission or distribution lines in any manner including build, own and transfer, and/or build, own and operate and/or build, own, lease and transfer and/or build, own, operate and transfer basis or otherwise ,and to acquire in any manner power transmission systems/networks, power systems, generation stations, tie-lines, sub-stations and transmission or distribution systems from State Electricity Boards, Power Utilities, Generating Companies, Transmission Companies, Distribution Companies, Central or State Government Undertakings, Licensees, other local authorities or statutory bodies, other captive or independent power producers and distributors and to do all the ancillary , related or connected activities as may be considered necessary or beneficial or desirable for or along with any or all of the aforesaid purposes which can be conveniently carried on these systems, networks or platforms.

4. To purchase, take on lease or in exchange, hire, apply for or otherwise acquire and hold for any interest, any rights, privileges, lands, building easements, trade marks, patents, patent rights, copyrights, licences, machinery, plants, stock-in-trade and any movable and immovable property of any kind necessary or convenient for the purposes of or in connection with the Company's business or any branch or department thereof and to use, exercise, develop, grant licences in respect of or otherwise turn to account any property, rights and information so acquired, subject to any permission required under the law.

5. To purchase or otherwise acquire and undertake all or any part of the business, property and liabilities of any person, firm or company carrying on any business which this Company is authorized to carry on, or the carrying on of which is calculated to benefit this Company or to advance its interest.

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

7. To enter into partnership or into any arrangement for sharing profits, union of interest, joint venture, reciprocal concessions or co-operation with any person, firm, association or company and to lend money to, guarantee the contracts of, or otherwise assist any such person, firm, association or company and to take or otherwise acquire shares and securities of any such association or company and to sell, hold, re-issue, with or without guarantees, or otherwise deal with the same.

8. To issue and deposit any securities which the Company has power to issue by way of mortgage to secure any sum less than the nominal amount of such securities, and also by way of security for the performance of any contracts or obligations of the Company or of its customers or other persons or corporations having dealings with the Company or in whose business or undertakings the Company is interested either directly or indirectly.

9. To receive money on deposit or loan upon such terms as the Company may approve, and to guarantee the obligations and contracts of customers and others.

10. To remunerate any parties for services rendered or to be rendered in placing, or assisting to place, any shares in the Company's capital, or any debentures, debenture stock or other securities of the Company, or in or about the formation or promotion of the Company, or the conduct of its business.

11. To establish and maintain local registers, agencies and branch places of business and procure the Company to be registered or recognised to carry on business in any part of the world.

12. To carry on any other trade or business, whether subsidiary or not, which can, in the opinion of the Company, be carried on advantageously in connection with any of the trades or businesses aforesaid, or which in the opinion of the Board of Directors, will enhance the value of the Company's property or be conducive either directly or indirectly to the attainment of the above objects or any of them.

13. To enter into, make and perform contracts of every kind and character which relate to, concern or affect any and all such business this Company is authorized and permitted to conduct as herein set forth, with any person, firm association, corporation, municipality, state.

14. To act as representatives, for any person, firm or company and to undertake and perform sub-contracts, and also act in the business of the Company through or by means of agents, sub-contractors and to do all or any of the things mentioned herein in any part of the world and either alone or in collaboration with others and by or through agents, sub-contractors or otherwise.

15. To take, acquire, buy, hold, own, manage, work, develop, sell, convey, rent, lease, mortgage, exchange, improve and otherwise operate and deal in, dispose of any moveable and immoveable property in Pakistan and all parts of the world or any interest or rights therein, without limit as to amount; to erect, construct and alter buildings and other structures; to make and enter into any and all manner and kind of contracts, agreements and obligations by or with any person or persons, corporation or corporations and with or by this Company for the erection, construction, equipment, improvement, working, rending, repairing, of any kind, whatsoever with full power to borrow and repay such money as may be required for the purpose of the business of the Company.

16. To guarantee, purchase, hold, sell, assign, transfer, mortgage, pledge or otherwise dispose of shares of the capital stock of, or any bonds, securities or evidence of indebtedness created by any other company, corporation or corporations; organize under the laws of Pakistan or any other state country, nation or government and while the owner thereof, to exercise all the rights, powers and privileges of ownership.

17. To buy and otherwise acquire the whole or any part of business, goodwill property and assets of any person, firm, company for corporation domestic or foreign, engaged in the business of the same general character as that for which this company is organized and to pay for the same in cash, stock, bonds or other securities of this company; and to assume the whole or any part of the liabilities of any such person, firm, company or corporation.

18. To have and exercise all the powers conferred by the laws of Pakistan upon the Company formed under the Companies Ordinance and to do any or all of the things hereinbefore set forth to the same extent.

19. To promote and establish companies and associations for the prosecution or execution of undertakings, works, projects or enterprise of any description, whether of a private or public character in Pakistan or elsewhere, and to acquire and dispose of shares and interest in such companies or associations or in any other companies or associations in the undertakings thereof.

20. To establish and support or aid in the establishment and support of associations, institutions, funds and conveniences calculated to benefit persons who are or have been directors of or who have been employed by or who are serving or have served the Company or any other Company which is subsidiary or associate of the Company or the dependents or connection of such persons and to grant pensions, gratuities, allowances, relief and payments in any other manner calculated to benefit the persons described.

21. To acquire from any sovereign state or authority, supreme, municipal, local and otherwise any concessions, grants or decree, rights or privileges whatsoever which may seem to the Company capable of being turned to account and to work, develop, carry out, exercise and turn to account the same.

22. To construct, maintain, carryout, work, sell, let on hire and deal in all kinds of works, machinery, conveniences and things capable of being used in connection with any of the objects of the Company.

23. To apply for, tender, purchase or otherwise acquire, any contracts, sub-contractor, licenses and concessions for or in relation to the objects or business herein mentioned or any of them and to undertake, execute, carry out, dispose of or otherwise turn to account the same.

24. To let out on hire all or any of the property of the Company whether immovable or movable including all and every description of apparatus or appliances, and to hold, use cultivate, work, manage, improve carry on and develop the undertaking, land immovable property and assets of any kind of the Company or any part thereof.

25. To sub-let all or any contracts from time to time and upon such terms and conditions as may be thought expedient.

26. To buy, sell, manufacture, refine, manipulate, import, export and deal, both wholesale and retail, in commodities, substances, apparatus, machinery, articles and things of all kinds capable of being used or which can conveniently be dealt in by the Company in connection with any of its objects.

27. To acquire and deal with any of the following:

a) Lands, building, easements or other interests in immovable properties for the purpose of the Company;

b) Plant and machinery;

c) Patent, patent rights or inventions, copy rights, designs, trademarks or secret processes; and

d) Shares or stock or securities in or of any company or undertaking the acquisition of which may promote or advance the interest of the Company.

28. To perform or do all or any of the following operations, acts or things:

a) To pay all the costs, charges and expenses of the promotion and establishment of the Company.

b) To erect buildings, plant and machinery for the purpose of the Company.

c) To sell, let, dispose of, or grant rights over all or any property of the Company.

d) To apply for, purchase or by any other means acquire and protect, prolong and renew, whether in Pakistan or elsewhere any trade marks, patents, rights, brevets, invention, licenses, protections, concessions and the like conferring and exclusive or non-exclusive or limited right to user or any secret or other information as to any invention which may seem capable of being used for any of the purposes of the Company or the acquisition of which may seem calculated, directly or indirectly to benefit the Company and to use, exercise, develop or grant licenses in respect of or otherwise turn to account the property, rights or information of acquired.

e) To manufacture, plant, machinery, tools, goods, or things for any of the purpose of the business of the Company.

f) To draw, accept and make an to endorse, discount, execute, retire, issue and negotiate promissory notes, hundies, bills of exchange, bills of lading other negotiable or transferable instruments.

g) To borrow money or otherwise in such manner as the Company may think fit, and in particular by the issue of debentures or debenture stock convertible into shares of this Company, or perpetual annuities; and security of any such money so borrowed, to mortgage, pledge or charge the whole or any part of the property, assets or revenue of the Company present or future, including its capital by special assignment or in trust and to give the lenders power of sale and other powers as may seem expedient and to purchase, redeem, or pay off any such securities.

h) To lend money with or without security and to invest money of the Company in such manner other than in the shares of the Company as the Directors think fit.

i) To accumulate funds and to lend, invest or otherwise employ moneys belonging to or entrusted to the Company upon any shares securities or investments upon such terms as may be thought proper and from time to time to vary such transactions in such manner as the Company thinks fit.

j) To invest deal with the moneys of the Company in any investments movable or immovable in such manner as may from time to time seem expedient and be determined (but not to act as an insurance company) and which are not immediately required for the purpose of its business in such investments or securities.

k) To create any depreciation fund, reserve fund, sinking fund, insurance fund or any special or other fund whether for depreciation, or for repairing, improving, extending, or maintaining any of the property of the Company or for the redemption of debentures or redeemable preference shares or for any other purpose whatsoever conducive to the interest of the Company

l) To enter into arrangements for joint working in business or for sharing of profits or for amalgamation with any other company firm in person carrying on business within the objects of the Company. To enter into any arrangements with any government or authorities, municipal, local or otherwise that may seem conducive to the Company's objects or any of them and to obtain from any such government or authority, any rights privileges and concessions which the Company may think it desirable to obtain and to carryout, executive and comply with any such arrangements, rights, privileges and concessions.

m) To be interested in, promote and undertake the formation and establishment of such intuitions, business or companies (industrial, agricultural, trading, manufacturing and other) which may seem to the Company capable of being conveniently carried on in connection with any of these objects or otherwise calculated directly or indirectly to render any of the Company's properties or rights for the time being profitable and also to acquire, promote, aid, foster subsidies or acquire interest in any industry of undertaking.

n) To sell the undertaking and all or any of the property of the Company for cash or for stock, shares, or securities of any other company or for other consideration.

o) To place to reserve or to distribute as dividend or bonus among the member or otherwise to apply as the Company may from time to time think fit any moneys received by way of premium on shares of debentures issued at a premium by the Company, and moneys received in respect of dividends accrued on forfeited shares, and moneys arising from the sale by the Company of forfeited shares or from un-claimed dividends.

p) To distribute any of the property of the Company amongst the members in species or kind but so that no distribution amounting to a reduction of capital be made except with sanction (if any) for the time being required by law.

29. To form, join or subscribe to any syndicate

30. To guarantee the payment of money un-secured or secured by or payable under or in respect of promissory notes, bonds, debentures, debentures stock, contracts, mortgage, charges, obligations, instruments and securities of or of any authority, supreme, municipal, local or otherwise or of any person whatsoever, whether incorporated of not incorporated and generally to guarantee or become sureties for the performance of any contracts or obligations.

31. To open any current, overdraft, cash-credit, account or fixed account with any bankers, shroff or merchants, including the agents of the Company and to pay money into and draw money from any such account.

32. To insure any of the properties, undertakings, contracts, guarantees or obligations of the Company of every nature and kind in any manner whatsoever.

33. To undertake any trust, the undertaking of which may seem to the Company desirable, and either gratuitously or otherwise.

34. To adopt such means of making known the business and/or products of the Company as may seem expedient and in particular by advertising in the press by circular, by purchase and exhibition of works of art and interest.

35. To do all or any of the things hereinbefore authorized either alone or in conjunction with, or trustees or agents for other or by or through factors, trustees or agents.

36. To do all such other things as are incidental or conducive to the attainment of the above objects or any of them.

37. It is hereby declared and undertaken that the Company shall not engage in banking business or Forex, illegal brokerage, or any business of an investment company, non-banking finance company, leasing, business of managing agency, investment, payment sales receipt scheme and insurance business directly or indirectly as restricted under the law or in any unlawful business or operations and that nothing contained in the object clauses shall be so construed to entitle it to engage in such business directly or indirectly, and the Company shall not launch multilevel marketing (MLM), *Pyramid* and *Ponzi* schemes.

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

39. And it is hereby declared that the word "Company" in this clause shall be deemed to include any partnership or other body of persons whether incorporated or not incorporated and whether domiciled in Pakistan or elsewhere and the intention is that the objects specified in each paragraph of this clause shall except where otherwise expressed in such paragraph, be independent of the main objects and shall be in no way limited or restricted by reference to or in reference from the terms of any other paragraph or name of the Company.

IV. The liability of the Members is Limited.

V. The authorized capital of the Company is PKR 100,000 (Pak Rupees One Hundred Thousand Only) divided into 10,000 (Ten Thousand) ordinary shares of PKR 10 (Pak Rupees Ten Only) each with the rights, privileges and conditions attaching thereto as per provided by regulations of the Company for the time being, with power to increase or reduce its capital and to divide the shares in the capital for the time being into several classes.

We are several Persons whose names and addresses as 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 out opposite to respective names:-

Sr. No.	Name	Father's Name	Nationality / CNIC No.	Occupation	Residential Address	No. of shares taken by each subscriber	Signature
1.	Xu Jun	Xu Xiaosheng	People's Republic of China Passport # PE0110988	Director	Room A903, International Port Apartment, Wu No.2, North Road East 3rd Ring Road, Beijing, China	1 (One)	
2.	Wu Ping	Wu Qinglin	People's Republic of China Passport # PE0789815	Director	Room 102 Jinyuan No. 27 Building, No. 12 Chnagqing Garden Community, Dongxihu District, Wuhan, Hubei Province, China..	1 (One)	
3	Liu Jinsong	Liu Shoubao	People's Republic of China Passport # PE1076007	Director	Room 101, No.5 Building, No 58 Yard, Qingta West Road, Fengtai District, Beijing, China.	1 (One)	
Total Number of Shares Taken						3 (Three)	

Dated: April 17, 2017

Certified to be True Copy

Deputy Registrar of Companies

Sponsor Profile

China Communications Construction Company Limited ("CCCC") is the main sponsor of the Project and will hold 75.5% equity in the Project, while the remaining 24.5% equity will be invested by Tianjin Energy Investment Group Company Limited. Details of project sponsors are in this section

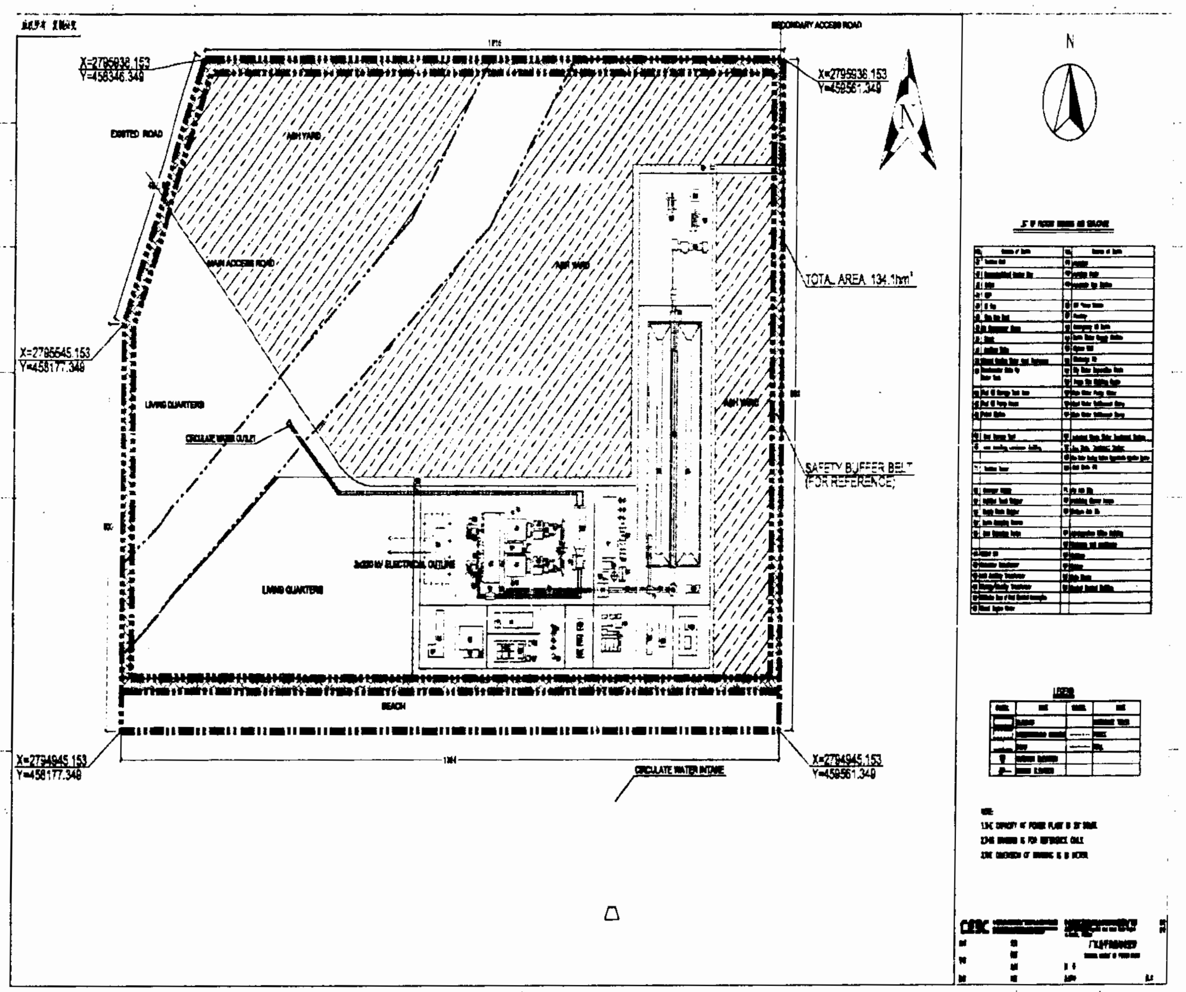
TECHNICAL DETAILS OF THE PROPOSED FACILITIY

Technology, Type and Model of Proposed Facility

1. Plant Technology

The Project considers a 300 MW coal-fired power plant as the total installed capacity. Given the current grid dynamics, the configuration has been decided as 2x150 MW. An option has been left open for a further 300 MW expansion in the future.

1.1 Layout Diagram



Boiler will be ultra-high pressure, once intermediate reheat, natural circulation, single furnace, π-type layout, four-corner tangential combustion, balanced ventilation, all-steel cradle, dry-bottom pulverized coal fired boiler.

Boiler is optimized for the South African bituminous coal. Boiler will be of open-air or semi-open layout; boiler operation floor will have an island-style layout, with one-unit one-boiler system.

The boiler model, its parameters and main technical specifications are as follows:

Maximum continuous evaporation of boiler	t/h	471.1
Superheater outlet steam pressure	MPa(g)	14.42
Superheater outlet steam temperature	°C	541
Reheat steam flow	t/h	389.3
Reheat steam inlet steam pressure	MPa(g)	2.94
Reheat steam inlet steam temperature	°C	359
Reheat steam outlet steam pressure	MPa(g)	2.74
Reheat steam outlet steam temperature	°C	541
Economizer inlet water supply temperature	°C	247
Exhaust temperature	°C	135
Boiler guaranteed efficiency (TRL)	%	92.1
Air preheater type	Three-position rotary type	
Steam temperature adjustment mode	Superheated steam adopts two-stage water-cooled way to adjust the steam temperature, and the reheater adopts flue gas bypass baffle to adjust the steam temperature which is supplemented by micro-sprinkler	

1.2 Turbine and Generator

Steam Turbine

Type	High pressure, once intermediate reheat, single axis, double cylinder double exhaust, single back pressure condensing steam turbine	
Model	N150-13.73/538/538	
Rate power	MW	150
Rated speed	r/min	3,000
Guaranteed heat consumption	kJ/kWh	8,233
Direction	Clockwise	
Main steam quantity	t/h	446
Main steam valve steam pressure	MPa.a	13.73
Main steam valve steam temperature	°C	538
High pressure cylinder exhaust pressure	MPa.a	2.82
High pressure cylinder exhaust temperature	°C	322.4
Reheat steam quantity	t/h	369.2
Combined reheat valve pressure	MPa.a	2.54
Combined reheat valve temperature	°C	538
Exhaust steam pressure	kPa	7.80
Cooling water temperature	°C	Designed: 28; Max: 31
Regenerative heating series	7 grades (2 high + 1 deoxygenation + 4 low)	
Feedwater temperature	°C	245.3

Generator

Model	QF-150-2	
Rated power	MW	150
Rated voltage	kV	15.75
Rated current	A	6,873
Rated power factor	0.80 (lagging)	
Rated speed	r/min	3,000
Cooling method	Air cooling	
Excitation mode	Self-shunt excitation system	

1.3 Combustion and Thermal System

The design scope of the system includes: cold and hot air systems, powder delivery systems, milling systems and flue gas systems.

1.4 Pulverized Coal Preparation System

Pulverization System

This study is based on opposed firing or corner tangential combustion. The type of mill and pulverizing system will be direct-fired milling system based on the coal quality characteristics, the possible coal variation range, the nature of the load, the mill application conditions, in combination with the furnace structure and the burner structure types, etc. The Project is envisaged to use bituminous coal which is very volatile and has explosive properties; the design coal's Hardgrove Grindability Index ("HGI") is 53, with moderate grindability. As per previous available data, the erosion wear index K_e is about 0.95, which is a slight wear. Keeping in view the volatility of the design coal, the grindability index, moisture and ash, and the possible coal varying range, the Project should adopt a medium-speed coal mill with positive pressure primary air fan direct blowing coal pulverizing system. The pulverizing system is described below.

The primary air will be supplied by two primary fans, and will enter the mill through two routes; one route will be heated through the air preheater as the hot primary air, and the other will serve as the pressure cold primary air. And then through the automatic adjustment by mill inlet hot primary air adjusting damper and the cold primary air conditioning damper, the mill inlet can obtain a satisfactory mixture of air temperature and flow. The mill will be equipped with air flow measuring device to measure the amount of primary air and adjust the wind and coal ratio.

The raw coal will be transported to the medium-speed mill by the coal feeder, dried and milled, and then separated from the desiccant (primary air) into the mill outlet separator. The fine pulverized coal enters the furnace for combustion, and the dis-qualified pulverized coal will return to the mill to continue milling, and the alien debris which is hard to mill enters the reject collection system.

Coal Mill

The coal mill will be sourced from China and will be HP-type, medium-speed, bowl-type coal mill produced in China. Medium-speed coal mills produced by Chinese manufacturers have been used before for 150MW to 350MW units. Each boiler will equipped with four HP-type mills, of which three are running and one spared.

Primary Air Fan

Since the cold primary air fan has such characteristics as little wind volume, high pressure, high speed, high requirements for the manufacture of materials, the Project will use double suction support centrifugal fans.

Raw Coal Hopper and Feeder

Four raw coal buckets are equipped with four coal feeders and four medium-speed mills; except the raw coal bucket corresponding to a spare mill. The total effective coal storage of the three raw coal buckets will range from 8 to 12 h coal consumption at BMCR.

1.5 Flue Gas and Air System

The boiler will be equipped with balanced ventilation; each boiler flue system will be configured with two (2) 50% capacity double suction support centrifugal blowers, two double-chamber five-electric field electrostatic precipitators (interim) and two static-blade axial flow fans or centrifugal fans.

Blower

Each flue gas and air system will be equipped with two 50% capacity centrifugal blowers.

Electrostatic Precipitator

The Electrostatic Precipitator ("ESP") will be selected to keep in line with the prevailing local environmental standards in Pakistan and to optimize efficiency, investment, land requirments, etc. The selected ESP will be able to achieve efficiency under the following conditions:

1- In the design conditions and meteorological and geographical conditions of the power plant;
2- A power supply area does not work (small partition power supply is equivalent to in-operation of two small partitions);
3- Flue gas flow is calculated according to the dust collector inlet flue gas in the maximum continuous evaporation of boiler, and the margin should be 10%;
4- Flue gas temperature is the design temperature plus 100°C.

Induced draft fan

The medium induced by the fan will be dust-laden gas, at a temperature of approximately 120°C, this phase tentatively sets 2 centrifugal fans, which are for operation totally, and no spare is provided.

Chimney

Chimney type and height will be designed to meet the environmental requirements and chimney corrosion requirements, and restricted by the power plant geological conditions, seismic intensity and other factors; it is proposed that the project can adopt the sleeve chimney with height of 180m (subject to the final EIA report).

Desulfurization and Denitrification

The desulfurization and denitrification equipment shall be provided as per the local emission standards; the desulfurization shall adopt seawater desulfurization process, to control sulphur oxide ("SO_x") emission concentration less than the local standard, and simultaneously set SCR denitrification facilities for effective control of nitrogen oxide ("NO_x") emission concentration.

1.6 Thermal System

Main steam and reheat steam system

The main steam and reheat steam system will adopt the unit double control system; in order to improve the unit, start performance and recovery quality, and to meet the minimum flow requirements in minimum load operation, While achieving FCB function, each unit has a set of high pressure and low pressure two-level series of turbine bypass systems, Capacity is tentatively set at 100% BMCR high pressure bypass + 65% BMCR low pressure bypass, final capacity will be determined in the basic design phase combined with the manufature's proposal.

Main water supply system

The main water supply system is equipped with two 100% capacity electric water supply pumps, one electric water supply pump is running, and the other electric water supply pump spared. Water supply console main line does not have a control valve, and the regulation is realized through the feed pump speed changes. DN100 electric bypass is set, and a water supply control valve is provided to meet the start and low load operation adjustment. Two high pressure heaters share a big bypass.

Regeneration system

The unit has seven sections of extraction steam for heating by the regenerative system, of which the first two extraction steams are connected to two high-pressure heaters, the third section used for the heating by the deaerator, the last four connected to four low pressure heaters one of which is mounted on the condenser throat. When the deaerator pressure drops to the constant pressure working pressure, its steam source is switched from the three-stage extraction to the auxiliary steam system.

Auxiliary steam system

The steam source of the auxiliary steam header is made up of three routes, in which one route is supplied by three-section steam extraction, and the other route by two-section steam after extracted by the pressure relief valve, and the last route by the start boiler.

Condensate system

The project uses titanium tube condenser, and the condensate pumps are two 100% rated capacity pumps, one used and the other spared. After the condensate passes the shaft seal heater, the main line passes through No. 1, 2, 3, 4 low pressure heaters and then into the deaerator; each low pressure heaters adopt a separate bypass system.

Heater drain system

Regeneration system consists of 7 levels, including two high-pressure heaters, a deaerator, and four low-pressure heaters. The steam turbine has seven sections of steam extraction for heating by the regenerative system. The first two sections are connected to two high-pressure heaters, the third for the deoxygenation heating and auxiliary steam, and the latter four to four low-pressure heaters. High-pressure heaters, low-pressure heaters use a systematic flow of drain, of which No. 2 low pressure drain is sent to the condensate pipeline at the heater outlet with drain pump.

Circulating cooling water system

The circulating water adopts the open circulation system, and the circulating water inlet and outlet pipes are respectively equipped with electric butterfly valves, the circulating water inlet pipes with rubber ball cleaning units. Water heat exchanger, water ring vacuum pump and other cooling water from the circulating water inlet lead. Turbine generator oil cooler, generator air cooler and other auxiliary cooling water using closed circulatory system, cooling water through the closed pump boost, through the water heat exchanger cooling and sent to the cooling equipment.

1.7 Electrical

1.7.1 Overview

The Project has been assumed to have access to the power grid with primary 220 kV voltage and the access plan is as follows: Power plant has two 220kV outlet lines, that is, the two new outlet lines get access to the new 220 kV substation; the new line conductor section is 2x630 square millimetres ("mm^2"); the power plant needs to have the branch operating conditions. Final access system program shall be subject to the demonstration results in the access system subject report.

1.7.2 Main Electrical Wiring

Both units get access to the system via 220 kV voltage, with 2 circuits of outlet lines; 220 kV indoor GIS distribution device is provided in the power plant. The main wiring adopts the form of double bus connection and the generator-double coil transformer unit wiring to get access to 220 kV electrical distribution device.

Generator lead-out line adopts full-chain off-phase closed bus, and the generator outlet temporarily considers the installation of circuit breakers. The generator outlet circuit breaker is installed between the generator and the main transformer, which can reduce the switch of auxiliary power when the unit starts and stops, improve the reliability of the plant power, prevent the expansion of main transformer and high voltage transformer, reduce the hazard of main transformer high-voltage side non-full-phase running negative sequence current on the generator rotor, reduce the high-side circuit breaker operating frequency and operation impact on the system as well as the trend changes.

This project each unit set up a non-excitation voltage double-winding transformer as a high-voltage work to change. Two units together set up a start / standby change as the unit start, standby power. The main transformer temporarily considering the on-load regulator, high-voltage auxiliary transformer considering non-excitation voltage regulator, whether the main transformer or high voltage auxiliary transformer should be adopt on-load regulation will be concluded in the next stage, according to the system to conduct a detailed calculation. The unit start standby power supply can be sent through the main transformer to the high Voltage auxiliary transformer, it can also through the start/standby transformer.

220 kV system adopts the direct grounding, which is achieved through the direct grounding of the neutral point of the main transformer high-voltage side. The neutral point of the generator adopts the grounding transformer and the secondary side series resistance to reduce the damage of the ground fault current to the iron core and suppress the transient voltage no more than 2.6 times of the rated phase voltage. Main transformer and start standby high voltage side neutral point is directly grounded, and 6.6kV system adopts the un-grounding mode.

1.7.3 Selection of Major Electrical Equipment

220 kV power distribution unit is temporarily of the indoor GIS layout, double bus wiring, with a total of 8 intervals, including: two (2) main transformer incoming line interval, one (1) start-up transformer incoming line interval, two (2) outgoing line intervals, a bus interval and two (2) bus equipment intervals. 220 kV GIS equipment is SF6 insulation type, with the rated current of 4,000 amperes ("A"), short circuit current of 40 kiloamperes ("kA"). The rated current of 220 kV circuit breaker and isolation switch is 3,150 A, and ultimately subjected to Pakistan NTDC access system report and approval advice.

The main transformer adopts three-phase double-winding low-loss forced oil circulation air-cooled transformer, with the capacity temporarily of 190 Mega Volt Amp ("MVA") (depending on the generator plant, and the exact number will be determined after the main unit is ordered), the voltage ratio of $242 \pm 8 \times 1.25\%/15.75$ kV, the impedance of initially Ud = 14%, and the main transformer adopts the on-load regulator; Generator circuit breaker is the imported SF6 circuit breaker, with the rated current of not less than 7,600 A, and rated breaking current of 80 kA.

1.7.4 Electrical Equipment Layout

The overall electrical plan is of the conventional arrangement, and the main transformer and the high-voltage auxiliary transformer are arranged outside the main power house's column A. According to the 6kV auxiliary power system high-voltage auxiliary transformer setting program, each unit has a high voltage auxiliary transformer installed in front of Column A of the steam engine room after the main transformer, in order to reduce the length of the auxiliary branch closed bus at the generator outlet. High-voltage auxiliary transformer and main transformer are equipped with firewalls.

220kV power distribution device is close to the transformer area, with double bus wiring, indoor GIS layout, and a total of eight intervals. The current phase's two main transformer and one start/standby transformer's incoming lines are connected by GIL, and two (2) 220kV outgoing lines are connected to power distribution device by the overhead line and. 220kV network control room is arranged nearby the 220kV power distribution device.

1.7.5 Auxiliary Power System

Connection of auxiliary power

The unit normal high-voltage power supply is connected from the generator outlet circuit breaker and the main transformer low-pressure side, and the high-voltage plant start/standby power supply is led from the plant 220kV system or start/standby transformer; each unit in this phase sets a high-voltage auxiliary transformer, temporarily no-load regulator three-phase split transformer. And the use of a split transformer or a two-coil transformer as the auxiliary transformer will be determined in the next stage according to the determined process load through calculation.

The access power grid of Gwadar is weak, the project shall consider setting the black start generator.

High-voltage auxiliary electrical wiring and arrangement

Each unit is provided with one HV unit auxiliary transformer with two sections of 6.6kV unit bus. The load, common load and desulfurization load of the double-set auxiliary machine of the turbine and boiler are tapped onto the bus section A and B.

The HV side power supply of HV auxiliary transformer is connected as branches by the generator outgoing line of the unit, and the LV side is connected to two sections of 6.6kV operating bus for each unit.

Two units are provided with one common HV starting/standby transformer (on-load voltage regulation), of which the 6.6kV side is connected to two sections of 6.6kV operating bus for each unit as a standby power to ensure that the sufficient capacity of starting power supply is supplied to unit for startup and the reliable spare capacity is also supplied.

"Fast switching device" is used between the incoming line power circuit breaker and the standby power supply circuit-breaker of the auxiliary working busbar, so as to support fast and smooth transition between the HV unit auxiliary transformer and the startup/standby transformer.

The motor circuit of 1000kW and above, and the transformer circuit of 1250kVA and above shall adopt the vacuum circuit breaker; the circuit requiring frequent starting and stopping, the motor circuit below 1000kW and the transformer circuit below 1250kVA shall adopt high-voltage fuse + vacuum contactor (F + C).

Integrated water pump is about 0.7km from the main power house, and two integrated water dedicated transformers are provided, with a total of two (2) low-voltage busbars, which are of the contact switches, and the two transformers are mutually spared.

Low-voltage auxiliary power wiring and layout

Low-voltage auxiliary power system adopts 400/230V, and the neutral point is the direct grounding system, PC-MCC, power and lighting are of separate power supply: The power is of three-phase four-wire power supply; lighting and maintenance network adopt the neutral point direct grounding mode and three-phase five-wire power supply.

In order to ensure the shutdown safety of unit in case of AC power outage and the emergent spare of important load, considering the actual local situations, two units will have two 400kW emergency diesel generators (the exact capacity will be confirmed by calculation in the next stage) as the security power supply in alternating current accident. Diesel generator sets are the mobile container type.

Low-voltage auxiliary power distribution devices are in the steam engine room and boiler room load centre, to achieve physical dispersion. The main power house inside and outside 400/230 V power centre (PC) and motor control centre (MCC) use the extraction and drawer switchgears.

DC system and AC uninterruptible power supply

The DC system of the unit control room is equipped with a 220 V DC system for each unit as a reliable power supply for such loads as the unit control, signal, relay protection, automatic device, accident lighting, DC oil pump and AC uninterruptible power supply, etc. Each unit 220 V DC system sets a group of 220 V battery, which are valve-regulated sealed lead-acid batteries, and no terminal battery is provided.

DC system wiring adopts single bus section, and the battery is connected to the two buses; in the normal condition, the two buses run at the same time. Two units are equipped with three sets of charging equipment, in which # 1 unit is equipped with two sets of charging equipment, one as a dedicated charging device of the unit, and the other as the public backup charging equipment of two units; the public charging device output knife switches are chained.

In order to ensure the uninterrupted and reliable power supply for the automation device, a 40 kVA AC uninterruptible power supply ("UPS") is set up for each unit in the current project. The device is composed of rectifier, inverter, and static switch and so on, with voltage and frequency stabilization performance; its working principle is that, in normal condition, the working power is connected from the auxiliary power, converted into direct current after rectification filtering, and then converted into alternating current by the inverter to supply power to loads. When the input AC power is lost, the inverter is powered by the 220 V DC system, and a bypass power supply is used as the power frequency AC power continuously to loads during the maintenance of converter.

Electrical system control and protection

A unit system unit boiler power centralized control mode is proposed; temporarily a control building is set according to the scale of one control centre for two units. The separate network control room is set, and the network control equipment is set locally in the 220kV network control room. The new central control building will be arranged between the two (2) boilers after the steam room.

PROSPECTUS

Prospectus

Introduction of Applicant

China Communications Construction Company Limited ("CCCC"), intends to set up a 300 MW imported coal based power plant at Gawadar, Balochistan. CCCC is a public limited company incorporated in China having incorporation no. 100000000040563. The registered office of the Company is No.85, Deshenmenwai Street, Xicheng District, Beijing, China.

The Joint Cooperation Committee of CPEC ("JCC"), keeping in view the strategic importance of Gawadar to CPEC decided to that a 300 MW imported coal based power project must be set up at the port city of Gawadar. For this purpose, CCCC was nominated by JCC to undertake this Project on an expedited basis. Accordingly, CCCC filed a Letter of Interest ("LOI") application with Private Power and Infrastructure Board ("PPIB") and were issued a Notice to Proceed on 12th April 2017 and the LOI on 26th May 2017.

Salient features of the facility for which license is sought

The broad parameters of the project are as under:

Type of Technology:	Pulverized coal based power plant
Location:	Gawadar, Balochistan
Installed Capacity:	02 x 150 MW
Fuel:	Imported Coal
Net Thermal Efficiency:	37.00%
Auxiliary Consumption:	9.3%
Annual Generation:	2,026 GWh

Proposed Investment

The total cost for the project is approximated USD 492.94 Million, which is expected to be financed in a debt to equity ratio of 75:25.

15.

SCHEDULE III

Schedule III

General Information

(i)	Applicant's Name	China Communications Construction Company Limited
(ii)	Registered Office	No.85, Deshenmenwai Street, Xicheng District, Beijing, China.
(iii)	Plant Location	Gawadar Port, Balochistan
(iv)	Type of Generation Facility	Imported Coal based Power Plant
(v)	Commissioning/Commercial Operation Date	April 2021
(vi)	Expected Life of the Facility from Commercial Operation/Commissioning	30 years
(vii)	Expected Remaining Useful Life of the Facility	30 years

1. Location maps, site maps and land

- Site map and Plant Layout attached as Annexure -1
- The Project will be located at Gawadar, Balochistan. The Project will be located within the jurisdiction of the Port, near the Sur Bundar area and will require a total of 330 acres of land.

2. Technology, Size of Plant and Number of Units

(i)	Type of Technology	Pulverized coal based Power Plant
(ii)	Installed Plant Capacity (Gross)	300 MW (Gross)
(iii)	Number of Units	2 x 150 MW
(iv)	Unit make, model & year of manufacture	2017
(v)	Auxiliary Consumption	9.3 %
(vi)	Net Capacity	272.10 MW

3. Fuel: Type, Imported/Indigenous, Supplier, Logistics

(i)	Primary Fuel	Bituminous Coal

(ii)	Alternate Fuel	Nil
(iii)	Fuel Source (Imported/Indigenous)	Imported
(iv)	Fuel Supplier	To be primarily sourced out of South Africa under a mix of long-term, medium-term and spot purchases
(v)	Supply Arrangement	[shipping](Marine)+[truck](Inland)
(vi)	Fuel Storage	Coal yard with storage capacity of 60 days at full load

4. Emission Values

		Primary Fuel
(i)	SOx (mg/Nm^3)	100
(ii)	NOx (mg/Nm^3)	100
(iii)	CO^2	N/A
(iv)	CO (mg/Nm^3)	800
(v)	PM10(mg/Nm^3)	30

5. Cooling Water Source

(i)	Cooling Water Source/Cycle	Once through cooling with seawater

6. Interconnection

(i)	Nearest Grid Facility	Proposed 220 kV Gwadar Substation
(ii)	Distance of Grid from Project Site	~20kms
(iii)	Voltage Level	220kV
(iv)	Single Line Diagram	Attached as Annexure-2

Note: The final interconnection proposal shall be determined by NTDC

7. Infrastructure

(i)	Road	The N10 National Highway passes north of the Project Site; the highway can connect to Gwadar Port and will become the main

		access. A port expressway has been planned for the east bay of Gwadar Port which will connect to the N10 National Highway.
(ii)	Rail	Currently, there is no railway line in the vicinity of the Project Site, however, there is a plan for a new railway line which can also be used for the power plant in the future.
(iii)	Port	Gwadar Port lies to the southwest of the Project Site. The Project envisages using the existing port infrastructure for coal receival from ocean going vessels and loading the coal onto trucks for transportation to Project Site.
(iv)	Staff Colony	Staff colony will be constructed within the project premises for housing of project personnel and will be provided with adequate amenities.
(v)	Amenities	Amenities typical to such a site including dispensary, club house, cafeteria, playgrounds, mosque etc.

8. Project Cost and Financing

Estimated Project Cost*	**USD million**
Capital Cost (incl. Owner Site EPC Works) Based on European boiler	342.00
Other Non-EPC Costs	
Land Acquisition	12.00
Project Development Costs	11.67
Company and Sponsor Costs	22.42
Custom Duties and Withholding Taxes	20.41
Insurance during Construction	3.42
O&M Mobilization	3.62
Sinosure Fee	36.03
Financing Fees and Charges	13.10

Interest during Construction	27.69
Total	**492.64**
Debt	369.71
Equity	123.24

9. Project Commencement and Completion Schedule

Activity	Duration (Months)	Start Date	End Date
Issuance of LOI			26-05-17
EPC Activities	04	15-07-17	15-11-17
Grid Study and approvals	03	14-04-17	20-07-17
CPPA-G Consent			10-04-17
Generation License Application & Approval from NEPRA	03	12-07-17	12-10-17
Tariff Application and Approval from NEPRA	03	12-07-17	12-10-17
Issuance of LOS	0.5	12-10-17	26-10-17
Signing of IA and PPA	03	26-10-17	26-01-18
Financial Close Activities	06	26-10-17	26-10-18
Construction Activities	30	26-10-18	26-04-21
Commercial Operations Date			26-04-21

10. Environment and Social Soundness Assessment

An Initial Environmental Impact Assessment is being carried out by Project's consultant and will be provided when completed. However, the Project and its Sponsor's unequivocally undertake that the Project will meet all Pakistani environmental standards.

11. Safety and Emergency Plans

Attached as Annexure -3

12. System Studies, Load flow, Short circuit etc.

Detailed Interconnection and Grid Study is being carried out by National Transmission and Despatch Company Limited ("NTDCL") and will be provided once completed.

13. Plant Characteristics

(i)	Generation Voltage	15,750 Volts

<table>
<tr><td>(ii)</td><td>Frequency</td><td colspan="2">50 Hz</td></tr>
<tr><td>(iii)</td><td>Power Factor</td><td colspan="2">0.8 (Lag) & 0.95 (Lead)</td></tr>
<tr><td>(iv)</td><td>Automatic Generation Control (AFG)</td><td colspan="2">YES</td></tr>
<tr><td>(v)</td><td>Ramping Rate</td><td colspan="2">(1) 100%～50%TMCR 5%/per min
(2) 50%～30%TMCR 3%/ per min
(3) below 30%TMCR 2%/ per min
(4) Step change in power 10%/ per min</td></tr>
<tr><td>(vi)</td><td>Time Required to Synchronize to Grid and Loading the Complex to Full Load from Cold Start</td><td>During cold start (i.e. when plant is started later than 72 hours after shutdown)
During warm start (i.e. when plant is started at less than 36 hours after shutdown)
During Hot start (i.e. when plant is started at less than 12 hours after shutdown)</td><td>a. Cold Start – [220] minutes
b. Warm Start – [130]minutes
c. Hot Start – [30]minutes</td></tr>
</table>

14. Control, Metering, Instrumentation and Protection

Attached as Annexure-4

15. Training and Development

The training and development program has been given due recognition so that safe and reliable operation and maintenance of the plant can be ensured. Training and Development programs have been devised to properly use various tools for training.

Apprenticeship Programs: One graduate and one skilled person will be absorbed in the plant for a period of one and half years in each of operation, electrical, instrumental and control, and mechanical department. He will be attached with assistant executive engineer level person. For skilled apprentice, the attachment will be with Foreman level person. Through such program the Plant will be serving the community as well as a database for company referral, when needed.

Training at Plant: Section wise training at plant on quarterly basis. The training to be imparted by senior plant management as well as by industry expert. The training to be imparted on two-tier basis; for lower management and middle management.

Training and Development abroad: The top tier to undertake management training and refresher on a six-monthly basis and to undergo foreign career development training every three months.

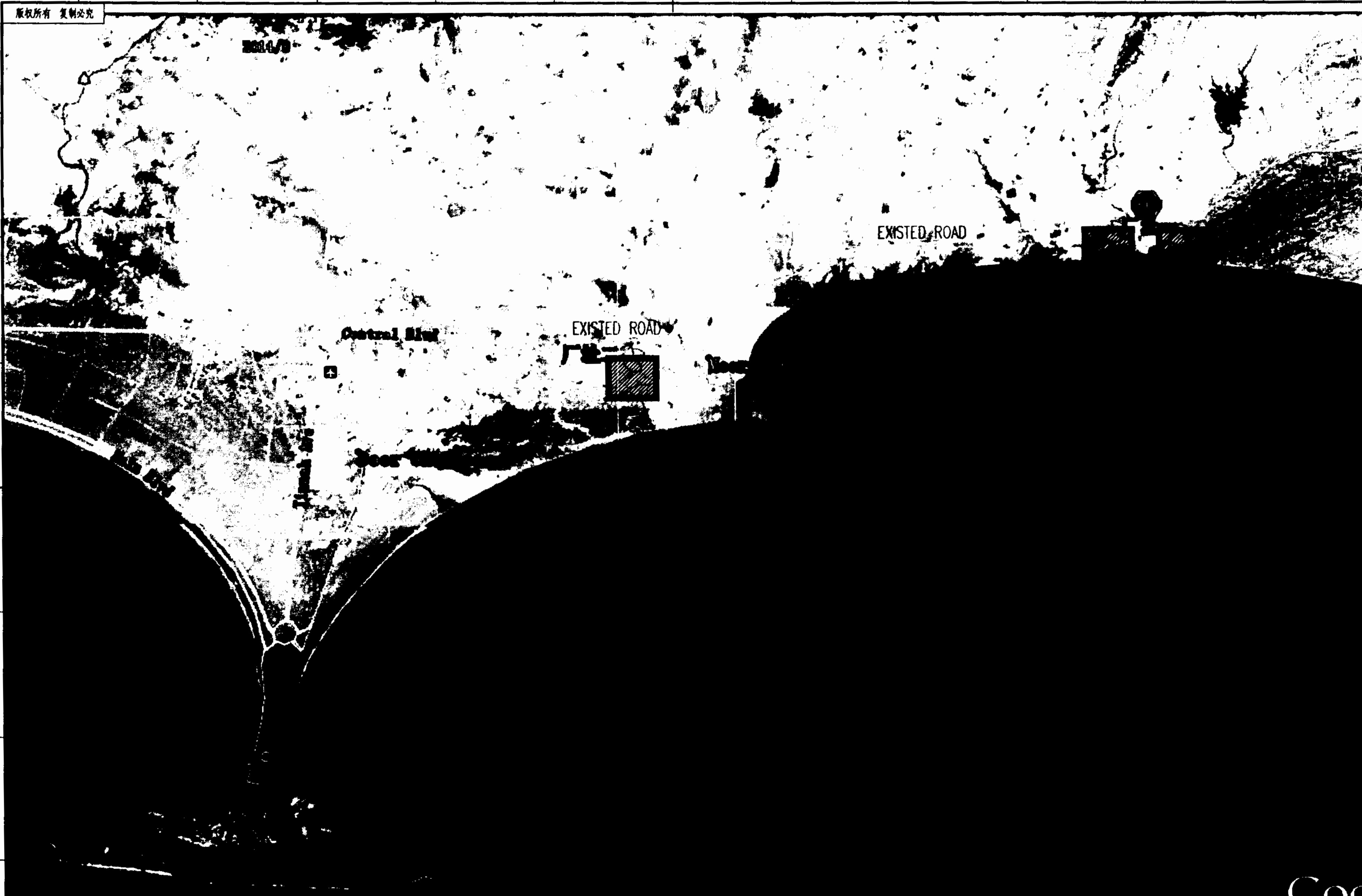
Operation and Maintenance Manuals: Referral to these manuals is a very good self-training and development tool. They are made by the experts of equipment and systems and are focused towards safe operation and corrective maintenance. They are very useful when consulted before and after the undertaking the work.

Visits and Trainings at Manufacturers' Works: Visits and trainings at outsourced maintenance firms is often a very good training source.

Working together with EPC Contractor: Each plant has certain unique features therefore the EPC contractor is often in the best position to operate and maintain. Entering into O&M agreement for an initial period of one or two years following project completion is a rich source of training and development of plant personnel.

Training and Development is an ongoing activity and the project Sponsors will devise the programs such that the benefits of various types of training are best attained.

ANNEXURE-1



批准	APPROVE		设计	DESIGN	
审核	REVIEW1		制图	DRAW	
	REVIEW2		比例	PROPORTION	
校核	CHECK		日期	DATE	

厂址地理位置图

SITE LOCATION MAP

图号	44-FA11411K-Z-01		
条形码		版本	A

N

LIST OF FACTORY BUILDING AND STRUCTURE

NO	Names of items	NO	Names of items
J1	Turbine Hall	P1	Absorber
J2	Generator&Coal Bunker Bay	P2	Aeration Basin
J3	Boiler	P3	Ammonia Gas Station
J4	ESP		
J5	ID Fan	S1	CW Pump House
J6	Flue Gas Duct	S2	Forebay
J7	Air Compressor House	S3	Emergency Oil Basin
J8	Stack	S4	Fresh Water Supply Station
J9	Auxiliary Boiler	S5	Siphon Well
J10	Closed Cooling Water Heat Exchanger	S6	Discharge Pit
J11	Condensate Make Up Water Tank	S7	Oily Water Separation Basin
		S8	Foam Fire Fighting Room
J12	Fuel Oil Storage Tank Area	S9	Rain Water Pump House
J13	Fuel Oil Pump House	S10	Coal Water Settlement Sump
J14	Petrol Station	S11	Rain Water Settlement Sump
M1	Coal Storage Yard	H1	Industrial Waste Water Treatment System
M2	Coal Handling Combined Building	H2	Sea Water Treatment System
		H3	Sea Water Cooling Sodium Hypochlorite Injection System
T1	Transfer Tower	H4	Unit Drain Pit
C1	Conveyor Gallery	F1	Fly Ash Silo
C2	Fullfilled Truck Weigher	F2	Fluidizing Blower House
C3	Empty Truck Weigher	F3	Bottom Ash Bin
C4	Truck Sampling Device		
C5	Coal Unloading Device	U1	Administration Office Building
		U2	Workshop and warehouse
D1	220kV GIS	U3	Canteen
D2	Generator Transformer	U4	Garage
D3	Unit Auxiliary Transformer	U5	Gate House
D4	Startup/standby Transformer	U6	Central Control Building
D5	Distribution Room of Plant Electrical Consumption		
D6	Diesel Engine House		

LEGEND

SYMBOL	NAME	SYMBOL	NAME
	BUILDING		INTEGRATE TRUSS
	UNDERGROUND BUILDING		FENCE
	ROAD		WALL
	OUTDOOR ELEVATION		
	INDOOR ELEVATION		

NOTE

1.THE CAPACITY OF POWER PLANT IS 2X150MW

2.THIS DRAWING IS FOR REFERENCE ONLY

3.THE DIMENSION OF DRAWING IS IN METER

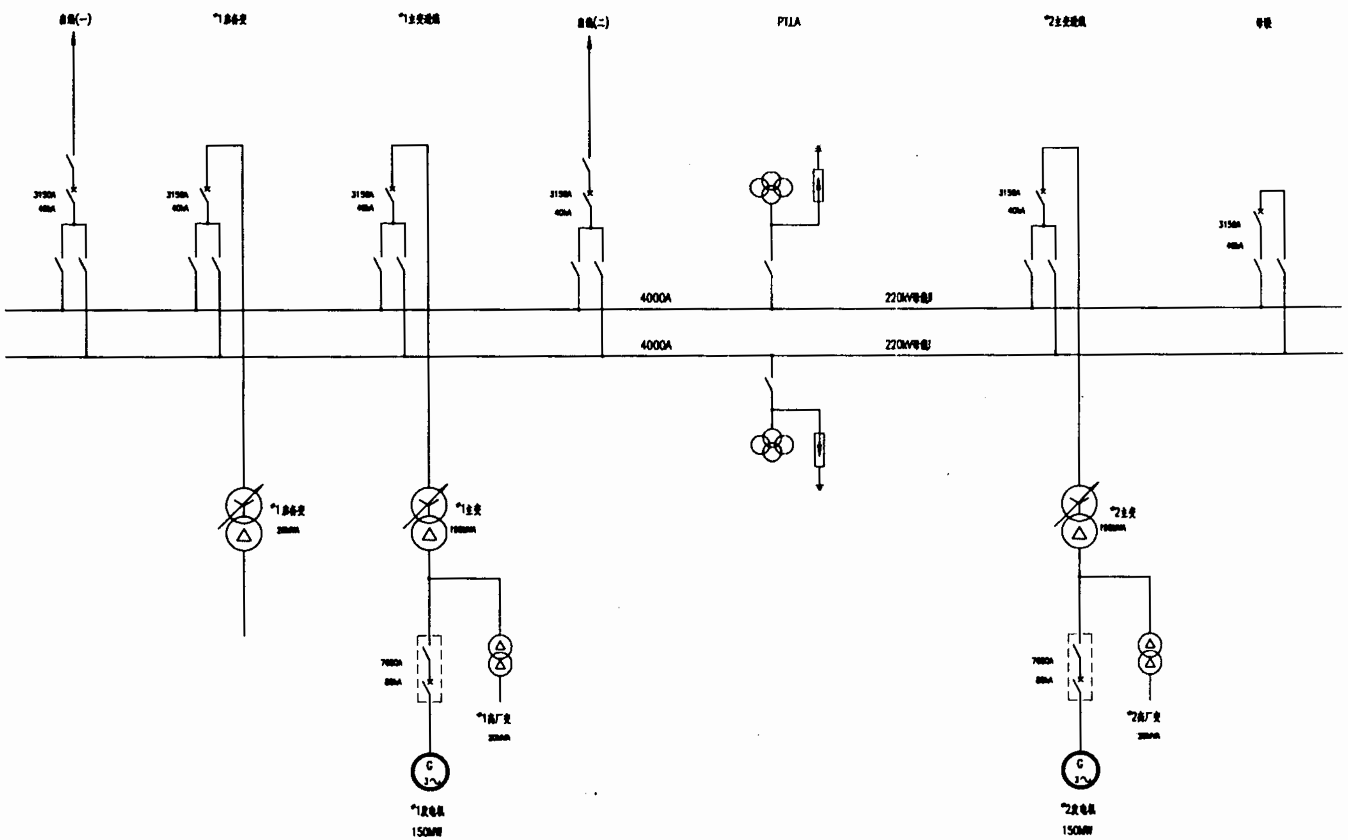
厂区总平面规划布置图(厂址二方案)

GENERAL LAYOUT OF POWER PLANT (SITE Ⅱ)

比例 1:2500

日期 2017.06

图号 44-FA11411K-Z-04



版 本	日 期	修 改 内 容 摘 要	修 改	批 准

				中交集团巴基斯坦瓜达尔2X150MW燃煤电厂项目 300MW (2X150MW) Imported Coal Based Power Project at Gwadar, Pakistan	可研收口 设计 Feasibility 阶段
批准		设计		电气主接线图 OVERALL SINGLE LINE DIAGRAM	
审核		制图			
		比例	/	图 号 44-FA11411K-D-01	
校核		日期	201706	条形码	版本 B

Safety and Emergency Plan

1.1 Fire protection and explosion protection

1.1.1 Fire protection design principle and measures for buildings (structures)

Fire protection design principle for buildings (structures)

The minimum distance among the main buildings (structures) of this project meets the minimum distance requirements of various buildings (structures) of power plant as specified in Code for the Fire Protection in Architectural Design(GB50016-2014) and Code for the Design of Large & Medium-sized Thermal Power Plants (GB 50660-2011).

Fire hazard and minimum fire resistance rating of various buildings (structures) during production

The fire resistance rating of various buildings (structures) of this project will meet the regulations of Code for the Fire Protection in Architectural Design(GB50016-2014), Code for the Fire Protection in the Design of Thermal Power Plant and Substation (GB50229-2006) and Code for the Design of Large & Medium-sized Thermal Power Plants (GB 50660-2011) as per the fire hazard during production.

Fire-proof and explosion-proof safety measures for main power building and the arrangement of escape corridor and access

The steel staircases that lead to various stories of steam turbine building and the exits that directly lead to outside are provided on Row A of the main power building to ensure that the distance from the farthest working point to safety escape exit in the main power building does not exceed 50m. All power distribution device rooms, cable interlayers and cable shafts are provided with Class C fire doors.

In addition to meeting the requirements of existing fire protection procedure and code, the traffic design inside the main power building concurrently considers the safety and accessibility of production, operation and maintenance.

1.1.2 Plant-wide fire protection and alarm facilities

The design of fire-fighting system of the power plant follows the working guideline "prevention first and combination of prevention and fighting action", and is in accordance with the requirements of the standards, regulations and codes listed in section 9.1.

Independent firewater supply pipe network will be provided in the plant area and will be arranged as per cyclic pipe network.

Based on the requirements of "Code for the Fire Protection in the Design of Thermal Power Plant and Substation" (GB50229-2006) and different protected objects, in addition to indoor and outdoor hydrant systems in this project, foam fire-fighting system, automatic sprinkler system, water spray fire-fighting system, gas fire-fighting system, automatic fire alarm system, movable fire extinguishers and the like will be provided, and a fire vehicle will also be provided.

Emergency oil tank will be provided outside the columns of Row A of the main power building to receive the oil drained from transformer and the oil tank of steam turbine under emergency condition.

Fire protection measures for transformer

The distance between transformers meets the fire protection requirements of relevant procedures and regulations. Transformers are provided with oil conservators and oil drain facilities so that the oil in oil conservator can be drained into emergency oil tank via the oil drain tube at the bottom of the oil conservator in case of emergency oil drain.

Fire protection for cables

The fire protection of cables is designed according to the requirements of Code for the Design of Cables of Electric Works GB 50217.

Necessary fire-resisting walls shall be provided inside cable tunnels and cable trenches; cable shaft holes, the openings beneath switchboard and wall-penetration holes shall be plugged, and fire-resistant partition and automatic fire extinguishers shall be provided in the locations where cables are dense.

Explosion-proof measures for electrical facility

The ventilator and motor in storage battery room shall be of explosion-proof type.

1.1.3 Technical safety measures for pressure vessel and explosive devices

Explosion-proof measures for boiler

Boiler will be provided with furnace safety supervisory system (FSSS). Furnace will be available with soot-blowing function. In order to prevent the existence of combustible substance inside furnace during furnace shutdown, furnace will be purged when main fuel trips and prior to the ignition of main fuel. Superheater and reheater will be provided with safety valves.

Explosion-proof measures for pressure vessel

Deaerator, blowdown flash tank, high-pressure heater and low-pressure heater will be provided with safety valves to prevent explosion.

1.1.4 Fire protection and explosion protection in oil tank farm and ammonia area

Since fuel oil tank farm is a critical fire-protection area, high enclosing wall will be provided surrounding the area to form an independent area. Fire dyke will be provided surrounding the fuel oil tank; the effective volume inside the fire dyke conforms to the requirement of "the effective volume inside fire dyke shall not be smaller than the volume of the largest oil tank in the tank bank". The distance between oil tanks and between oil tank and fire dyke meets the requirement of "the distance from vertical oil tank to the basal slope line inside fire dyke shall not be one half smaller than the height of tank shell". The distance among various buildings (structures) in the fuel oil tank meets the fire separation requirement as specified in Technical Procedure for the Design of General Arrangement and Transportation of Thermal Power Plant. In addition, firewater and foam fire-fighting systems will be provided inside the fuel oil tank farm according to fire protection code.

Ammonia is also a critical fire-protection area, isolation wall will be provided surrounding the area to form an independent area.

1.2 Prevention of electrical injury, mechanical injury and other injuries

1.2.1 Design principle and protective measures for plant-wide lightning-protection grounding

The lightning-protection grounding of this project will be designed according to the relevant requirements of Overvoltage Protection and Insulation Coordination of AC Electrical Installations DL/T620. The incoming lines/outgoing lines of 220/132kV power distribution devices will be provided with lightning rod and lightning conductor; independent lightning rod will be provided in fuel oil pump house; several lightning rods will be installed on the top of stack; lightning arresting band will be provided on high buildings such as the coal crusher house of coal-handling system, etc., to protect against direct strike lightning.

Fuel oil pump house and its piping will be provided with static electricity and lightning induction protection.

The plant-wide grounding will be in accordance with Code for the Design of the Grounding of AC Electrical Installations GB50065-2011, and grounding material will be of steel.

1.2.2 Technical measures against electrical maloperation

1. Blocking device is provided between disconnecting switch and applicable circuit breaker and between knife switches. The blocking device is consisted of mechanical, electromagnetic and electrical circuit blocks.
2. High-voltage switch cabinet will be consisted of the equipment available with "five-prevention" function.

1.2.3 Isolation and protection measures for live electrical equipment

1. The safely clear distance of all items of live electrical equipment is not smaller than the minimum value specified in relevant procedures.
2. The enclosures of live electrical equipment are ground.
3. In order to prevent overvoltage from endangering personal safety, contact potential and step potential shall be decreased as far as possible when the form and arrangement of grounding device are determined; And measures shall be taken to ensure that contact potential and step potential will not exceed the values specified in relevant procedures.

1.2.4 Measures against mechanical injury

There is a great amount of rotating equipment during the operation of power plant; it is essential to get done well with the protection of rotating machinery to protect the personal safety of operation personnel. It intends to take the following measures in the aspect of preventing mechanical injury:

1. The exposed rotating part of rotating machinery is provided with protective hood.
2. Necessary blocking device is provided for rotating machinery.
3. The crossover staircases with guardrails are provided at the crossover point of long-distance conveying machinery.
4. Protective hood and removable guardrails are provided at the shaft ends of the tail roller and all other turning rollers of belt conveyer respectively.
5. Protective hood or shield is provided in the rotating part of the equipment of coal-handling system; Removable guardrails are provided on the two sides of belt conveyer; guard fence is provided below the weight box of vertical tension device.
6. Enclosing shield is provided within the throwing range of belt iron separator.
7. Belt coal conveyer is provided with start-up predictor and the device against wrong start-up; Pull switches are provided along the line so as for brake under emergency condition.

1.2.5 Measures against fall injury

1. Guardrails or cover plates will be provided around the staircases, platforms, pits, basins, openings and holes of the power plant. The height of the guardrail around indoor platforms and openings/holes is not smaller than 1.05m; the height of the guardrail around outdoor platforms and openings/holes is not smaller than 1.10m; the height of the guardrail around the platforms and openings/holes above 20m high is not smaller than 1.20m. Anti-slip measures will be taken for staircases and platforms.
2. The parapet with clear height being above 1.20m is provided on the roof that can be stamped.
3. The access ladders on stack and the like are provided with guard rings; Resting platform is provided in the middle of access ladder.

1.3 Safety Colour and Marking

The colour-conditioning design for workplace is in favour of strengthening identification sense, concentrating attention and reducing asthenopia; and, colour-conditioning design can adjust the emotion of operation personnel to improve labour enthusiasm during operation, to improve production efficiency and to decrease the occurrence rate of accident.

In accordance with the regulations of Safety Colour GB2893-2008 and Safety Marking GB2894-2008, four kinds of safety colour, i.e., red (representing prohibit and danger), yellow (representing warning and attention), blue (representing instruction and observance) and green (representing passing and safety), will be used to transmit safety information so that personnel can promptly find or identify safety marking, and can be reminded of in time, thus preventing the occurrence of accident and hazard.

See the following table regarding the location and type of safety colour and safety marking.

Marking	Safety Colour	Location	Content
Prohibit	Red	Cable Entry, the entrance of oil system room	No smoke or fire
Warning	Yellow	Fencing of electrical equipment	Warning electric shock
		Equipment enclosure or framework on which temperature-rise exceeds 65K	Warning high temperature
		Guardrails around collecting well and lifting hole	Warning drop down
		Upper end of steel ladder above 2.0 m	Warning drop down
		The entrance of mechanical maintenance room and repair shop	Warning mechanical injury
		Inclined steel ladder above 55°	Caution, stumbling
		Main traffic crossings	Warning vehicle
Instruction	Blue	Compressed air equipment house	Ear plug required
Prompt	Green	Fire-fighting facility	Hydrant
			Fire extinguisher
			Fire hose
		Evacuation exit	Escape corridor, emergency door

1.4 Other Safety Measures

The design of lighting system will be in accordance with Technical Regulation for the Design of the Lighting of Power Plant and Substation (DL/T5390-2014). The lighting system of this project is consisted of three independent subsystems, i.e., normal AC lighting system, emergency AC lighting system and DC emergency lighting system.

The AC lighting system will be of 380/220V three-phase four-wire neutral solidly grounded system; lamp voltage is 220V, and the lighting voltage for the maintenance of boiler body is 12V. As for the lighting of cable tunnel, 220V power supply with leakage protection will be adopted.

Various corresponding Units in the main power building will be provided with main AC emergency lighting switchboards respectively. The main AC emergency lighting switchboard will be supplied from the normal lighting section of corresponding Unit during normal operation, and will be automatically switched to emergency power supply in case of emergency condition.

DC emergency lighting device is only arranged in central control room and diesel generator house; emergency lighting inverter switchboard is arranged in central control building, with supplied being powered from 220V DC switchboard and emergency power supply section. DC emergency lighting device is powered from emergency power supply section during normal operation, and will be automatically switched to DC power supply after all AC power supplies disappear. DC pilot lamp is provided inside the main loop of the central control room.

1.5 Labour Security Authority and Facility

1.5.1 Working Environment Monitoring & Supervision

It is tentatively considered to set up a working environment monitoring & supervision station in this project.

1.5.2 Safety Education Office

It is tentatively considered to set up a safety education office in this project.

1.6 Security System

Based on the actual situation of the legal address and site of this project, see the special report entrusted by the Owner for details about security proposal.

1.7 Comprehensive Assessment

After the above-mentioned measures are taken, the safety work condition of the workplace of the operation personnel of the power plant can meet the requirements of relevant standards.

2. Occupational Health

2.1 Basis for Preparation

2.1.1 Applicable China national standards, regulations and codes

1. General Rule for the Design of the Safety and Health of Production Equipment (GB5083-1999);
2. Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010);
3. Occupational Exposure Limit for the Hazardous Factors in Workplace, Part 1: Chemically Hazardous Factors (GBZ2.1-2007);
4. Occupational Exposure Limit for the Hazardous Factors in Workplace, Part 2: Physical Factors (GBZ2.2-2007);
5. Code for the Design of Noise Control in Industrial Enterprises (GB/T 50087-2013);
6. Standard for the Design of Architectural Daylighting (GB50033-2013);
7. Code for the Design of the Heating, Ventilation and Air Conditioning of Industrial Building (GB 50019-2015);
8. Code for the Design of General Plan of Industrial Enterprises (GB50187-2012);
9. Guideline for the Gas Management and Test of Sulfur hexafluoride Electrical Equipment (GB/T8905-2012);
10. Code for the Design of Compressed Air Station (GB50029-2014).

2.1.2 Industrial procedures, codes and regulations

1. Code for the Design of Large-sized Thermal Power Plant (GB 50660-2011);
2. Procedure for the Design of Occupational Safety of Thermal Power Plant (DL5053-2012);
3. Procedure for the Design of Occupational Health of Thermal Power Plant (DL5454-2012);

4. Technical Procedure for the General Arrangement and Transportation of Thermal Power Plant (DL/T5032-2005);
5. Regulation for the Architectural Design of Thermal Power Plant (DL/T5094-2012);
6. Code for the Design of the Heating, Ventilation and Air Conditioning of Power Plant (DL/T5035-2016);
7. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 1: Coal-handling System (DL/T5187.1-2016);
8. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 2: Prevention and Control of Coal Dust (DL/T5187.2-2004);
9. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 3: Coal-handling Automation (DL/T5187.3-2012);
10. Code for the Chemistry Design of Thermal Power Plant (DL/T5068-2014);
11. Technical Regulation for Lighting Design of Power Plant and Substation (DL/T5390-2014);
12. Specification for the Monitoring of the Working Environment of Electric Power Industry (DL/T799.1~7-2010).

2.2 Process links and locations where health protection shall be provided

1. Coal-handling system (including coal-unloading device, coal crusher house, belt layer and various forwarding stations) in which dust is produced;
2. The protection measures to be taken for the locations where hazardous substance and corrosive fluid exists;
3. The heat insulation and cooling for the main power building of the power plant belonging to high-temperature workshop;
4. Prevention and control of the noise originated from the rotating machinery such as turbogenerator unit

2.3 Measures against dust, toxic substance and chemical injury

2.3.1 Dust-proof design principle and measures

Dust-proof design principle

With the design principle of the prevention and control of coal dust of coal-handling system, the comprehensive prevention and control of "prevention first and combination of prevention and control" will be performed for the coal-handling system of the power plant according to Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010), Code for the Design of Large-sized Thermal Power Plant (GB 50660-2011), Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 2: Prevention and Control of Coal Dust (DL/T5187.2-2004)and Code for the Design of the Heating, Ventilation and Air Conditioning of Power Plant (DL/T5035-2016).

Comprehensive treatment measures for coal dust

The area of dust removal equipment room will be minimized in the design and arrangement of dust removal system; close cooperation with the personnel of relevant disciplines will be obtained to accomplish integral arrangement in combination with entire coal-handling architecture to control the volumes of various coal-handling buildings within the most rational range by means of sharing some passages and spaces as far as possible, thus decreasing engineering cost.

Multi-tube impulse type hydraulic dust-removing unit will be provided at the coal drop point of the forwarding station on the head of coal bunker room. This unit can treat coal dust preferably to reach and meet national environmental protection requirements, thus creating a good working environment.

Negative-pressure induced draft dust-removing units will be provided on raw coal hoppers.

Dust-removing facilities are provided in coal crusher house, various forwarding stations and coal bunker rooms to prevent dust nuisance.

Material regulators are provided in various material drop points where fall head is great, to decrease the shock of coal brick on rubber belt and to reduce flying coal dust.

Spray facility is provided in coal yard to prevent dust nuisance in coal yard area.

Pipe transfer will be used in pneumatic ash-handling system; bag-type dust removal unit will be arranged on the top of ash silo.

2.3.2 Measures against toxicity and chemical injury

The corrosive fluid and hazardous gases stored and produced in the locations of power plant are mainly stored or produced inside chemical system. In order to allow the concentration of the hazardous substance of workshop to be lower than the allowable maximum concentration as specified in Occupational Exposure Limit for the Hazardous Factors in Workplace (GBZ2.2 2007) to protect the physical health of operation personnel, it intends to take the following protective measures:

1. Protective weir is provided around acid & alkali storage equipment. Safety passages, showers, flushing and draining facilities are provided in acid & alkali storage rooms, metering rooms, and acid & alkali unloading pump houses. Pumping mode is used when concentrated acid and alkali liquor are loaded and/or unloaded.
2. Acid & alkali pipe will not be arranged overhead in the indoor locations where personnel pass by; Where overhead arrangement is necessary, protection measures will be taken on flange and connections.
3. The drummed ammonia that is used for chemical dosing will be placed in chemical dosing room. Breather is provided for the mixing solution tank of ammonia liquor to prevent ammonia from being diffused into air.
4. Chemical dosing room is provided with mechanical ventilation unit.

2.4 Heatstroke Prevention, Explosion Protection and Ventilation

2.4.1 Ventilation System

1. Ventilation of steam turbine house

The ventilation mode of natural air intake and mechanical exhaust will be adopted for steam turbine house. Outdoor air naturally gets into the steam turbine house via the electric rainproof shutter below the operation story on Row A and the opened windows on the operation story of the steam turbine house; damp and hot air is exhausted with the ventilator on the roof of the steam turbine house.

2. Central control building

The diesel generator house inside the central control building is provided with mechanical ventilation unit, and explosion-proof axial flow fan is used for exhausting air. Cable interlayer is provided mechanical ventilation unit, and axial flow fan is used for exhausting air. Air-conditioning house is provided mechanical ventilation unit and axial flow fan is used for exhausting air. Other process rooms inside the central control building will be provided with mechanical ventilation systems according to actual demand and the requirement of process equipment as well as specific arrangement respectively; and applicable technical measures will be taken according to explosion protection and anticorrosion requirements.

With respect to the air intake mode of various rooms, combined air inlet or shutter air inlet will be used to naturally suck air as required.

3. Storage battery room

The battery of storage battery room is of maintenance-free lead-acid battery; emergency ventilation unit is provided. The ventilation mode of natural air intake and mechanical exhaust with axial flow fan is adopted. Anticorrosion and explosion protection will be considered for all ventilation equipment.

4. All power distribution devices and MCC rooms in the entire plant are provided with mechanical ventilation units; These ventilation units are used for emergency exhaust as well as ventilation during normal operation.
5. With respect to the remaining production and auxiliary production buildings, mechanical ventilation systems are respectively provided for the rooms, in which hazardous gases and residual heat and residual moisture are produced, according to actual demand and the requirement of process equipment; And applicable technical measures will be taken according to explosion protection and anticorrosion requirements.

2.4.2 Air-conditioning system

A central control building is provided for two Units in this project. The air-conditioning system of the central control building mainly serves for process equipment rooms such as unit control room, engineer room, electronic equipment room and the like.

Local split type air conditioners will be used for local arrangement and control in the remaining control rooms of the plant and the rooms in which process system has applicable requirements for temperature and humidity.

2.5 Noise and Vibration Prevention

2.5.1 Analysis for the environmental sound sources of the power plant

The environmental sound sources of the power plant mainly include the noise resulted from the operation, vibration, friction and collision of various types of mechanical equipment; the noise resulted from the movement, expansion, exhaust and leakage of high-pressure gas flow in various types of fan, air duct, steam turbine and steam pipe; the noise resulted from the combustion and vaporization of steam inside boiler and the convection process of flue gas; the noise resulted from the alternating motion of the magnetic field of power generator, exciter, transformer and other switchgears; and the noise resulted from the driving of the transportation vehicles and other vehicles in the plant area, etc.

2.5.2 Design standard for noise control

In accordance with Code for the Design of Noise Control in Industrial Enterprises (GB/T 50087-2013), the noise limits of various types of workplace are shown in the table below.

Workplace	Limit [dB(a)]
Production workshop	85
Background noise level in the duty room, observation room, restroom, office, lab and design room inside workshop	70
Precision assembly line, precision machining workshop and computer room in normal operation condition	70
Background noise level in main control, central control room, communication room, telephone exchange room, fire duty room, general office, conference room, design room and lab	60
Background noise level in doctor's office, classroom, duty dormitory room	55

Note: background noise level refers to the noise level that is transmitted from outdoor to indoor.

In accordance with Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010), the noise design requirements for non-noise workplace are shown in Table 10.5.2-2/

Location	Limit dB(A)	Working Efficiency Limit dB(A)
Observation (duty) room of noise workshop	≤75	≤55
Office and conference room of non-noise workshop	≤60	
Main control room, precision machining room	≤70	

2.5.3 Prevention and control measures for noise

Decreasing the ambient noise of workshop is one of important measures that ensure safety operation, protect the physical and mental health of staff and improve the working environment of operation personnel. Decreasing noise shall first proceed with the radical treatment of equipment, i.e., decreasing the noise level of noise source; and then, take necessary measures in the aspect of architectural arrangement and the treatment of building construction, allowing the ambient noise value of workshop to reach the allowable national standards. The specific measures to be taken in design are as follows:

1. Manufacturers are requested to provide the equipment conforming to the noise standard of national regulations when the type of various main equipment and auxiliary equipment is chosen.
2. Control valves and relief valves shall be of low-noise valves.

3. With respect to coal crusher, high-pressure fan, attempering & depressurizing units, air compressor and the head of steam turbine on which high noise may be produced, silencing and sound-insulating measures shall be taken.
4. Silencers shall be provided on the steam exhaust pipe of boiler ignition and boiler safety valve to atmosphere.
5. Sound-insulating doors and windows shall be provided for central control room where noise-prevention requirement is high. Closet shall be provided at the entrance of central control room; to decrease the indoor reverberant sound, porous sound-absorbing mineral wool board lined with mineral wool felt shall be used for suspended ceiling.
6. The closed doors and windows of communication room, chemistry water sampling room and the like, where air conditioners are used, already have sufficient sound-insulating performance.

2.5.4 Health limits for vibration

In accordance with Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010), the health limits for local vibration strength are shown in the table below. The vertical or horizontal vibration strength of auxiliary rooms being affected with vibration shall not exceed the limits are also given in the table below.

Daily Exposure Time (hrs)	Health Limit (m/s^2)
4.0<t≤8.0	0.62
2.5<t≤4.0	1.10
1.0<t≤2.5	1.40
0.5<t≤1.0	2.40
t≤0.5	3.60

Daily Exposure Time (hrs)	Health Limit (m/s^2)	Working Efficiency Limit (m/s^2)
4.0<t≤8.0	0.31	0.098
2.5<t≤4.0	0.53	0.17
1.0<t≤2.5	0.71	0.23
0.5<t≤1.0	1.12	0.37
t≤0.5	1.80	0.57

2.5.5 Vibration-proof measures

1. Manufacturers are requested to provide the equipment conforming to the vibration standard of national regulations when the type of various main equipment and auxiliary equipment is chosen.
2. Vibration-damping measures shall be taken at the connections between the ventilation duct, enclosing construction and floor slab of central control room, main control room, unit control room, electronic computer room and the like; Their air-conditioning systems shall also be provided with vibration-damping measures.
3. With respect to the design of steam/water pipe subject to vibration, vibration-damping measures shall be taken for their supports and hangers.

2.6 Personal Protection Equipment for Occupational Disease

The power plant shall provide its working personnel with personal protection equipment conforming to applicable national standards, e.g., providing anti-dust respirators for dust workers; providing protective clothes, caps, gloves and goggles for those who contact acid and/or alkali; providing noise-proof ear plugs for those who are exposed to noisy atmosphere; providing necessary gas masks for those who manually add ammonia and hydrazine or manually prepare toxic substance such as hydrochloric acid, sulfuric acid, etc.; providing shielding clothes for those who work in microwave station and switchyard, etc. All personal protection equipment chosen shall conform to the requirements of applicable national standards.

2.7 Warning Identification for the Hazard of Occupational Disease in Workplaces

Warning identification for the hazard of occupational disease shall be provided in the eye-striking positions of power plant where the hazard of occupational disease possibly occurs.

2.8 Occupational Health Management

Adhere to the working guideline of occupational disease "prevention first and combination of prevention and control" to create the working environment and condition, which conforms to occupational health standards and health requirements, for labours. Strengthen the training of staff in occupational health knowledge to fully understand the severity and preventability of the hazard of occupational disease, and to strengthen individual protection awareness.

Establish the strict management and utilization system for personal protection equipment to check the allocation, distribution and use of the protection equipment of occupational disease and personal protection equipment to ensure that staff can strictly use valid personal protection equipment of occupational disease under normal production condition.

Establish occupational health and safety work management system to ensure that enterprises can follow national regulation regarding the protection facility of occupational disease, i.e., the protection facility of occupational disease of construction project shall be designed, constructed and put into production and service in the same time as that of the main part of the project; the maintenance and management of production equipment and protection facility shall be strengthened during routine production to avoid the occurrence of "escape, overflow, dripping and leakage" so as to ensure the normal operation of health protection facility; take and make good occupational health protection measures for accident and maintenance.

Establish the management system of occupational health supervision to accomplish institutionalized management. Carry out occupational health supervision for working personnel at regular intervals; if occupational contraindication or suspected occupational patient(s) is (are) found, applicable work adjustment and alteration for this type of personnel shall be performed, and when necessary, vacation even diagnosis and treatment shall be provided to minimize the occurrence of occupational disease.

Establish the periodic monitoring and assessment system for the hazard factors of the occupational disease of workplace, and attach importance to the impact of the prevention and control of the hazard factors of occupational disease on the health of working personnel during equipment maintenance.

The emergency response and rescue plan for occupational disease shall be established and made good after project is put into production; warning identification and notices shall be provided according to Warning Identification for the Hazard of Occupational Disease in Workplace (GBZ158-2003).

2.9 Occupational Health Authority and Facility

It is tentatively considered to set up an occupational health monitoring & supervision station and to equip conventional monitoring apparatus and devices in this project.

2.10 Comprehensive Assessment

After the above-mentioned measures are taken, the sanitary condition of the operation personnel of the power plant in workplace can meet the requirements of relevant standards.

Control, Metering, Instrumentation and Protection

Steam Turbine

Number	Name	Type	Quantity
1	OPC solenoid valve	SOLENOID VALVE	2
2	Lube oil pressure test solenoid valve	SOLENOID VALVE	2
3	EH oil pressure test solenoid valve	SOLENOID VALVE	2
4	Condenser vacuum test solenoid valve	SOLENOID VALVE	2
5	AST solenoid valve	SOLENOID VALVE	4
6	Latch solenoid valve	SOLENOID VALVE	1
7	Condenser vacuum	GAUGE	2
8	Lube oil pressure	GAUGE	2
9	EH oil pressure	GAUGE	2
10	ASP pressure	GAUGE	1
11	AST pressure	GAUGE	1
12	OPC pressure	GAUGE	1
13	Lube oil pressure	PRESSURE SWITCH	4
14	Condenser vacuum	PRESSURE SWITCH	4
15	EH oil pressure	PRESSURE SWITCH	4
16	ASP pressure	PRESSURE SWITCH	1
17	AST pressure	PRESSURE SWITCH	3
18	OPC pressure	PRESSURE SWITCH	1

Generator: Rotor turn to turn short circuit monitor

Electric system:

Metering	Main	HV Side of generator step-up transformer
	Check	HV Side of generator step-up transformer
	Main	HV Side of Standby transformer
	Check	HV Side of Standby transformer
	Main	Switchyard Outline
	Check	Switchyard Outline
Generator Protection	87G	Generator Differential Protection
	32R/32F	Reverse Power/Low Forward Power Protection
	40	Loss Excitation Protection
	46	Generator Negative Phase Sequence Protection
	49	Overload Protection
	51G	Generator Symmetrical Over Load Protection
	51V	Complex Voltage Started Overcurrent Protection
	78	Pole Slipping Protection
	81	Frequency Protection
	59L	Turn to turn Protection
	59G	Stator Over-Voltage Protection
	50BF	Generator Circuit Breaker Failure Protection
Transformer Protection	87T	Transformer Differential Protection (220kV Line included)
	51T	Ac Time Over-current Protection
	51N	Ac Time Over-current Relay for Zero Sequence
	64T	Ground Detector Relay
	24T	Over Fluxing Protection
	49	Overload Relay
	26O	Thermal Device for Oil
	26W	Thermal Device for Winding
	63S	Sudden Pressure Switch
	63P	Pressure Relief Device
	71	Level Switch for Oil
	96	Buchholtz Relay
Switchyard	87B	Busbar differential Protection
	50BF	Circuit Breaker Failure Protection

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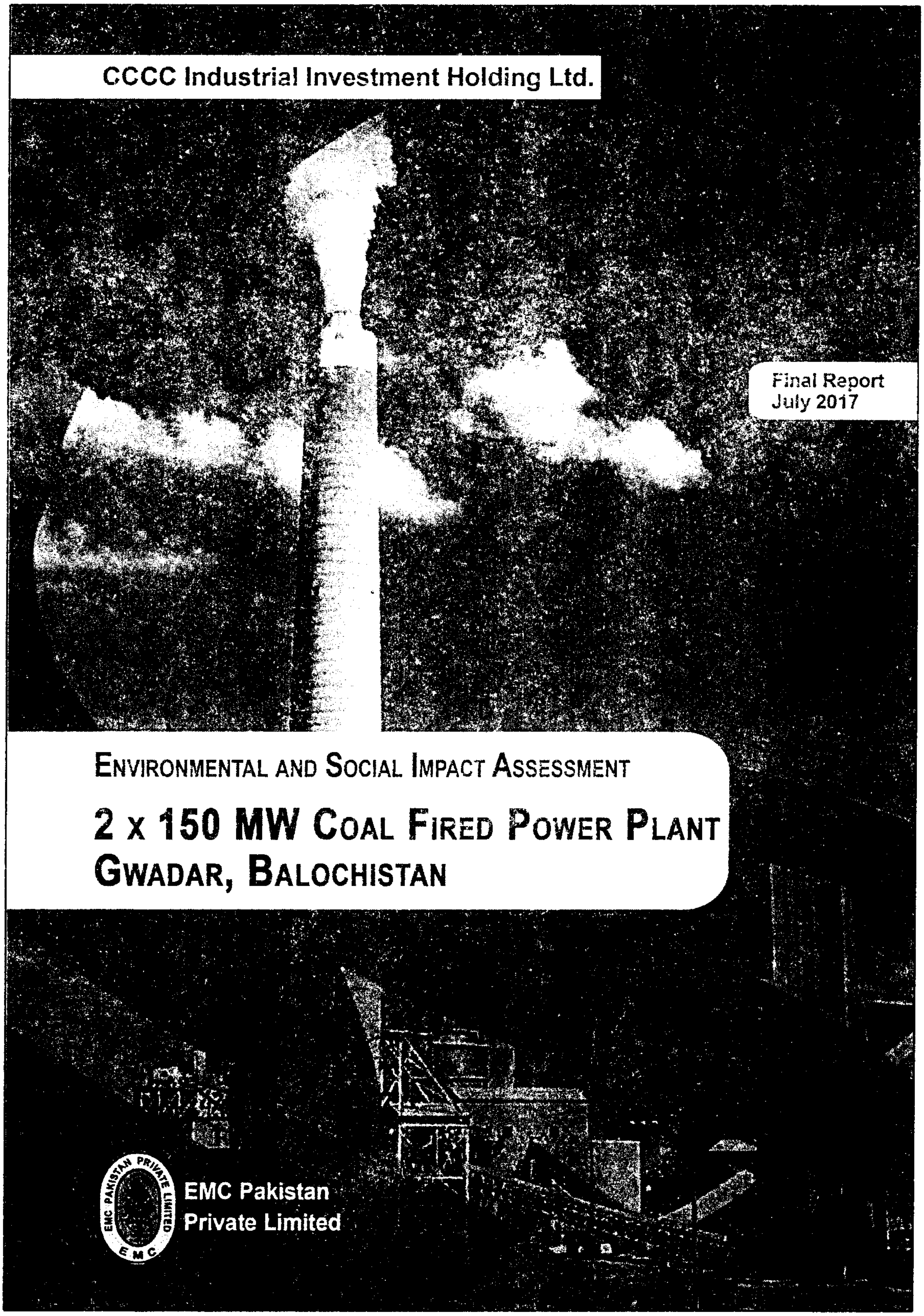
CCCC Industrial Investment Holding Ltd.

Final Report
July 2017

Environmental and Social Impact Assessment

2 x 150 MW Coal Fired Power Plant Gwadar, Balochistan



EMC Pakistan Private Limited

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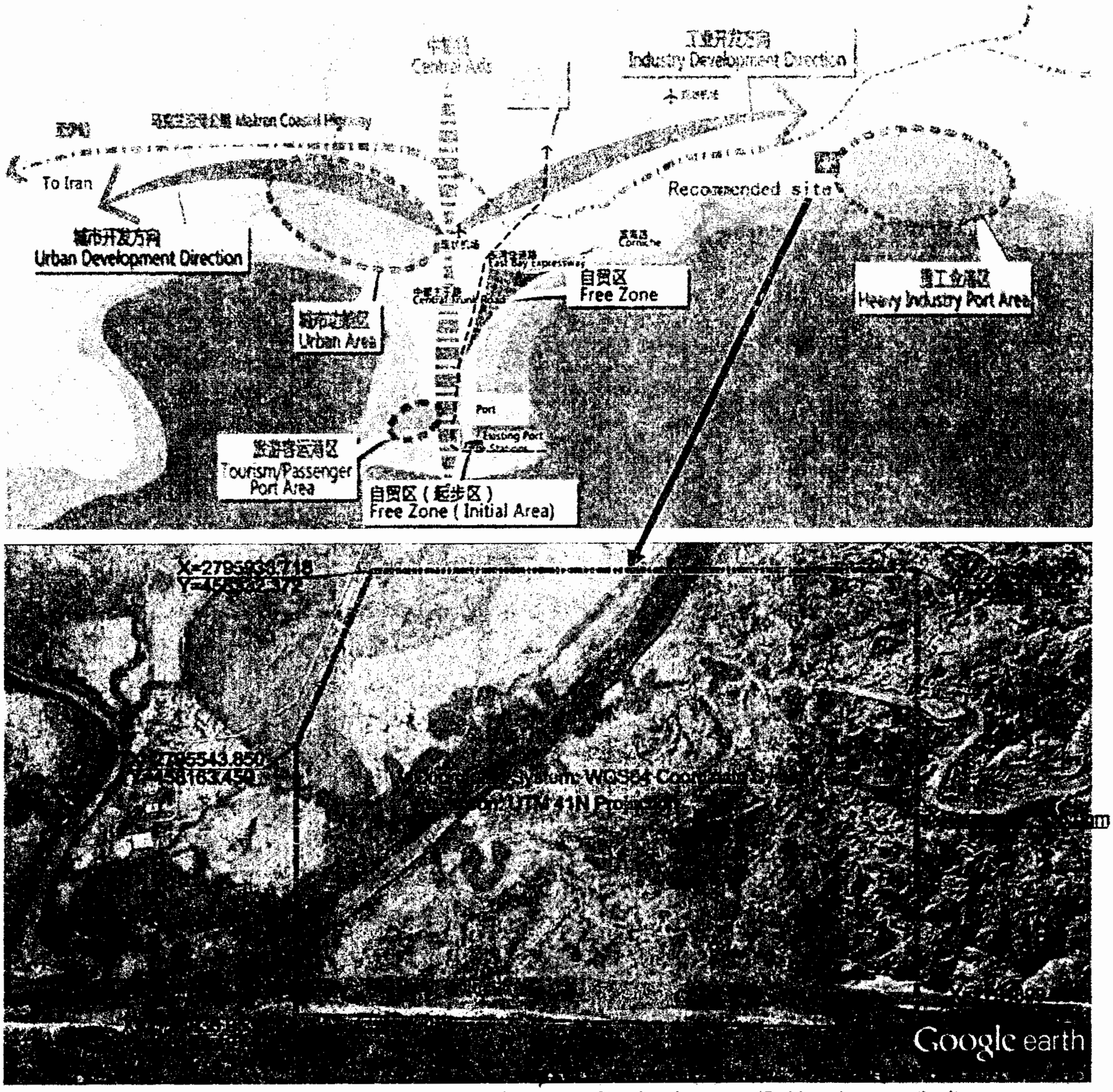
Environmental & Social Impact Assessment (ESIA)

The Project

CCCC Industrial Investment Holding Ltd (hereinafter referred as Project Proponent) proposes to construct & operate a 2 x 150 MW (Gross), [super-high pressure], pulverized-coal-power plant (CPP) with a net capacity of [271.5] MW (the "Plant") over an area of 200 acres, near Sur Bundar, Gwadar, Balochistan as shown in figure 1. The proposed site is located approximately 37 km from the Port along the coast. It has an Arabian Sea towards the south, National Highway (N10) towards the north and the barren lands towards the east and west. The project site is free of any encumbrances and is presently a wasteland with flat topography. The landform elevation is approximately seven (7) to 21.



The South Boundary is the boundary of land and sea specified by relevant authority

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Figure 1: Location of proposed site for 2 x 150 MW Coal Power Plant

The main objective of the proposed Project is to respond to the Energy Policy 2013 aiming at utilization of coal for power generation and thus provide energy security to the Country. Once complete, the Project will not only supply power to the Gwadar area, but also the Makran Coastal region, which will be significant for relieving the supply shortage in Balochistan. This Project will be the first step towards rapid growth in Gwadar and its surrounding areas.

Power will be sold to the Central Power Purchasing Agency (Guarantee) Limited ("CPPA-G") under a 30-year Power Purchase Agreement ("PPA") on a "Take or Pay" basis and will be evacuated through a [220] kV transmission line to be built by the National Transmission & Despatch Company Limited.

The major systems of the proposed project include:

- Coal handling and processing system
- Supercritical boiler
- Steam turbine and condenser
- Electrical power generator and power export system
- Cooling water system
- Fly Ash and Bottom Ash handling system
- Utilities and waste management system
- Dust prevention, and fire monitoring and prevention facilities.

The layout of proposed Power Plant is shown in Figure 2.

Legal Requirement

This Environmental & Social Impact Assessment (ESIA) responds to Section 15 of the Balochistan Environmental Protection Act 2012 and the procedures set therein. It takes into account the likely adverse impact of activities on the physical, biological and social environment on the macroenvironment and microenvironment of the project.

According to Pakistan Environmental Protection Agency (Review of IEE & EIA) Regulations 2000, a proponent of a project falling in any category listed in Schedule II shall file an EIA with the Balochistan Environmental Protection Agency, since the listed projects are generally major projects and have the potential to affect a large number of people. Thermal Power Plants above 200 MW are placed in Schedule II thus requiring an Environmental Impact Assessment.

The EIA report has been prepared after identifying the environmental aspects and screening the potential impacts to ensure that the proposed activities pertaining to construction and operation of proposed 2 × 150 MW Coal Power Plant are environment friendly and evaluated through environmental assessment carried out in accordance with applicable laws and regulations. Initial field surveys for the ESIA study were carried out during the months of May and June 2017 by a team of environmentalists, sociologists, botanist, wildlife specialist and marine biologist. Relevant data to establish the baseline and to carry out environmental impact assessment were collected during field observations in the course of surveys; consultations and meetings with government departments, NGOs and communities; and ground truthing of available secondary information.

Secondary information was collected from GDA, archives of the consultants, government departments and NGOs. Applicable World Bank guidelines and environmental assessment procedures prepared by the Pakistan EPA were followed in the preparation of the ESIA report.

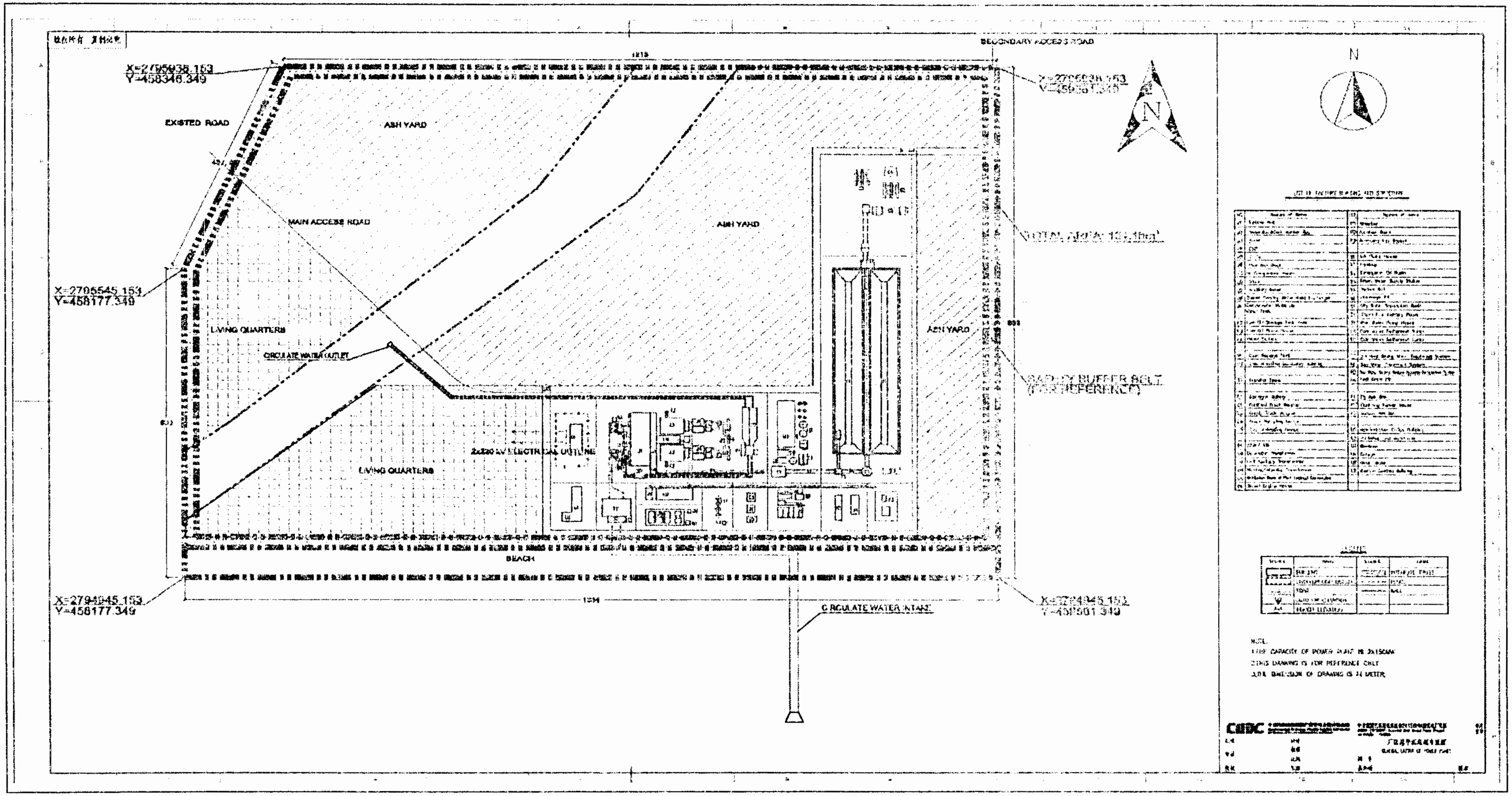

Figure 2: Layout of proposed 2 x 150 MW Coal Power Plant

ESIA Team

CCCC Industrial Investment Holding Ltd commissioned EMC Pakistan Private Limited for conducting the ESIA study of the Proposed Project to assess the likely environmental and social impacts that may result from Project activities and to identify measures to mitigate negative impacts, if any. EMC formulated the following team of experts for conducting the ESIA study and preparing the report:

Table ES-1: ESIA Study Team

S. No.	Name	Position in Project
1	Engr. Syed Nadeem Arif	Project Director
2	Saquib Ejaz Hussain	Project Manager / Expert on Air Dispersion Modeling
3	Mr. Shams ul haq Memon	Senior Environmentalist & Ecologist
4	Dr. Mirza Arshad Ali Beg	Senior Environmentalist & Climate Change Specialist
5	Dr. Badar Ghauri	Senior Air Quality Expert
6	Dr. Shahid Amjad	Senior Marine Biologist
7	Dr. Lekhraj Kella	Senior Ecologist
8	Dr. Ali Rashid Tabrez	Senior Geologist
9	Mr. Khurram Shams Khan	Social Safeguard Specialist
10	Mr. Shahbaz Ahmed	Environmental Scientist
11	Engr. Sohaib Tariq	Energy Management Specialist

Project Components

The project comprises the design, construction, commissioning and operation of coal-fired power station & associated infrastructure for proposed 2 x 150 MW Coal Power Plant in Gwadar.

Sea Transport: Project Coal will be shipped via Panamax vessels from South Africa to Gwadar as per the design coal. The total shipping time will be [16] days: [1] days for coal loading at the Richard Bay Terminal; [14] days at sea; [1] days for coal unloading at the Port.

Inland Transport: The coal will be either be unloaded and moved to the terminal yard for storage or loaded directly on to trucks through the loading system and transported to the Project Site. The road distance between the Port and the Project Site is about [40 km].

Coal Receival System: The upper part of the vehicle unloading device is semi-open, with a span of 15m and a column spacing of 10m. Each column spacing has two unloading lots. Unloading parking spaces are designed to accommodate five (5) trucks at one time. There will be two (2) shifts a day, and each shift will span over five (5) hours. The hourly unloading frequency will be approximately 13 trucks.

The lower part of the coal unloading unit is a double seam sewer. Under the sewing coal slot are the dual belt conveyors; each belt conveyor is equipped with two bridge impeller coal feeders with an output ranging from 100 to 500 t/h.

The coal unloading device is equipped with vibrating coal levelling grate to remove the accumulated coal. In order to prevent the coal chute from blocking, the coal tank wall is equipped with the polymer wear-resistant liner.

Coal Storage: The Project plans to set up an open bar bucket wheel stacker reclaimer coal field given the annual coal requirement. Given the Project Site is affected by the monsoon, the coal field is designed to accommodate that; the annual integrated number of days affecting the terminal coal unloading operation is 65 days, and the number of consecutively-affecting days is not more than 45 days. Keeping that in mind, the plant coal field is designed based on 60 days. There will be two (2) coal piles in the coal yard, each with a length of 350 m, a width of 45 m, a height of 14 m and a total storage capacity of 17.7 × 10^4 t.

The coal field sets a bucket wheel stacker with rated pile material output of 400 t/h, rated reclaim capacity of 200 t/h and one (1) road belt conveyor. Bucket wheel stacker reclaimer has the shunt function, to shunt coal about 200 t/h to the coal warehouse, and the rest shunted to the coal field for storage. The coal yard is equipped with two coal briquettes and a loader, which, as the coal storage site transport and underground coal hopper coal supply auxiliary equipment, can improve the utilization of the coal field.

To ensure the safety of coal system, the coal field also has an underground coal bucket for emergency coal supply, and the coal can be supplied by coal pusher and coal loader. The underground coal hopper sets a vibration feeder, with rated output of 200 t/h; under the vibration feeder, a single belt conveyor is set with rated output of 200 t/h.

Screening System: The crusher room is arranged after the coal field, and two (2) sieving and crushing equipment are set to match with the two-way belt conveyor system. One will be running and the other will be used as a spare, or in certain cases the two will be running simultaneously but only for a short period of time. The ring hammer crusher is used with output 150 t/h, feed particle size ≤ 300 mm, and discharging granularity ≤ 30 mm. The roller screen is used with the output of 200 t/h, feed size ≤ 300 mm, and discharging granularity ≤ 30 mm.

Conveyor Belt: The conveyor belt in front of the coal yard is designed as: width= 800 mm, velocity= 2.5 m/s and quantity= 400 t/h. The conveyor belt after the coal field is designed as: width= 800 mm, velocity= 1.6 m/s and quantity= 200 t/h. Similar to the coal field ground belt, the belt conveyors are of two-way setting, one will be running and the other will be used as a spare, or in certain cases the two will be running simultaneously but only for a short period of time.

The coal handling system is of three-shift operation, and will run approximately five (5) hours per shift. In the coal unloading device and the coal field output and the trans-shipment into the main power house, there are the belt conveyor telescopic device or electric baffle tee, which can achieve cross-running. The bunker bay belt conveyor floor adopts the economical and reliable electric double-sided plow unloader for coal blending.

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Ancillary Services: The project sets up the equipment for plant-entering coal and furnace-entering coal sample preparation and measurement, calibration, deironing, and coal-containing wastewater treatment. In order to prevent the coal field dust from flying and coal from spontaneous combustion, water spray devices surround the coal field. In order to prevent the coal dust in the bridge puddle (road) from flying, the spray dust removal device is set at the belt conveyor outlet. The transfer station, crushed coal room, coal warehouse and coal pushers are equipped with hangers for the lifting of equipment. Coal handling system is equipped with lighting, communications, fire, ventilation, dust and other facilities. Coal handling system maintenance and repair is generally considered by the whole plant.

Ash and slag yard: The ash, slag and gypsum produced in power plant will be mainly discharged to ash storage yard that will be set up to the north-east side of power plant.

Major Components of the Plant & Design Concept: The major components included in the layout plan are: Ash and Slag Disposal Yard, Construction Yard, Plant Area, Turbine House, Heater Bay, Coal Bunker Bay, Boiler, ESP, Central Control Building, Stack, Transformer, 500 kV Switch Yard, Startup Boiler, Fly Ash Silo, Cooling Tower and etc. The plant has been designed to meet National Environmental Quality Standards (NEQS) as well Best Available Control Technology (BACT) emission limits.

The commissioning and Commercial Operation of the proposed 2 x 150 MW CPP will be ~30 years.

The Baseline

The geographic formation divides Gwadar into three distinct geographic zones: Coastal zone, Plain zone and Mountain Zone. Most of the population is concentrated in Coastal Zone followed by plain Zone (30%) and Mountainous Zone (5%). Annual rainfall is very scarce, usually 4 to 5 inches per year.

Gwadar is situated on the southwestern Arabian Sea coast of Pakistan in Gwadar District of Balochistan province. Gwadar is situated on a natural hammerhead-shaped peninsula forming two almost perfect, but naturally curved, semicircular bays on either side, namely the Paddi Zirr (West Bay) and Deymi Zirr (East Bay). Gwadar is largely flat barren land with two hills, the Koh-e-Batil (maximum height 449 ft.) at the head of the hammerhead peninsula and Koh-e-Mehdi (maximum height 1,112 ft.) to the east of the city. Following an earthquake in September 2013 a small island called Zalzala Jazeera formed approximately 2 kilometers (1.2 mi) off the coast.

The continental shelf of the Pakistan is a wind-forced shelf, influenced by summer monsoonal winds that are in excess of 30 knots that blow in the southwest direction. High energy waves in the SW monsoon influences the process of erosion. Coastal upwelling also prevails along Pakistan coast, which induce higher primary productivity.

The elements of temperature and rainfall are of prime importance in the study of seasons. A synthesis of these elements leads to the four seasons described below;

- NE Monsoon (Cold season) – mid November to mid-February
- Pre-SW Monsoon Transition period (Warm season) – mid March to mid-May.
- SW Monsoon season- June, July to August
- Post Monsoon Period Transition - mid September to mid-November

Tide type in Gwadar is irregular semi-diurnal tide.

MSL	Maximum Tide level	Minimum Tide Level	Mean Tide Range	Maximum Tide Range	Mean High Tide Level	Mean Low Tide Level
136	271	-55	141	308	208	67

Extreme tide levels listed below are referred from the nearby project directly.

- 50 years return period high water level : 363cm
- 100 years return period high water level : 390cm
- 50 years return period low water level : -79cm

The predominant direction and speed of the oceanic currents in the offshore area is generally low, about 0.25 m/s. The speed increases to 0.5 m/s during the SW monsoons. The constancy in direction varies from 33 percent to 66 percent during the SW monsoons due to a variation of the direction of winds, which affects the current. The direction is directly related to the prevailing wind system. The current is generally easterly in the SW monsoon and westerly in the NE monsoon. There is a clock-wise gyre during SW monsoons and anti-clockwise gyre during the NE monsoons.

The Makran coast is located along an active plate boundary lying in the offshore region where Arabian plate is being actively subducted northwards beneath Afghan and Lut blocks. The active margin of Makran Coast remained a site of earthquakes throughout the historical and modern times.

Seismotectonic studies along the Makran coast have identified a number of seismites of Holocene times associated with capable faults. The instrumental and historic seismicity catalogue reveals that the Makran coast active margin is marked by low seismicity presently clustered in the south of Pasni. The infrequent large events occurred all along the Makran coast. The event of 1945 (magnitude 8. I) with shallow depth of 25 km located near Pasni caused ground ruptures, modification of landscape, rock falls, liquefactions, Fire and above all 5 to 10 m high tsunami. (Geological Bulletin Univ. Peshawar Vol. 35, pp. 43-56,2002)

Seismotectonic analysis of the Makran coastal areas shows that the risk factors related both to human settlements as well as important civil structures should be rated high.

This area of the Arabian Sea is also known for its mud volcanoes, and for the episodic formation of islands in the shallow waters off the coast. These islands are typically destroyed within months. The oceanic crust of the Arabian Sea is, according to estimates, being subducted under Eurasian plate at a rate of about 4 cm/year. A sediment pile of wet sticky sludge has been building up on top of this subduction region to a thickness exceeding 6 km.

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The Building Code of Pakistan (2007) Seismic Zoning Map places the Gwadar area in Zone-3 (which can be subject to severe damage during an earthquake) giving a peak horizontal ground acceleration of 0.24 to 0.32 g.

Geotechnical Investigations carried out in the area did not reveal the presence or extent of groundwater and it was also confirmed by the local people during the survey. Due to the impervious nature of overburden deposits at site, mainly consisting of lean clay and silty clays with traces of fine sand, the chances of discovering ground water reserves are limited. The hydrogeological conditions of the project site and its surrounding area reflect the unavailability of groundwater horizon in both quality and quantity. Previous groundwater investigations studies carried out in and around the project site have also not shown any positive results.

In Gwadar district, rain and Non-Perennial Rivers are the main source of drinking water through storage dams built by the government or ponds located near human settlements. The major seasonal rivers of the macroenvironment are Shadi Kaur in Pasni, Dasht River in Jiwani, Akra Kaur and Sawar Kaur in Gwadar and Basal in Ormara with numerous minor tributaries.

The Akra Kaur Dam, located approximately 30 km north of Gwadar is the main source of water supply to the town but due to the increased demand, scanty rainfall as well as rapid siltation in the dam, this is not a reliable source.

In compliance to Balochistan Environmental Act 2012, the baseline data of air quality of the project site was assessed using its USEPA recommended monitoring equipment at six locations in the environs of the proposed project area. Air Quality data (concentration) of criteria pollutants such as NOx (as sum of NO & NO_2), SO_2, CO, PM_{10}, $PM_{2.5}$ along with Noise Levels were collected for 24 hours at each site. The meteorological parameters (wind speed, wind direction, temperature & relative humidity) were also measured onsite. Samples were collected and analyzed in the Lab. Results of these pollutants were compared with NEQS and found well within the limits. However, it is expected that the pollutant level will increase but not beyond the permissible limits (NEQS) in construction and operation phase of the proposed project.

Two major types of habitats have been found in the study area which includes the intertidal area and the adjacent landward area. The coastal area is thus comprised of areas within the intertidal zone and also the adjacent area towards the landward side of the sea shore up to a width of one km. It contains both land and ocean components within land and ocean boundaries that are determined by the degree of influence of the land on ocean and ocean on land.

The area of interest in Sur Bunder (Gwadar) constitutes of consolidated clay hills in the background. Visual observations show that the beach sediments ranged from coarse to fine sand that are typical of a gentle slope beach profile from intertidal wave breaker zone, surf zone and the brem crest followed by the sand dunes. The beach sediments were made up of very fine sand grains to shell particulates. The sources of sediments on the beaches were mostly of terrigenous origin with fragmented shell pieces. The sediments observed were well sorted; suggesting strong wave action during the S.W Monsoon, generally associated with a high energy level beach. Some of the sandy beach locations surveyed for coastal habitats had a gradual steep beach profile that would support strong wave action during the S.W monsoon period. At the highest high water mark (Landwards towards the Berm crest).

The exposed beaches in the area of interest showed little variation in the types of substrate and the animal habitats. The coastal marine habitat survey however showed a diversified community of Gastropods, Bivalve Mollusks, & Crustacean fauna on the exposed beaches at low tide. The result of the spatial dispersion of the animal population and the distribution pattern within the habitat is given in table 4.10. Most of the observed invertebrate species of Mollusk were either found to be in aggregate associations or were randomly distributed in the area of interest. The aggregated species observed in the habitat survey were Cerithium spp, Littorina spp, Barnacles Periglypta spp and the Ocypod crabs, (ghost crabs). The Ocypod crab was found to have aggregated substrate dwellings at high water mark on the sandy coast.

The number of fishing boats registered in Gwadar in 2007 was 1,700. In Sur Bunder, the registered boats are 548 and 441 in Pishukan. Registered numbers of fishermen are estimated to be 7,844 in Gwadar. Approx. 3540 fishermen are in Sur Bander, and 3,317 are in Pishukan. Total fish catch landed in Sur Bunder, in the year 2014 was, 15663.993 Kg.

The nearest human settlement is the fishing village of Sur Bunder, less than 1 km from the project site and 18 km from the city of Gwadar. The micro-environment describes the socio-economic conditions of Sur Bunder based on observations during the site visit, village surveys and consultations with stakeholders at the local level including representatives of the Local Government, Non-Governmental Organizations, and Community-Based Organizations. Sur Bunder is located in Gwadar's Eastbay, between the Koh-e-Mehdi and Jabal-e-Sur, a small mountain outcrop on the south-eastern tip of the village. Administratively, the village of Sur Bunder is spread across two Union Councils-UC Sur Bunder and UC Gurab.

Since independence, the coastal village of Sur Bunder has played an instrumental role in supporting the local and regional fishing economies. Several factors have contributed to the steady growth of the fishing industry in the area, including the vast abundance of fish species, protection of small fishing vessels from high wave action and availability of small-scale cold storage facilities. To facilitate local fishermen, the Gwadar Development Authority has initiated the development of a new fish landing jetty and allied harbor works in a small bay created by Jabal-e-Sur on a fast-track basis. The major components in the allied harbor works includes a reclamation bund, approach road, auction hall, administration building, break water, repair yards, cold storage, ice plants and packing and processing facilities.

Public Consultation

Scoping Sessions were held with all primary and secondary stakeholders including government and non-government organizations, for the purpose of communication, information dissemination, exchange of views, soliciting feedback and suggestions on issues pertaining to the project, to plan future actions, to identify areas of concern, and initiate needs assessment.

The objectives of these meetings were to:

- Inform the Public and the Institutional and Grass root stakeholders about the proposed 2 x 150 MW Coal Power Plant in Gwadar, explain its objectives and the potential positive and negative impacts;
- Identify and address concerns of all interested and affected stakeholders;
- Assess the level of awareness on the proposed Project,
- Instill trust between stakeholders and the proponent to promote cooperation.
- Look for information on the macroenvironment and microenvironment of the Project and into significant environmental impacts that may accrue on initiation of Project activities and based on the information given by the stakeholders estimate measures to be adopted to minimize the severity of impact, and
- Provide a mechanism to resolve issues identified by communities, before project plans are finalized and development begins, thereby, avoiding public outcry and resentment;
- Determine the impact of future development plans in the project area

Overall, the community welcomed the project and offered to collaborate with the project proponent as and when required. They believed that development of their area would improve the economic status of there are however, they expressed concern regarding inclusions of locals in the economic development of Sur Bunder. Their needs and aspirations should not be ignored. They desired that the proponent should offer employment opportunities to local people, wherever possible. Stakeholder concerns and suggestions are shared below:

Table ES-2: Issues & Concerns and Expectations of Local Community

Themes	Issues and Concerns	Community Expectations	Remarks
Impact on Fishing activities	▪ Fishermen raised the concern that the proposed project may disturb access to their fishing grounds, their only source of livelihoods ▪ Fish catch is already decreasing, resulting in reduced incomes, if there is further suppression of the existing resources, fishermen will have nowhere to go ▪ Special consideration, in this regard should be given to fishermen with small boats who are most economically vulnerable in the area	▪ Development of project should ensure minimal disturbance to existing fishing grounds ▪ Where possible, access of fishermen to their fishing grounds should be allowed within a 'safe' distance from the project ▪ Identification of no-go areas for the fishermen must be clearly identified and the same communicated to them for the construction and operation phase.	▪ The proponent shall take necessary mitigation measures to minimize any adverse impact on the fishing activities due to the development of CPP Project
Impact on	▪ The local fishermen should	▪ Grievance Redress	▪ GRM will be

Table ES-2: Issues & Concerns and Expectations of Local Community			
Themes	Issues and Concerns	Community Expectations	Remarks
livelihood and Grievance Redressal	be consulted regarding all developments in and around Sur Bunder, as we have been living in the area for generations, our interests should be safeguarded. ▪ As part of the development of the new jetty, space for small and large boats should be separated, small boats need more protection than larger boats and are more vulnerable to damage and wear and tear from the sea ▪ Fishermen should be able to approach the authorities directly in case of any problems and issues	Mechanism (GRM) should established for the project to effectively address all types of complaints and suggestions of the community ▪ The GRM with all related components should be in place before commencement of project construction phase and should continue throughout project operations	part of institutional arrangements for CPP Project
Potable Water Supply to Local Community	▪ Water is one of the biggest problems in the area. The water supply from Akra Dam is decreasing and homes have to wait for several weeks before they can get water. ▪ Underground water is brackish.	▪ Reliable source of drinking and domestic water is urgently required for growing needs of Sur Bunder ▪ Option of introducing desalination plant must be reviewed	▪ Potable water supply to this area will be facilitated due to new project's contributing to local economy.
Education facilities for local communities	▪ There is a significant need to improve both the quantity and quality of education facilities in the area. ▪ The government schools have very few rooms, which limits the number of classes that can be conducted. The physical structure of some of the government schools is in poor condition ▪ There is a severe lack of science teachers in the area,	▪ Number of rooms in government schools should be increased and physical structure of the schools should be reinforced ▪ Number of government schools (especially at primary level) should match Sur Bunder's requirements ▪ Arrangements should be made to introduce	▪ Educational facilities improvement will be facilitated due to new project's contributing to local economy.

Table ES-2: Issues & Concerns and Expectations of Local Community			
Themes	**Issues and Concerns**	**Community Expectations**	**Remarks**
	therefore the focus is largely on teaching arts subjects. The development of Gwadar is bound to require workers with technical backgrounds, but such educational facilities are not available for our future generations. ▪ Sur Bunder has grown rapidly, but there are only 3 primary schools in the area, young children cannot travel far from home	teaching of math and science subjects in public schools	
Health care facilities for local communities	▪ The existing BHU was established in 1984 and since then, population of Sur Bunder has increased significantly, but no new health facilities have been developed ▪ There is only 1 male doctor, 5 supporting staff and few beds at existing BHU ▪ Only limited lab facilities are available, and no ultrasound facilities ▪ There is only 1 ambulance for entire village ▪ Medicine is only available for a few days a month at the BHU	▪ Number of public health facilities, including lab and ultrasound should match the population ▪ Ambulatory services should be significantly enhanced ▪ Appropriate quantity and quality of medicine should be available all-year round	▪ Healthcare facilities improvement will be facilitated due to new project's contributing to local economy.
Solid Waste disposal system	▪ Piles of garbage can be found in residential and market areas of the village, which poses a huge health hazard for the locals ▪ No solid waste management system is in place ▪ Local Government representatives complained	▪ Appropriate budgetary allocations must be made and disbursed to the local UC for solid waste management ▪ UC representatives should be provided technical expertise for introduction of a proper	▪ CCCC shall take care of the solid waste generated from the project

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Table ES-2: Issues & Concerns and Expectations of Local Community			
Themes	**Issues and Concerns**	**Community Expectations**	**Remarks**
	of not being given funds to employ workforce for solid waste management	solid waste management system for the village	
Employment Opportunity	▪ During off-peak seasons, fishermen hardly earn enough to meet their basic needs ▪ Those residents of Sur Bunder who have earned graduate degrees do not have job opportunities in the area: their capabilities are being wasted ▪ Local residents, therefore demanded employment opportunities both for skilled and unskilled workers ▪ Moreover, local leaders suggested that training programs should be held for local residents in the area of expertise required during the construction and operation phase. This would increase their chance of being hired for employment by the proponent	▪ Employment opportunities should be provided for skilled and unskilled workers ▪ Training Needs Assessment should be conducted to identify training needs of locals ▪ An appropriate Training Center should be established that would manage the training and job placement needs of locals in the project	▪ Local people will be preferred for unskilled & semi-skilled jobs to the extent possible.

Screening of Alternatives, Impacts & Mitigations

CCCC Industrial Investment Holding Ltd will take possession of 200 acres of land. The site is located in Gwadar (Coordinates: 25.11 °N, 62.34 °E) in the Southwest of Balochistan. It will be the only sea outlet in the CPEC, connecting Xinjiang 2,940 kilometers ("km") north of Gwadar, to the Arabian Sea. The Project will be located within the jurisdiction of the Port, near the Sur Bundar area and will require a total of 200 acres of land, which the Sponsors will acquire with the assistance of the Government of Balochistan ("GoB"). The project will not cause displacement of population / relocation of villages. The adverse effect of land take is therefore not expected to be severe.

As of now, there is the N10 National Highway which is to the north of all the site alternatives. The highway can connect to the Port and will become the main access for all the sites. There is a branch road to the east of Site 2 which leads to the Sur Bandar town. A port evacuation expressway has been planned for the east bay of the Port which will connect to the N10 National Highway. Moreover, there is a plan for a new railway line which can also be used for the power plant in the future.

Towards the southwest of the chosen sites lies the Port. Construction on the port started in March 2002 and Phase I of the construction was completed in February 2015. Currently, the port has three (3) 20,000-ton ("t") berths and can also be used to dock two 50,000 t vessels. Phase II of the construction process is underway. The port is managed and operated by the China Overseas Port Holding Co. Ltd. ("Port Authority"). The port was formally opened for navigation on 13th Nov 2016.

Designing of the proposed 2 x 150 MW Coal Power Plant Project and its different components has taken the following aspects into consideration:

Raw coal contains carbon (C), nitrogen (N), sulfur (S), ash, trace amounts of mercury (Hg) and other elements. Once these elements go through a combustion process with air, pollutants such as NOx, SO_2 and SO_3 and are formed. The pollutants of concern from coal power plant are sulfur dioxide [SO_2], nitrogen oxides [NOx], carbon monoxide, and particulate matter [PM]. They are also called "criteria" pollutants because the EPA sets the criteria for permissible levels. Metals are constituents of coal and are emitted as part of fly ash during combustion. Trace metals emissions include antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead. The atmospheric pollutants caused by coal-fired power plant mainly include SO_2 and NOx. As for soot and dust, the dilution, diffusion and purification capabilities of atmosphere shall be utilized as practical as possible and proper prevention & control measures shall be taken as well to minimize pollution impact. It intends to take the following measures in the aspect of the prevention and control of flue gas:

Prevention and control measures for soot and dust

High-efficiency electric precipitator will be adopted in this project after analysis; meanwhile, after soot and dust are further removed and scrubbed in desulfurization unit, the requirement that emission capacity does not exceed 30mg/Nm^3 can be met.

Prevention and control measures for SO_2

The flue gas desulfurization technology applicable to this project includes two kinds of technology, i.e., seawater method and limestone-gypsum wet method desulfurization. Both the two kinds of technology are the most mature flue gas desulfurization process in the world at present, and have the advantages of high desulfurization efficiency, steady operation, high reliability and the like. Since this project is on seaside, and the analysis with available seawater parameters reveals that seawater desulfurization is applicable, it is recommended to adopt seawater desulfurization, considering economic efficiency and maintenance performance. The final determination of desulfurization process shall be based on environmental impact assessment. The emission of SO2 in flue gas can meet the requirement that emission concentration shall be ≤100mg/Nm3 can be met after desulfurization.

Prevention and control measures for NOx

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As for the control of nitrogen oxides, it intends to adopt low-nitrogen combustion technology and to construct SCR unit synchronously. With respect to the denitration proposal of this project, it intends to adopt SCR for denitration, and reducing agent will be of the ammonia-producing process from liquid ammonia. The reducing agent NH3 will be transferred to the ammonia/air mixer in SCR area; after ammonia is mixed with dilution air and is diluted to a safety concentration (below 5% volume concentration), the mixture is sprayed into the flue gas duct at the inlet of SCR reactor via ammonia injection grid. With the action of catalyst, the mixture reacts with the NOx in flue gas to form nontoxic and pollution-free N_2 and H_2O to remove NOx. The NOx concentration in flue gas can meet the environmental emission requirements, i.e., $\leq 100mg/Nm^3$, after denitration.

Emission with high stack

Emission with high stack is one of important measures for mitigating ground pollution. Therefore, stack height shall be chosen rationally to make the best of the diffusion and self-cleaning capacity of atmosphere, thus minimizing the ground concentration of pollutant and obtaining maximal economic benefit under the precondition that environmental protection requirements are met. It is tentatively considered to use a 180m-high steel sleeve stack to emit flue gas in this project; the final height of stack shall be based on the official reply of environmental protection impact assessment.

Provision of continuous monitoring system of flue gas

This project will be provided with automatically continuous monitoring system of flue gas. The items to be monitored include soot & dust, CO, SO_2 and NOx, as well as applicable flue gas parameters such as oxygen content, flue gas rate, flow, flue gas temperature and the like.

Analysis for the impact of atmospheric pollution

The atmospheric pollutant produced in coal-fired power plant is mainly the coal-fired flue gas emitted during production, with main pollution factors being soot & dust, SO_2 and NOx.

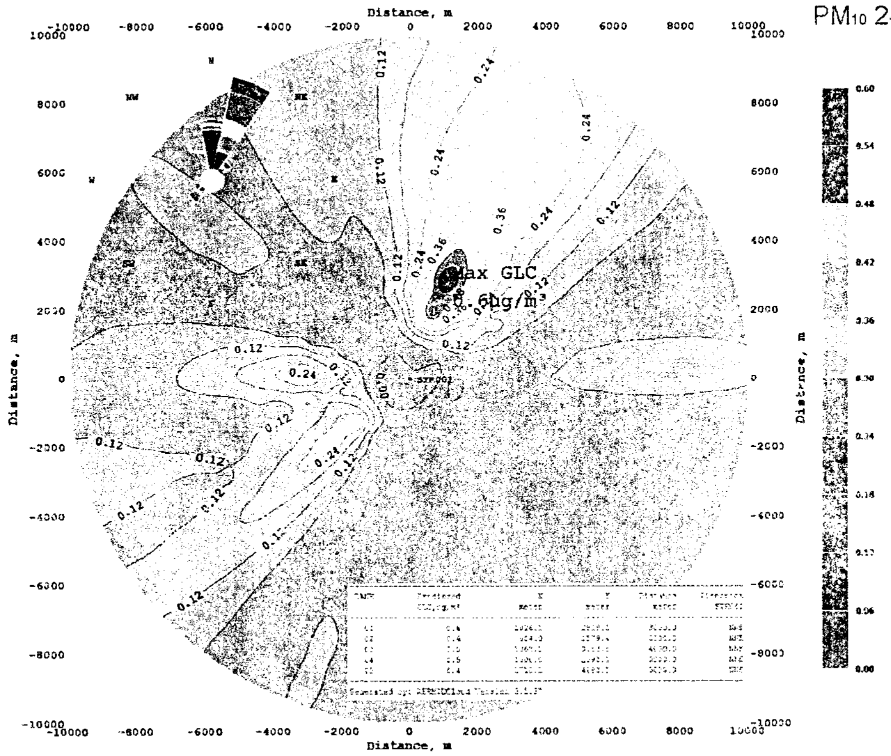
USEPA regulatory model was used to simulate criteria pollutants from major sources in the project area & predict air quality for SO_2, NOx, PM_{10} & $PM_{2.5}$. Hourly micro-meteorological parameters like wind direction, wind speed and ambient temperature were utilized for the modeling purpose.

The emission source data and the calculations were provided by the client.

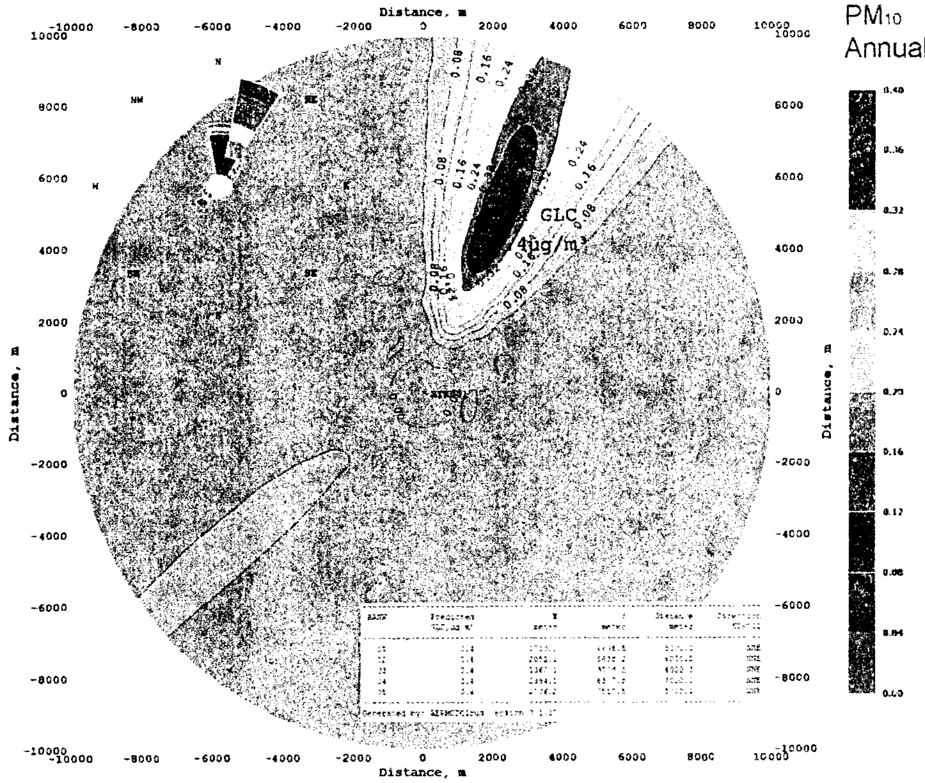
The maximum concentration levels were modeled for 24-hour averaging period and annual averaging period to correspond with the NEQS requirements.

The results of the air dispersion modeling are presented below:

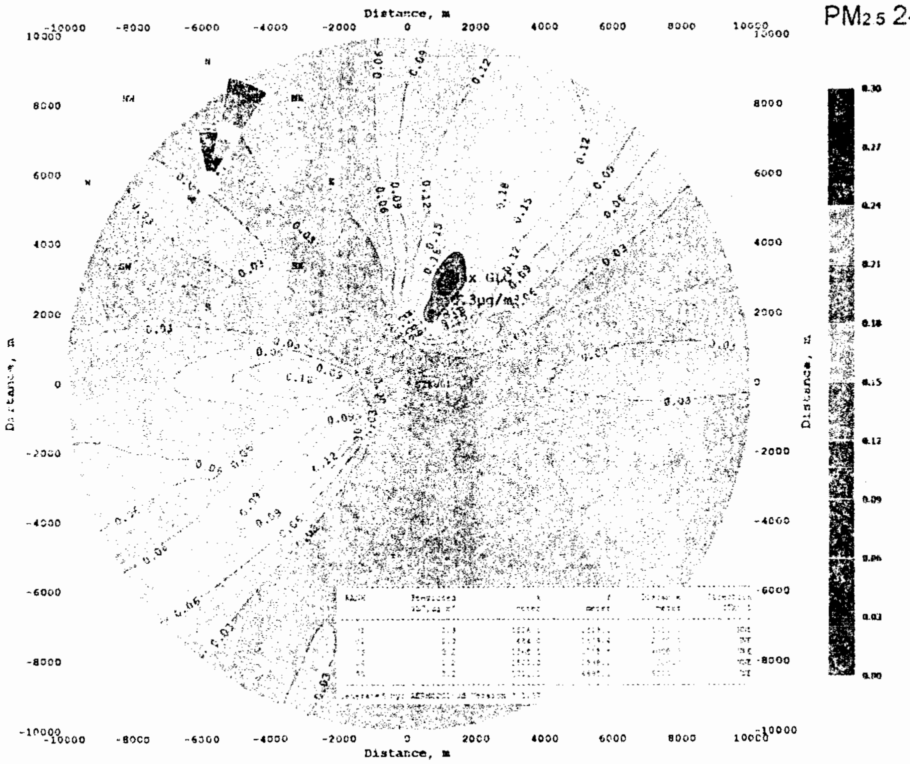
PM_{10} 24 Hr



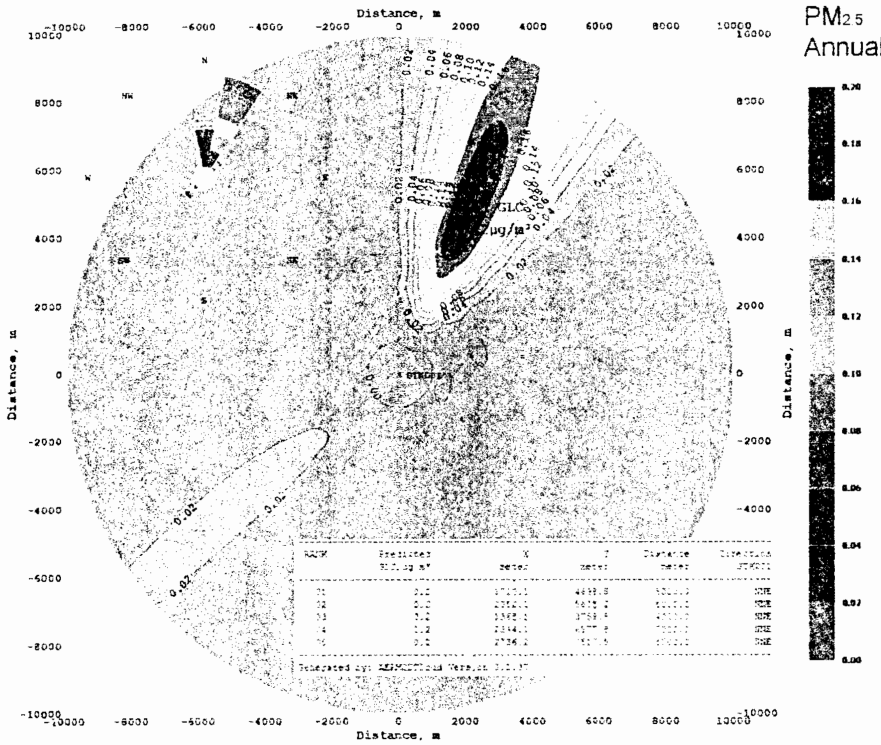
PM_{10} Annual



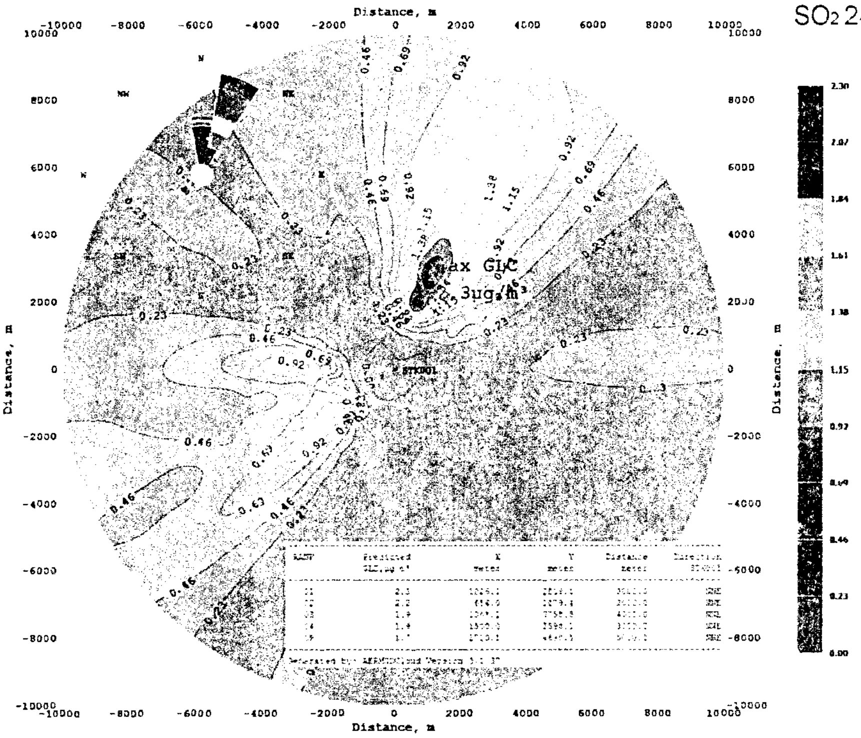
PM2.5 24 Hr



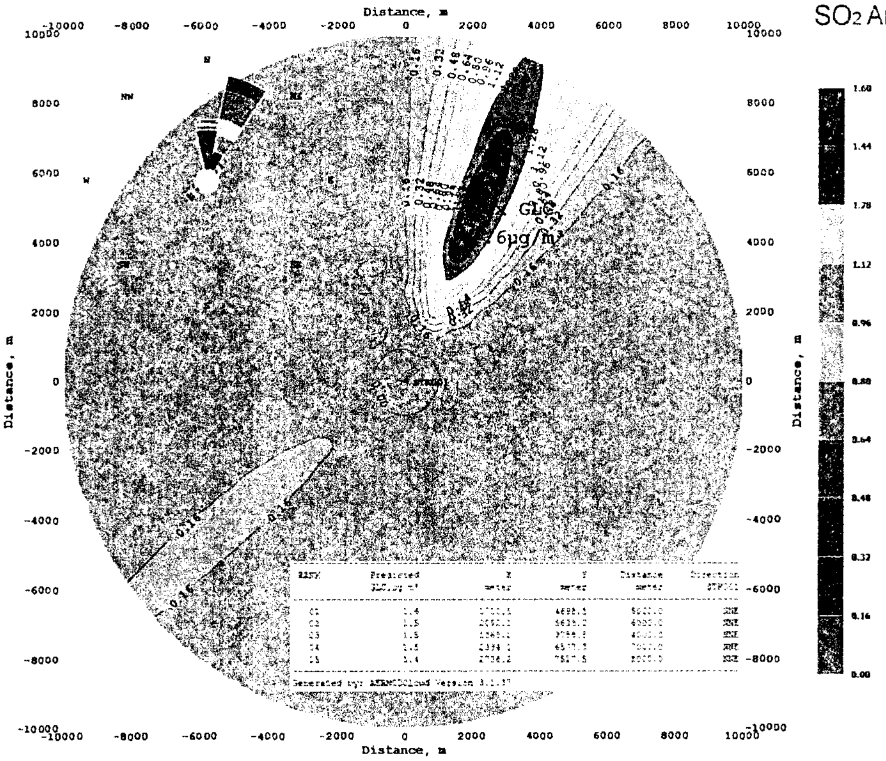
PM2.5 Annual



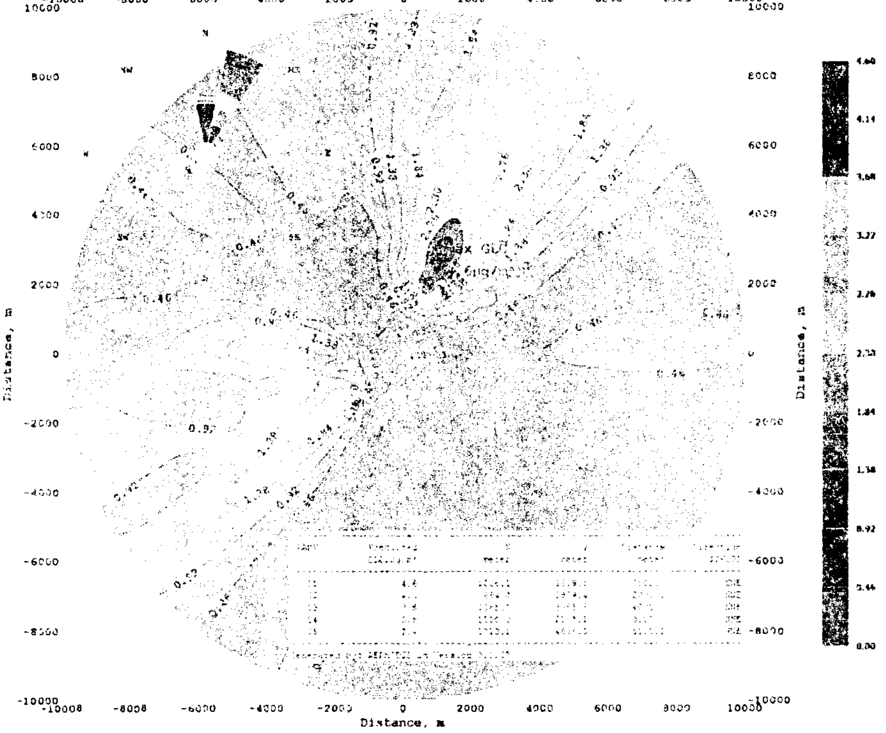
SO2 24 Hr



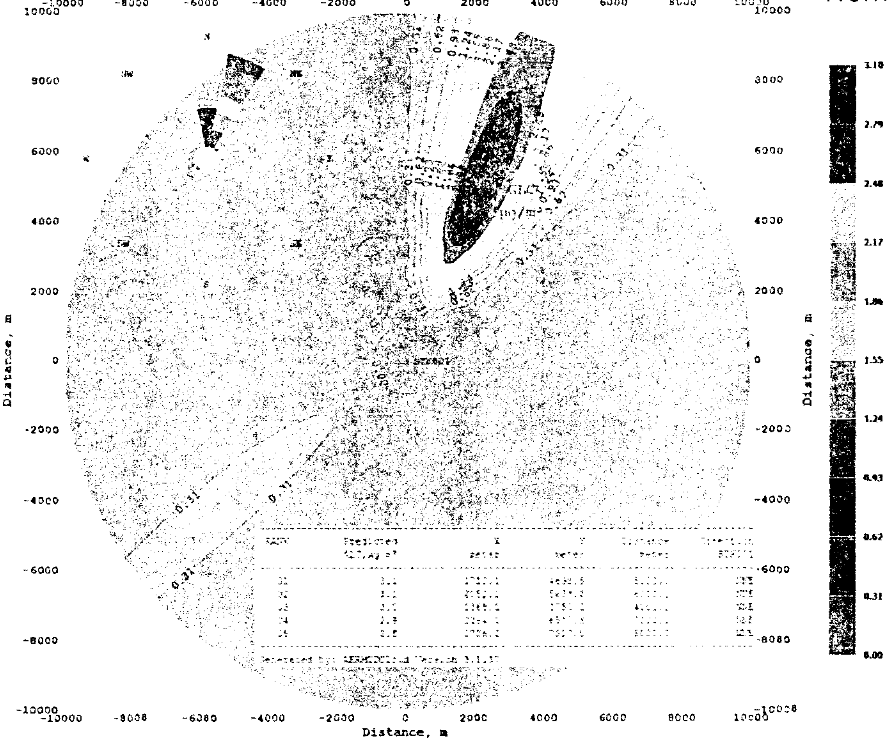
SO2 Annual



NOx 24 Hr



NOx Annual



The Annual Maximum Ground Level Concentration (GLC) for major pollutants with and without control are depicted in the following table:

Stack height, m	Pollutant	Increment in Concentrations caused by the Project (with control)	NEQS ($\mu g/m^3$)	International
		Annual	Annual	Annual
180	SO_2	1.6	80	50 (WHO)
	NOx	3.1	40	100 (World Bank)
	PM10	0.4	120	50 (World Bank)
	PM2.5	0.2	15	

The 24-Hr Maximum Ground Level Concentration (GLC) for major pollutants with and without control are depicted in the following table:

Stack height, m	Pollutant	Increment in Concentrations caused by the Project (with control)	NEQS ($\mu g/m^3$)	International
		24-hr	24-hr	24-hr
180	SO_2	2.3	120	125 (WHO)
	NOx	4.6	80	150 (World Bank)
	PM_{10}	0.6	150	150 (World Bank)
	$PM_{2.5}$	0.3	35	

The 180 m tall stack heights with high momentum and buoyancy takes the plume above the highest mixing height. This results in lowest ground level concentration of air pollutants in the study area. The stack design will conform to the following emission limits:

Parameters	Lignite Boiler Emission (mg/Nm^3)
Particulate matters	$\leq$ 30 mg/Nm^3
SO_2	$\leq$100 mg/Nm^3
NOx (as NO and NO_2)	$\leq$100 mg/Nm^3

For all criteria pollutants (particulates, SO_2 & NO_X), the inclusion of appropriate flue gas cleaning systems will meet all current requirements reliably and economically. These systems use well-proven technology such as ESPs for fine particulates removal, FGD for SO_2 control, together with combustion modifications (low-NOx burners) for control of NO_X.

LO-NOx burner plus air classification technology will be used for denitrification, so as to limit the NOx emission at the boiler outlet to fulfill the emission standard without using other DeNOx devices.

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Each boiler is equipped with two electrostatic precipitators with a dust removal efficiency of at least 99.7%, so as to achieve a dust concentration of less than 30mg/Nm^3 at its outlet.

Flue Gas Desulphurization (FGD) units using lime slurry will be installed to limit SO_2 emissions on the existing as well as the proposed plant.

A complete extractive-type continuous emission monitoring system (CEMS) will be provided with flue gas analyzers for SO_2, NO_x, CO_2, and opacity meters for the unit. The CEMS will be furnished with sampling systems, sample conditioning, sample lines, analyzers, a programmable logic controller (PLC), and a shelter to house the CEMS equipment. The PLC will have a redundant link to the plant DCS.

Coal and coal waste products, including fly ash, bottom ash, and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and, radium, which are dangerous if released into environment. Major portion of these heavy metals may remain with ash. The efficient ash management system adopted for the proposed power plant shall control release of ash as well as heavy metal into environment.

Continuous online monitoring system for SPM, CO, SO_2 and NOx with computer display and recording facility will be installed to facilitate regular checkup of air emissions and ensure compliance with the prescribed standards.

The wastewater from the plant includes recurrent wastewater and incidental wastewater. The recurrent wastewater includes ultra-filtration backwash drainage, fresh water reverse osmosis thick water, acid-alkali wastewater of boiler make-up water treatment system, desulphurization wastewater, acid-alkali wastewater of condensate polishing; while the incidental wastewater includes rinse water of air pre-heater and chemical washing wastewater.

The proposed power plant adopts an integrated water and wastewater management system including reuse, recycling and treatment of wastewater. No waste and wastewater shall be discharged to the environment without satisfying the requirements of NEQS. Hence, the discharge of treated wastewater will not result any change in water quality to have impact on the receiving water bodies.

Ash is the prime coal combustion products that release as fly ash and bottom ash during the operation of power plant. Ash collection and management system comprise of Electrostatic Precipitator (ESP) that have 99.7% efficiency to arrest fly ash. Hence, ash deposition on the surrounding ecosystem habitat and components will be minor. The ash residue will be managed through collecting, conveying and storage.

Both the bottom ash and fly ash handling systems are controlled by program. The bottom ash handling system of each boiler uses a set of PLC system that locates in the same control room in the electrostatic precipitator building together with the PLC of the ash handling system. In long

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term, the project targets 100% utilization of this generated ash with adoption of efficient ash management system.

Plant safety and industrial hygiene measures will be given utmost attention as per provisions stipulated in the Factories Act.

Workers exposed to mechanical accident-prone areas will be provided with personal protective equipment (PPE). The non-respiratory PPE includes tight rubber goggles, safety helmets, welders hand shields and welding helmets, plastic face shields, ear plugs, ear muffs, rubber aprons, rubber gloves, shoes with non-skid soles, gum boots, safety shoe with toe protection which will be provided to workers. All safety and health codes prescribed by the OSHA will be strictly implemented in the plant.

Two explosion risks exist with firing pulverized coal; dust and methane. Adherence to the National Fire Protection Association (NFPA) requirements and guidelines, in particular NFPA 850 and NFPA 654, reduces the risk of explosion hazards.

The following measures will be implemented during the pre-construction and construction phase of the project to minimize the socioeconomic impacts:

→ The designated area will be used as far as possible.
→ The Project will be designed to avoid construction anywhere near residential areas, settlements, houses and buildings.
→ Campsites will be constructed at least 500 m from any settlement.
→ Land price will be determined according to the relevant rules, and in consultation with the affected community.
→ Written agreements will be made for any temporary or permanent land acquisition.
→ The acquired land will be clearly marked and the actual land take will be limited to the agreed limits.
→ Continuous liaison will be maintained with the affected community and their concerns addressed appropriately.
→ The construction activities will not block the existing roads and tracks. If unavoidable, alternate routes will be provided in consultation with the affected people/concerned department.
→ Construction crew's interaction with local population will be minimized. Project proponent and contractor will maintain liaison with local community. The communities will be informed of the construction activities well in advance.
→ Unskilled and skilled employment will be provided to the local communities
→ Opportunities and workplaces will be created for the local people;
→ Safe drinking water will be provided to the local residents;
→ Better access to education and healthcare will be provided to the local population in collaboration with local CBOs.

- → The construction area will be cordoned off, and no irrelevant personnel will be allowed inside the demarcated area.
- → The construction machinery will not be left unattended. Any excavation at the site will not be left open for extended period, appropriate crossover passages will be provided in consultation with the local population.
- → Safe driving practice will be enforced for the project vehicles. A speed limit of 20 km/h will be enforced for the project vehicles passing through settlements.
- → It will be ensured that the supplies (water, fuel, construction materials, camp supplies, etc.) are sourced in a manner not adversely affecting the local population.
- → The capacity and existing demand on the sources will be estimated, and these estimates will be used for the project needs only when surplus capacity is available.
- → The construction crew will undergo medical screening before being deployed in the field.
- → All sites of archaeological, historical, cultural and religious significance will be avoided. If any artefacts are discovered during the excavation, the relevant authorities (Department of Archaeology and Museums, Government of Pakistan.

Environmental Management Plan (EMP)

The EMP includes mitigation, enhancement, compensation and contingency measures for each of the three phases of the project – pre-construction, construction and post construction/ operation. The management plan covers air quality management plan, noise management plan, waste management plan, site establishment plan, water resources management plan, ash management plan, ecosystem management plan, and socio-economic management plan. Scope of those management plans will adopt pollutants abatement measures in different phases of the power plant. Some of the pollution abatement measures take account of inbuilt construction and some of them are external. Inbuilt measures include ESP, FGD, ETP, WTP, Ash disposal, Occupational health and safety and regular training and motivations to the employees. External measures include green belt development, air quality monitoring stations, water quality monitoring stations, acoustic monitoring and regular training and monitoring to the respective management plan.

Table ES-3: Mitigation Measures Proposed to be Implemented During Construction Phase

Mitigation Measures Proposed	Responsibility	Regulation	Targets to Achieve	Risks and Consequence of Failure, if any
Air Environment				
Water sprinkling in vulnerable areas	CCCC + Contractor)	-	Control of fugitive dust from construction areas	Increase in SPM emissions
Proper maintenance of vehicles & construction equipment	CCCC + Contractor)	-	Control of NOx Emissions	Nil
Transportation of construction material in covered trucks, wherever possible	CCCC + Contractor)	-	Control of fugitive dust from construction areas	Increase in SPM emissions

Table ES-3: Mitigation Measures Proposed to be Implemented During Construction Phase				
Mitigation Measures Proposed	Responsibility	Regulation	Targets to Achieve	Risks and Consequence of Failure, if any
Noise Environment				
Proper maintenance of vehicles, equipment and machinery	Contractor	NEQS for Ambient Noise and Vehicular Emissions	Control of ambient and in plant noise levels	Increase in noise levels
Provision of acoustic covers/enclosures on equipment and machinery, wherever possible	Contractor	-	Control of ambient and in plant noise levels	Increase in noise levels
Provision of ear muffs/earplugs to the workers in high noise areas and enforcement of its use	Contractor	OHSA	Protection of workers	Health effects on individual workers.
Water Environment				
Channelization of effluents from construction area through network of drains	CCCC + Contractor)	NEQS for effluent	Control of suspended solids in effluents from construction area	Increase in total suspended solids in effluents
Construction of temporary sedimentation tanks for the effluents from construction area	CCCC + Contractor)	NEQS for effluent	Control of suspended solids in effluents from construction area	Increase in total suspended solids in effluents
Socio-Economic Environment				
Provision of environmentally safe camping area for the migrant laborers	CCCC + Contractor)	-	To provide clean & healthy living environment to work force	Unhealthy living conditions, spread of diseases
Arrangements tor water supply and sanitation	CCCC + Contractor)	-	To reduce stress on surrounding population	Stress on existing utilities, conflicts with local people
Solid Waste Management				
Disposal of construction debris	Contractor	-	Control of pollution	Air/Water Pollution
Reclaiming of inbuilt area with appropriate vegetation/land scaping	Contractor	-	Create a good visual environment	Unpleasant surroundings

Table ES-4: Mitigation Measures Proposed to be Implemented During Operation Phase				
Mitigation Measures Proposed	Responsibility	Regulation	Targets to Achieve	Risks and Consequence of Failure, if any

Table ES-4: Mitigation Measures Proposed to be Implemented During Operation Phase				
Mitigation Measures Proposed	**Responsibility**	**Regulation**	**Targets to Achieve**	**Risks and Consequence of Failure, if any**
Air Environment				
High Efficiency ESPs	CCCC	Guidelines for CPP for Pakistan	To reduce the emission levels of PM_{10} to 30 µg/Nm^3	Increase in PM emissions
180 m Tall Stack	CCCC	-	Wider dispersion of PM, SO_2 and NOx	Degradation of airshed
Coal Dust Extraction and Suppression Systems	CCCC	-	Control of fugitive dust from coal handling plant	Increase in fugitive emissions
Sprinkling over bottom ash disposal area	CCCC	-	Control of fugitive dust from ash pond	Increase in fugitive emissions
Reclamation of ash pond	CCCC	-	Control of fugitive dust from ash pond	Increase in fugitive emissions
Water Environment				
Main Plant Effluent Treatment Plant	CCCC	NEQS	Removal of contaminants to conform to regulatory standards for discharge of effluents	Increase in parameters
Sewage Treatment Plant	CCCC	NEQS	Removal of contaminants to conform to regulatory standards for discharge of effluents	Increase in parameters
Noise Environment				
Design of equipment	CCCC+ Equipment Supplier	-	To control noise levels to NEQS limits for industrial noise	Increase in in-plant and ambient noise levels
Provision of acoustic enclosures/barriers/shields to reduce noise	CCCC+ Equipment Supplier	-	Attenuation of noise in source receptor pathway	Increase in in-plant and ambient noise levels
Provision of personal protective equipments like ear plugs and ear muffs	CCCC	OSHA	Protection of sensitive receptor	Health impact on workers in high noise areas
Solid Waste Management				
Dry collection of fly ash & supply of ash to entrepreneurs	CCCC	-	Facilitate supply of dry ash to entrepreneurs	Reduction in quantity of ash utilized.
Ash Utilization	CCCC+Other entrepreneurs)	-	Reduce land requirement for ash disposal and pollution from ash disposal site	increased land requirement
Disposal of Unused Ash	CCCC	-	Environmentally safe disposal of unused ash	-

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Table ES-4: Mitigation Measures Proposed to be Implemented During Operation Phase				
Mitigation Measures Proposed	Responsibility	Regulation	Targets to Achieve	Risks and Consequence of Failure, if any
Plant Rejects	CCCC	-	Reuse within plant/ sale to smaller industries for reuse through an EPA certified contractor / consultant	-
Municipal Solid Waste	CCCC	-	Environmentally safe disposal of municipal waste from township	Air and water pollution, spread of disease vectors
Others				
Afforestation and Green Belt Development	CCCC	-	Ecological improvement. Attenuation of air pollutants (PM, SO_2 and NOx) and noise in source receptor pathway	-
Control of Fire and Explosion Hazards	CCCC + Vendor for Main Plant)	-	Safety	Increased risk of fire and explosion

The implementation and monitoring of EMP shall have to be ensured. Therefore, a team of Independent Monitoring Consultant (IMC) along with EPA Certified Laboratory has to be engaged with responsibility of strong monitoring during implementation of EMP & their environmental and social consequences.

Conclusion

The EIA study finds that the impacts of the project activities at the pre-construction, construction and operation stages have been adequately addressed and mitigation measures duly proposed wherever needed. Adoption of mitigation measures will ensure reduction of impact on the micro and macroenvironment as well as socio-economic conditions to acceptable levels and discharge of emissions to comply with the NEQS. The development of this project will be compatible with the requirements of the Balochistan Environmental Protection Act 2012 as well as other regulatory requirements of Government of Pakistan. The issue of safety has been duly incorporated in the design and operations phases of the project.

On the basis of the findings of the EIA Study, it is possible to conclude that proposed 2 x 150 MW CPP Project will thus respond to all aspects of sustainability: Economic, social and environmental and will thus be a sustainably viable project.

300 MW Gwadar Coal-fired Power Project
Project Feasibility Study

Version dated July 2017

Table of Contents

List of Acronyms

°C	Degrees Celsius
A	Ampere
AC	Alternating Current
BEPA	Balochistan Environment Protection Agency
BMCR	Boiler Maximum Continuous Rating
CCCC	China Communications Construction Company
CCR	Central Control Room
CCTV	Closed-circuit television
CIF	Cost, Insurance and Freight
cm	Centimetre
CO	Carbon Monoxide
COD	Commercial Operations Date
CPEC	China Pakistan Economic Corridor
CPPA-G	Central Power Purchasing Agency (Guarantee) Limited
CSA	Coal Supply Agreement
dB	Decibel
DC	Direct Current
DCS	Distributed Control System
DISCOs	Distribution Companies
DSRA	Debt Service Reserve Account
DWT	Dead weight tonnage
ESIA	Environmental and Social Impact Assessment
EMP	Environmental Management Plan
ENR	Engineering News Record
EPC	Engineering, Procurement and Construction
EPCC	EPC Contractor
ESP	Electrostatic Precipitator
FC	Financial Close
FGD	Flue Gas Desulfurization
FO	Furnace Oil
FOB	Free on Board
ft	Feet
G	Gravity
GDA	Gwadar Development Authority
GoB	Government of Balochistan
GOP	Government of Pakistan
GWh	Gigawatt hour
ha	Hectares
HGI	Hardgrove Grindability Index
HHV	Higher heating value
HP	Horsepower
Hrs	Hours
HSD	High-Speed Diesel
Hz	Hertz
ID	Identification Card
IDC	Interest during Construction
IED	Improvised Explosive Device
IPP	Independent Power Producers

IRR	Internal Rate of Return
JCC	Joint Cooperation for CPEC
kA	Kiloamperes
Kcal/kg	Kilocalories per kilogram
Kg/m^3	Kilograms per cubic metre
KIBOR	Karachi Interbank Offered Rate
kJ	Kilojoules
Km	Kilometres
kN	Kilonewton
kN/m^2	Kilonewton per square metres
kPa	Kilopascal
KPK	Khyber Pakhtunkhwa
kV	Kilovolts
kWh	Kilowatt hour
LHV	Lower heating value
LIBOR	London Interbank Offered Rate
Local CPI	Local Consumer Price Index
LV	Low-voltage
m	Metres
m/s	Metres per second
MCS	Modulating Control System
Mg/Nm^3	Milligrams per cubic metre
MIS	Management Information System
Mm	Millimetre
MPa	Megapascal
MT	Metric tonnes
MVA	Mega Volt Amp
MW	Megawatts
MWh	Megawatt hour
NAR	Net as received
NCV	Net Calorific Value
NEPRA	National Electric Power Regulatory Authority
NEQS	National Environmental Quality Standards
NFPA	National Fire Protection Association
NIO	National Institute of Oceanography
NM	Nautical miles
NO_x	Nitrogen Oxide
NPV	Net Present Value
NTDC	National Transmission Despatch Company Limited
O&M	Operations and Maintenance
OEM	Original Equipment Manufacturer
PEPA	Pakistan Environment Protection Agency
PGA	Peak Ground Acceleration
PKR	Pakistani Rupees
PPA	Power Purchase Agreement
RBCT	Richards Bay Coal Terminal
RFP	Request for Proposal
RMB	Renminbi
rpm	Revolutions per minute
SCR	Selective Catalytic Reduction

SO_x	Sulphur Oxide
t	Tonnes
t/a	Tonnes per annum
t/h	Tonnes per hour
t/m^3	Tonnes per cubic metre
TEIG	Tianjin Energy Investment Group
US CPI	United States Consumer Price Index
USD	United States Dollar
V	Velocity
V	Volt
WACC	Weighted Average Cost of Capital
WAPDA	Water and Power Development Authority

List of Tables

List of Figures

1. Introduction

This draft feasibility study provides relevant till date information about the 300 megawatts ("MW") (gross) imported coal-fired power plant to be set up in Gwadar, Balochistan, Pakistan (the "Project").

Located near the Gwadar Port (the "Port"), the Project is a vital part of the China Pakistan Economic Corridor ("CPEC") and will help ameliorate the ongoing acute shortage of electricity.

2. Executive Summary

2.1 Project Background

In May 2013, the Chinese Premier, Li Keqiang visited Pakistan and proposed joint development projects focusing on energy, infrastructure and agriculture. This development was put forth as the China Pakistan Economic Corridor ("CPEC"). Through CPEC, Gwadar's deep-water port and its surrounding areas have become a major part of this economic development. Gwadar's strategic position will attract many industrial projects which in turn will have significant power requirements.

Currently, Gwadar depends on approximately 70 MW of imported power from Iran. Of this 70 MW, approximately 14 MW is allocated to Gwadar, while the Makran Coastal region utilizes the remaining 56 MW. Moreover, there is no interconnection point in or close to Gwadar for the national grid. Instead there is a relatively independent grid that connects Gwadar, Turbat, Panjgur and Pasni. Further construction is underway to connect Pasni to the Ormara Naval Base. The limited power supply coupled with an inefficient distribution system results in daily outages of twelve (12) hours ("hrs") in cities and sixteen (16) hrs in rural areas.

Keeping in view the strategic importance of Gwadar to CPEC and the anticipated rapid growth therein, the Joint Cooperation Committee for CPEC (the "JCC"), decided in its sixth (6th) meeting, held in Beijing in December 2016, that a 300 MW imported coal fired power project (the "Project") must be developed on fast track basis at the port city of Gwadar. The Project is intended to not only meet the current demand for power in Gwadar and adjoining areas, but will also support future demand growth. The JCC nominated China Communications & Construction Company ("CCCC" or the "Sponsors") or its nominated subsidiary to undertake this development on an expedited basis.

2.2 Project Overview

The Project envisages setting up of a 300 MW (Gross), pulverized-coal-fired power plant with a net capacity of 272.1 MW (the "Plant") at Gwadar. Power will be sold to the Central Power Purchasing Agency (Guarantee) Limited ("CPPA-G") under a 30-year Power Purchase Agreement ("PPA") on a "Take or Pay" basis and will be evacuated through a 220kV transmission line to be built by the National Transmission & Despatch Company Limited ("NTDC").

Once complete, the Project will not only supply power to the Gwadar area, but also the Makran Coastal region, which will be significant for relieving the supply shortage in that part of Balochistan. This Project will be the first step towards rapid growth in Gwadar and its surrounding areas.

2.3 Project Sponsors

China Communications Construction Company Limited ("CCCC" or "Main Sponsor")

CCCC is listed on the Shanghai and Hong Kong stock exchanges (Ticker symbols: 601800, 1800, respectively). As a world leading extra-large infrastructure comprehensive service provider, CCCC is involved in traffic infrastructure, equipment manufacturer, real estate, comprehensive urban development, etc. Its aim is to provide clients with complete solutions and integrated services for investment and financing, consultancy and planning, design and construction, as well as management and operation. At present, CCCC is the largest harbour design and construction company, highway and bridge design and construction, dredging, container crane manufacturer, and the largest offshore oil drilling platform design company in the world. Moreover, it is the largest international project contractor, the largest design company, the largest express highway investor, and possesses the largest dredging fleet in China. In 2016, CCCC was ranked 110th by Fortune 500 and ranked third (3rd) in Top 250 International Contractors by Engineering News-Record ("ENR"), a leading magazine for the construction industry. CCCC, being the Main Sponsor will hold 75% of the total shareholding.

Tianjin Energy Investment Group ("TEIG" or "Co-sponsor")

Tianjin, a state-owned corporation, was founded in May 2013 and has registered capital of RMB 10 Billion. As a main entity based in Tianjin, it is involved in the construction, operation, and management of energy projects. Accumulated installed capacity of invested and constructed units is 12,558MW, which more than 90% of total adjustable installed capacity of Tianjin. It has constructed the largest fuel gas heat power plant in China, Tianjin Chengnan Fuel Gas Heat Power Plant. Projects in association with large power generation enterprises of China, namely Huaneng Group, Datang Group, SDIC Power Group, China Guodian Corp., China Huadian Corp., and Guohua Power Group, include Beijiang Power Plant, Yangliuqing Heat Power Plant, Dongbeijiao Heat Power Plant, Beitang Heat Power Plant, Junliangcheng Heat Power Plant, Dagang Power Plant, and Panshan Power Plant.

2.4 Project Structure and Project Company Organization

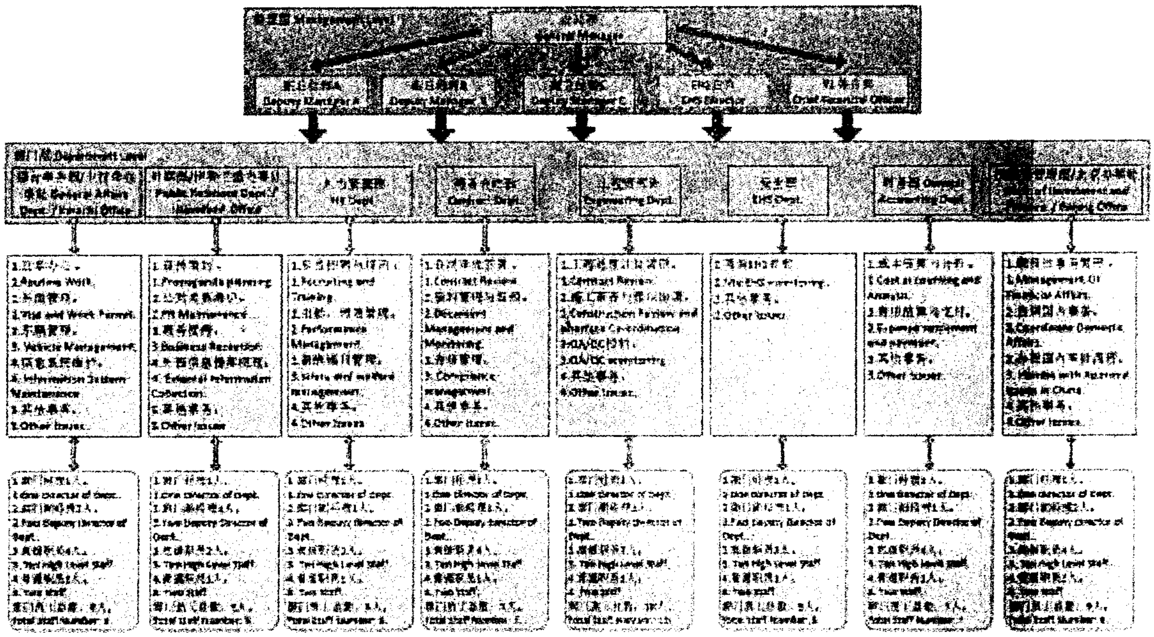

Figure 1 – Organogram

2.5 Project Implementation

The Project will be implemented through a fixed price, date-certain, turn-key EPC Contract. The EPC contract will include boilers, steam turbines and generators, balance-of-plant, water intake and outfall, and all other associated facilities for the Plant. The EPC contractor will coordinate, through the Project Company, any interfaces with the relevant governmental agencies and obtain on its own, necessary permits, within its scope, associated with the execution of EPC Contract works. In addition, the EPC Contractor will be responsible for remaining in full compliance with existing environmental regulations during the EPC Contract execution phase.

The general operations and maintenance of the Project, post COD, will be managed by the O&M contractor with the goal of operational efficiency and compliance with all applicable laws and covenants. O&M Contractor will be selected through a competitive basis.

About six months prior to commissioning, the O&M contractor is expected to be available on site to begin the process of acclimatizing and transitioning ownership of the complex from the EPC teams. Training will be conducted on all aspects of the facility until all aspects of the Plant's operation have been adequately transitioned, as identified in the O&M Agreement.

2.6 Construction Period

The Project is expected to be completed in 30 months from Financial Close ("FC").

2.7 Pakistan Power Sector and Project Rationale

For the past decade or so, Pakistan has been suffering from an acute energy crisis due to rising demand exacerbated by structural flaws within the sector. Some of the major reasons contributing to this crisis include:

- Inefficient transmission and distribution
- Increasing demand
- Inefficient use of energy
- Expensive energy mix and
- Improper pricing

Installed capacity in the country grew at an average rate of 5.51% during the period 1990-2015. However, this increase in capacity has been unable to meet the demand of electricity leading to a demand-supply gap, which can go as high as 6,600 MW during peak hours resulting in prolonged power outages and loss in economic activity. Given, Gwadar's strategic importance in Pakistan and the larger CPEC, it is important to ensure a dependable power supply for economic growth. According to the information provided by the Gwadar Development Authority ("GDA"), the current power supply scheme is based on 70 MW of power imported from Iran. Given the anticipated increase in demand this will not be sufficient for the power requirements of the region. This Project can not only supply power to the Gwadar area, but also to the Makran Coastal region. This will fulfil the rapid growth in demand for electricity, improve the reliability of power supply and thus, accelerate economic development in the Gwadar area.

2.8 Project Site

The Project is proposed to be located at Gwadar in the Southwest part of Balochistan. It will be the only sea outlet in the CPEC, connecting Xinjiang 2,940 kilometres ("km") north of Gwadar, to the Arabian Sea. The Project will be located within the jurisdiction of the GDA, near the Sur Bundar area and will require a total of 330 acres of land, which the Sponsors will acquire with the assistance of the Government of Balochistan ("GoB"). The GoB proposed several sites for the Project. Subsequently, the Main Sponsor undertook its initial site survey in January 2017 and based on the findings of the survey, Site 3 (the "Site"), was chosen as the recommended site and confirmed to GDA on 18th May 2017. Site acquisition process is underway with GDA. Details of the sites and site selection criteria/process is given below in Section 4.

The Site is mostly flat land, unsuitable for farming, and sparse settlements nearby. The N10 National Highway is to the north; the highway can connect to the Port and will become the main access. An expressway has been planned for the east bay of the Port which will connect to the N10 National Highway. Moreover, there is a plan for a new railway line which can also be potentially used for the power plant in the future. Towards the southwest of the Site lies the Port. Construction on the port started in March 2002 and Phase I of the construction was completed in February 2015. Currently, the port has three (3) 20,000ton ("t") berths and can also be used to dock two 50,000 t vessels. Phase II of the construction process is underway. The port is managed and operated by the China Overseas Port Holding Co. Ltd. ("Port Operator"). The port was formally opened for navigation on 13th November 2016. The Gwadar Airport, at present, is a small airport located in the central axis of Gwadar, about 15 km from the Port. Gwadar International Airport is planned near Darabele about 10.5 km from the Site.

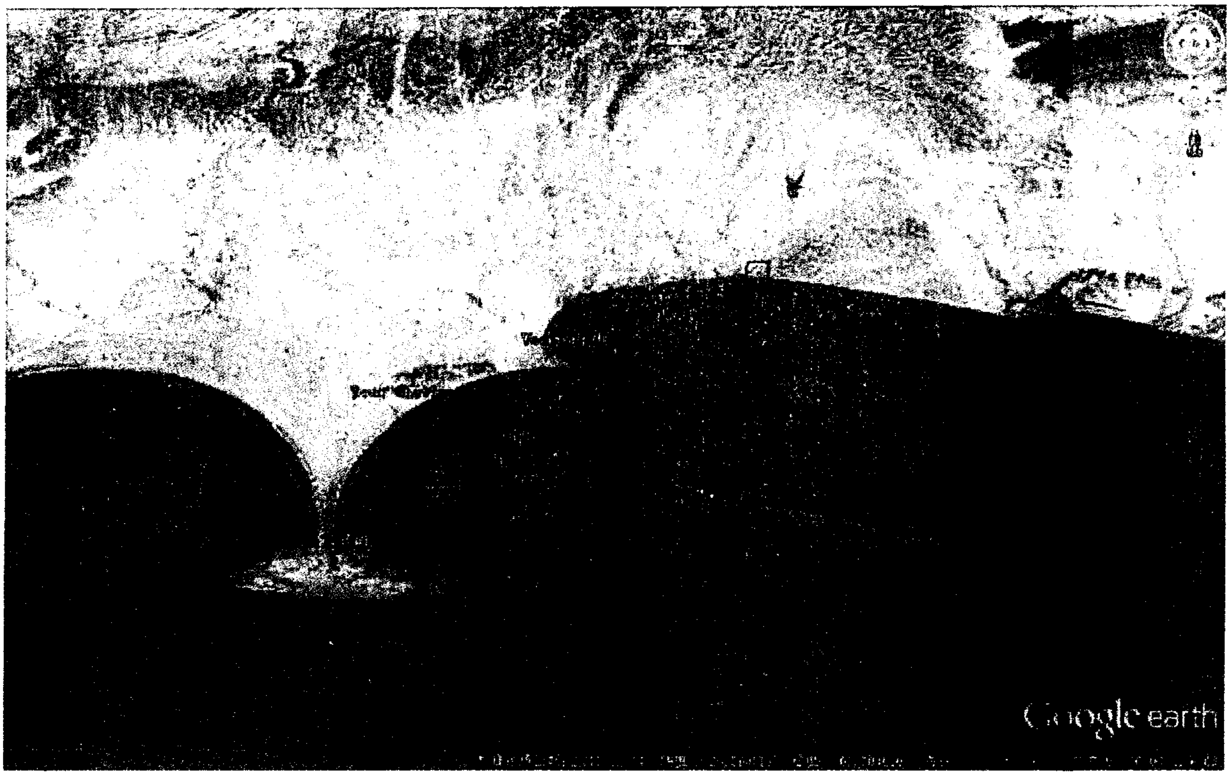

Figure 2 - Geographic Location of the Site

2.9 Design Requirements and Design Life

The Project shall be designed and executed to comply with all national and local laws, regulations and mandatory requirements in Pakistan. Any equipment that is imported, shall be designed, manufactured and inspected in accordance with corresponding technical standards of the technology introduced, such as GB, ASME, IEC, ASTM, NFPA or corresponding standards and specifications of the company from which the technology is being sourced. Fire protection design of the Project shall adopt NFPA Standard.

The plant will be designed for a 30-year operation life cycle having a net capacity of not less than 271.1 MW and an annual availability of not less than 85%.

2.10 Interconnection

The complex is proposed to be connected with the planned 220kV infrastructure, with two loops of outgoing lines, to be built by NTDC. Interconnection Point shall be the outgoing gantry of the switchyard after stepping it up to 220kV. At present, there is only a 132kV interconnection point near the Site. A Grid Interconnection Study is being undertaken by NTDC and is in its final stages.

2.11 Project Construction

Project construction work scope shall include the main power island inside the plant enclosure, auxiliary facility area and building in front area of the factory, and coal receival equipment in the plant, seawater intake and drainage facility, sewage disposal facility and ash disposal area outside the enclosure, etc.

The scope of the EPC Contractor is currently based on the preliminary design and scope determined by the review and recommendation of the relevant component studies to the Feasibility Study, and includes the foundation design, ground treatment, connecting roads, green belts, plant roads, enclosures, gates, constructions temporary facilities like offices, living camp area, owner office building, material library, security rooms, security watch towers and other ancillary buildings; all supply of equipment, sourcing of equipment and material (including equipment manufacturing supervision and expediting) of systems from relevant suppliers and their works; construction and installation; commissioning (including equipment tests, system commissioning tests required by the Owner and tests under the PPA; defects repair and minor tweaks during the various test runs, etc.

2.12 Project Technical Details

2.12.1 Project Configuration and Generation

Boiler

The Project shall consist of two (2) 150 MW ultra-high-pressure coal-fired units and their auxiliary.

The two boilers shall be of high-temperature and super-high-pressure drum boiler, with natural circulation, single furnace, outdoor, steel framework, coal-fired, solid residue discharge type.

Turbine

The Contractor shall provide two 150MW super-high-pressure condensing turbines and auxiliary equipment. It is envisaged that turbines shall be of super-high pressure, single reheat, single axis and double-cylinder double-exhaust impulse condensing type.

Unit operation mode: constant pressure - sliding pressure - constant pressure or constant pressure - sliding pressure operation;

Load property: with basic load and the capability of peaking operation at and have the capacity for on-load peaking operation 30%~100% TMCR load, and support FCB function.

The regenerative stage number of unit is temporarily determined as Type VII and will be finally determined by the Sponsors after comprehensive comparison according to the characteristics of main unit. Besides, the regenerative scheme shall be provided with proven and reliable operation performance.

Steam turbine generator

The scope of steam turbine generator of the Project is 2×150MW air-cooled steam turbine generators, which will include the generator body, excitation system, cooling system, lubricating oil system, detection device, as well as necessary accessories, spare parts and special tools.

Main technical parameters of steam turbine generator and excitation system are:
Rated power: 150MW
Cooling mode: air cooling
Rated power factor: 0.8 (lagging, provisional)
Rated voltage: 15.75kV or voltage determined by other generator factory
Frequency: 50Hz
Speed: 3,000r/min
Number of phases: 3
Rotation direction of generator: consistent with that of the steam turbine.

2.12.2 Fuel Range

Table 1 – Coal Element Analysis

Coal quality index	Symbol	Unit	Designing Coal (South Africa RB3)	Check coal (South Africa-Indonesia 5:5 mixture)
Industrial analysis				
Total moisture	Mt	%	9.27	17.29
Air dried basis moisture	Mad	%	4.44	9.84
Ash as received	Aar	%	17.56	11.25
Dry ash-free basis	Vdaf	%	32.42	41.33
Fixed Carbon	Car	%	49.45	41.93
Miscellaneous				
Lower heating value as received basis	Q_{net}, ar	kcal/kg	5371	4991
High heat value as received basis	Q_{gr}, ar	kcal/kg	5591	5254
Hardgrove grindability index	HGI		53	48
Elemental analysis				
Carbon as received	Car	%	59.20	55.59
Hydrogen as received basis	Har	%	3.46	3.66
Oxygen as received basis	Oar	%	7.98	10.05
Nitrogen as received	Nar	%	1.49	1.24

Coal quality index	Symbol	Unit	Designing Coal (South Africa RB3)	Check coal (South Africa-Indonesia 5:5 mixture)
basis				
Sulphur as received basis	St.ar	%	1.04	0.88
Analysis of ash content				
Silica dioxide	SiO_2	%	53.39	50.82
Aluminium oxide	Al_2O_3	%	22.65	22.39
Iron oxide	Fe_2O_3	%	6.56	8.18
Calcium Oxide	CaO	%	6.92	6.92
Magnesium Oxide	MgO	%	2.23	2.29
Sodium Oxide	Na_2O	%	0.19	0.3
Potassium Oxide	K_2O	%	0.66	0.82
Titanium Dioxide	TiO_2	%	1.06	1.04
Manganese dioxide (MnO_2)	MnO_2	%	0.5	0.41
Sulfur trioxide	SO_3	%	5.22	6.11
Phosphorus pentoxide	P_2O_5	%	0.62	0.53
Ash fusion temperature				
Deformation temperature	DT	°C	1240	1140
Softening temperature	ST	°C	1270	1160
Hemisphere temperature	HT	°C	1290	1170
Flow temperature	FT	°C	1310	1240
Graininess	<50mm	%	99.2	95.87

2.12.3 Fuel Storage

In the coal handling system for the Project, one outdoor strip type bucket-wheel stacker / reclaimer shall be provided in the coal yard. In order to mitigate operations disruptions on account of coal supply related events, the coal yard shall have not less than 60 days, at full despatch, design coal storage capacity.

Coal stacking density is considered to be 0.9t/m³, the stacking coefficient is calculated by 0.85, and the coal pile height in the yard should not exceed 14m. Wind dust wall shall be set around the coal yard, exceeding by 3m the top of coal pile. Coal retaining wall not lower than 1.5m is to be set around the coal pile. To prevent dust flying in coal yard and autoignition potential of the pile, water injectors shall be set around the pile.

One bucket-wheel stacker reclaimer with 500t/h rated stockpile output and 300t/h rated reclaiming capacity and 1 belt conveyor shall be provided. The coal yard shall be equipped with two (2) coal bulldozers and one (1) wheel loader to serve as the auxiliary equipment for transfers in coal yard and loading of underground coal hopper, so as to improve the use ratio of coal yard.

To ensure loading system safety, one (1) additional underground coal hopper shall be set in the coal yard for emergency loading, and the coal bulldozer and wheel loader shall be used for loading. One (1) vibrating feeder shall be set for underground coal bucket with 300t/h rated output; single-way belt conveyor shall be set below vibrating feeder with 300t/h rated output.

One steel structure coal bulldozer house shall be constructed near the coal yard. There are 3 stalls in coal bulldozer house, and one electric single girder bridge crane with 5t weight shall be provided therein.

2.12.4 Flue Gas Desulfurization ("FGD") Selection

The seawater desulfurization process has major advantages for a seaside power plant where seawater for cooling and adequate drainage options with no or manageable risk of recirculation. The seawater desulfurization process is characterized by simple process, reliable systems and convenient operation and maintenance. The maintenance workload of system is little because this process uses seawater to absorb SO_2, and other additives are not used.

The required desulfurization rate can be achieved under the condition that sulfur content of firing coal is low and seawater salinity is suitable, etc., thus meeting the environmental protection requirements.

Solid waste will not be produced, and there is no release of secondary pollution of waste slag, and, the occupation / utilization of stockyard and landfill is avoided, thus minimizing the additional impact of FGD unit operations on environment.

Seawater based FGD is superior to the wet method desulfurization system which is more complicated with higher operations and maintenance demands. In addition to the civil and mechanical works for wet desulfurizer and its flue gas systems, such desulfurization process warrants accessory systems such as limestone storage, slurrying, gypsum recovery, discharge, wastewater treatment and the like. The wet method desulfurization system will consume limestone and fresh water resources.

Technically speaking, both the above-mentioned solutions are feasible. Since this Project is on the seaside, it is preliminarily judged that seawater parameters are suitable for seawater desulfurization on the base of past engineering experience; for this reason, considering economic efficiency and maintenance performance, it is recommended to adopt seawater desulfurization. The final desulfurization process shall be determined according to the official and written reply on environmental impact assessment and accurate seawater quality analysis information.

2.12.5 Electrostatic Precipitator ("ESP")

Each boiler should be fitted with at least four ash transporting pipelines. The economizer ash bucket of each boiler should be fitted with one independent ash transporting pipeline to transport ash to the ash storage; Electric Field II of electric precipitator will serve as the emergency backup electric filed for Electric Field I, and the pneumatic conveying system can replace 100% operations of conveying system in Electric Field I in case of failure in Electric Field I; the flying ash of any boiler can be conveyed to any ash storage.

2.12.6 Plant Cooling Water

A seawater once-through cooling water system shall be adopted and the and the water will be sourced from the Arabian Sea on the south of the Site.

The seawater channels shall be sized in line with the demands of the 2 × 150MW complex including of cooling, desulphurization and other water requirements for the complex and human consumption.

The flow of seawater once-through cooling water system shall be as follows:

Arabian Sea→Intake structure→ Cooling water pump house → Cooling water supply pipe → Condenser→ Cooling water discharge pipe →Siphon well→ Drainage pipe or box culvert → Seawater desulfurization system →Discharge structure →Arabian Sea.

The cooling water of electric power plant shall meet the following requirements: 1) The temperature rise at 100m outside the discharge outlet shall not exceed 3° C, this is however subject to the final Environmental and Social Impact Assessment ("ESIA"); 2) The temperature rise near the water intake shall not exceed 0.5 ° C.

According to the situation of the sea area near site, it is assumed that water depth of 8 meters under the lowest tide level is about 1.3km away from the shore.

The seawater channels, intake and outfall if required, shall ensure that there is no recirculation of the reject water into the water intake.

2.12.7 Fire Protection

The Contractor shall provide a complete firefighting system for the whole power plant. The firefighting system shall meet the local fire codes and specifications in Pakistan, as well as NFPA fire protection rules.

The scope of the Fire Protection scope shall cover plant, the fire protection for building structure of the plant, the thermal system and combustion system, thermal control electrical system of the plant area, air-conditioning and ventilation system, water supply and drainage system, office building and duty room and life service-related building, etc.

The Contractor is responsible for all works within the scope of approval and acceptance of firefighting system of the whole plant by the respective fire department, if any and the codal requirements of the NFPA code.

2.12.8 Coal Handling System

The coal handling system includes equipment design, manufacture, procurement, transportation, storage, construction, installation, testing, commissioning, pilot run, defect elimination, final delivery and all works for truck unloading system, strip-type coal yard, loading system, transfer station, coal crusher house, deironing and other stray metal removal, sampling, weighing, calibration, maintenance lifting, flushing and other systems and equipment, as well as spare parts, special tools and technical services (including foreign side technical service, training, etc.).

After import, from South Africa, and being unloaded at the jetty at the Gwadar port, the coal shall be transported to the plant coal yard by truck.

At the coal yard 30t dumper shall be used with one truck coal unloading ditch and 6 unloading stalls shall be constructed. Through type unloading is used for the coal trucks to accelerate the unloading speed.

Truck coal unloading device shall be operational on two shifts a day. Three truck scales (2 loaded truck scales and one no-load truck scale) shall be set at entrance and exit of the plant, and two truck sampling devices shall be provided in front of loaded truck scale.

Dual-way belt conveyor with dual belt width B=800mm, belt speed V=2.8m/s and 500t/h output shall be set below the coal ditch. Each belt conveyor is fitted with one bridge w the coal ditch. Each belt c~500t/h adjustable output). After the coal in coal slot is transferred to coal yard or the output is adjusted, coal is directly supplied to the raw coal bunker in the main power house.

Vibrating coal grate shall be provided above the truck coal unloading device to remove the coal accumulated on coal grate, and spray dust suppression device shall be set on it.

The coal crusher house is to be installed behind the coal yard with two sets of filtering equipment, so as to match with the dual-way belt conveyor. It supports one for operation and one for backup, and simultaneous operations of both circuits.

Electronic truck scale shall be used to measure truck supplied coal in the Project. There are three (3) truck scales, two (2) loaded truck scales and one (1) no-load truck scale, in the Project with 100t weighing capacity.

Two (2) truck sampling units will be provided and shall be arranged in front of loaded truck scale to sample the truck coal.

The coal handling system in the Project shall be subject to necessary centralized monitoring and control by coal handing DCS system, and ball type automatic cloud platform camera will be provided near all important coal handling technological equipment, which shall be accessible to coal handling television system.

2.12.9 Fuel Oil

Boiler firing and stabilizing fuel oil shall be light diesel oil which will be transported to the complex via fuel lorries. Reference features of the light diesel oil are provided in Table 2.12.9-1.

Table 2 - Features of 0 # light diesel oil

Content	Unit	Data
Moisture	%	Mark
Ash content	%	≤ 0.01
Sulfur content	%	≤ 0.5
Mechanical impurity	%	None
Existent gum	mg/L	None
Cetane number		> 45
Closed-cup flash point	°C	≥ 55
Freezing point	°C	≤ 0
Kinematic viscosity (under 20°C)	mm^2/S	3.0-8.0
Engler viscosity (under 20°C)	°E	1.20-1.67
10% residual carbon evaporant	%	≤ 0.3
Acidity	Mg KOH/L	70
Proportion under 20°C	kg/m^3	820-850
Lower heating value	kJ/kg	42,600

2.12.10 Ash Disposal

Ash disposal system shall consist of the following sub systems.

Slag removal system: the slag removal system from outlet of lower interconnecting box baffle of boiler to the outlet of slag discharge device at the bottom of slag storage, including all the equipment, valves, pipes, pipe supports and hangers and accessories in the system shall be provided.

Dry ash removal system: the ash removal system from outlet of ash bucket for electrostatic precipitator and economizer to the outlet of unloading equipment in ash storage, including the following subsystems: fly ash delivery system for economizer, fly ash delivery system for electrostatic precipitator, ash storage exhaust and filtration system, compressed air system, gasifying air system, compressed air system for dedusting instrument (including pulse jet cleaning air system of exhaust gas filter in ash storage) and unloading system in ash storage. Provide aforesaid complete dedusting system with complete functions, and provide equipment, pipes, pipe supports and hangers, valves and accessories.

Pebble coal system: from flange under pulveriser pebble coal outlet to the mobile pebble coal bucket under buffering pebble coal bucket discharge port, as well as outward transport to load spot by electric fork lift truck. Including control system, equipment, valve, fork lift truck, mobile pebble coal bucket and all accessories.

Compressed air system: integrated with the air compressor for instrument and plant as the whole plant air compressor station.

Auxiliary system facility assorted with ash, slag and pebble ash delivery and storage shall also be provided.

2.12.11 Electrical System and Switchyard

The Project will adopt the 220kV as evacuation voltage and power output shall be evacuated by the power purchaser through a 2-circuit outgoing line. However, the ultimate evacuation scheme shall be decided in consultation with the NTDC. The main single line scheme is as follows (tentative).

The two 150MW units are connected to a new 220kV indoor GIS power distribution device through the generator-transformer unit connection, with 2-circuit outgoing line. The double bus connection is adopted for the 220kV power distribution device.

The generator circuit breaker (GCB) is provided in the generator outlet of the Project.

The isolated-phase bus is used to connect the terminal outgoing line of the generator with the step-up transformer, one for each generator, on the low voltage side and the auxiliary transformer on the high voltage side. The SF6 gas-insulated metal-enclosed transmission line (GIL) is used to connect the step-up transformer on the high voltage side and the start-up/standby transformer on the high voltage side with the indoor GIS.

The indoor GIS double bus connection mode is adopted for 220kV power distribution unit. It may be noted the final evacuation scheme and the specifics shall be determined in consultation with the power purchaser.

The evacuation and back feed network around the Project is either non-existent or weak. As part of his scope of work the EPC Contractor shall provide the start-up/standby transformer and black-start capability based on the required capacities in line with the Project endowment.

The transformer, power centre and motor control centre of the low-voltage plant of the main power house shall be set in pairs to establish double loop power supply channel. The auxiliary building area is provided as a mutually concealed standby for the LV plant transformer supplying power to the power centre set by pairs.

Each unit shall be equipped with a 220V DC system. A set of 220 V battery is set for 220 V DC system of each unit, the valve-regulated lead-acid batteries are adopted and the end battery is not set.

UPS system is equipped with necessary transmitter and alarm total signal and is connected with centralized monitoring system through hard wiring.

2.12.12 Instrumentation and Control

All thermal automation systems of all process systems shall include the instrument detection, control, interlock and protection systems of the following, though not limited, systems:

1) Boiler and auxiliary system;
2) Turbine and auxiliary system;
3) Generator and auxiliary system;
4) Fuel oil system;
5) Compressed air system;
6) Boiler make-up water treatment system;
7) Seawater desalination system;
8) Chemical sampling and dosing system;
9) Integrated water pump room;
10) Industrial wastewater treatment system;
11) Domestic sewage system;
12) Oily wastewater system;
13) Coal contained wastewater system;
14) Coal handling flushing water system;
15) Circulating water pump room system;
16) Circulating water dosing treatment (electrolyzing seawater for producing chlorine) system;
17) Ash handling system;
18) Slag handling system;
19) Air-conditioning system;
20) Flue Gas Desulfurization system (FGD);
21) SCR Denitration system (SCR).

The Project uses an automation network consisting of Plant-level management information system (MIS), Distributed Control System (DCS) and control system for balance of plant system. A design principle of control function distribution and information concentration management is implemented.

Unit automatic control system with complete functions shall be designed. Modulating Control System (MCS) with perfect functions adapting to basic requirements of unit operating and features of boilers and steam turbine shall be designed to meet safe and economic operating requirements of the unit.

Distributed control system (DCS) shall be used for boiler, turbine, generator and electric systems. The centralized control mode shall be built around the boiler, turbine, generator and electric system as well as balance of plant. Central Control Room (CCR) will be set with the principle of "one CCR for two units". Operator can make monitoring and adjustment under normal operation condition of the unit and emergency treatment or shutdown under abnormal operation condition of the unit at central control room.

BOP control network shall be set for water, coal and ash area, which adopt the same hardware as unit DCS, is used to centralized data acquisition, sequential control, alarm, and other functions of monitor and control for all auxiliary workshops (systems). Local control room for water, coal and ash system shall be respectively set to complete monitoring for water, coal and ash system. Meanwhile, operator stations for BOP control network shall be set at CCR to monitor and control all auxiliary systems, workshops, etc.

Each unit is equipped with vibration monitoring and analysis system (with one set of workstations) to complete vibration monitoring and fault diagnosis and analysis of steam turbine generator unit and main auxiliary engine (primary air fan, forced draft fan, induced draft fan, condensate pump, feed water pump and circulating water pump), and the analysis results and guide information shall be send to MIS by communication mode.

One set of flame detection system is set for each boiler to connect with DCS through hard-wiring.

Simulation system shall be set for the Project to train operators.

I&C laboratory equipment, which shall be configured with the principle of free from overhaul tasks, should be supplied satisfied with DL/T 5004-2010 Guide for Furnishing Test Apparatus, Maintenance Device and Architectural Area of Fossil Fuel Power Plant.

2.12.13 Black Start

The power grid around the project Site is at best weak and unstable. Therefore, the EPC Contractor shall provide a black-start capability via and appropriately power generator system to self-start one of the units.

The self-starting power supply shall be set inside the premises. A containerized, diesel fired, generator set, is being recommended. Start-up Fuel Storage and Supply System shall also be provided at site.

2.12.14 Project Execution: Mobilization and Construction

There is no resettlement and relocation for this Project, so when the site is acquired by the Sponsors, the mobilization and construction start should be relatively easy.

2.12.15 Temporary Facilities and Transportation of Equipment to Site

Necessary temporary facilities such as dormitory, Guard House and security watch tower, Parking garage, sports centre, storage Facilities, military and security personnel housing, temporary constructions for the office, labour camp area, Owner office building, and other ancillary buildings, construction water and power supply system shall be provided.

2.13 Project Fuel

2.13.1 Coal Transportation and Receival

The Project at Gwadar is approximately 690 km from Quetta, the capital city of Balochistan Province, and approximately 500km from Karachi. As per the current configuration, the Project's annual coal consumption will be approximately 950,000 metric tons ("MT") (based on LHV as received basis over 5,371kcal/kg) at 85% load. The selection of coal is mainly based on heating value requirements, ease of transportation and stability of supplies. Given the size of the Project, shipping distances and costs, South Africa and Indonesia have been shortlisted as potential sources of coal.

Coal will be transported to the coal terminal at the exporting terminal from where the coal will be transported via marine shipping to Gwadar. Shipping distances to Gwadar are approximately the same from the RBCT in South Africa and the Balikpapan Port in Indonesia, 4,350 nautical miles ("NM") and 4,060NM, respectively. The types and grade of vessels selected will meet the requirements of the loading and unloading ports. Vessels will have a dead weight tonnage ("DWT") of 40,000 to 60,000 and will be equipped with booms and grabs. Given a draught of approximately 12m, the super Handysize Panamax with a loading capacity of 50,000 DWT is recommended. The total shipping time to Gwadar will be approximately 20 days: 2-3 days for coal loading at the Richard Bay Terminal; 15 days at sea; 2-3 days for coal unloading at the port.

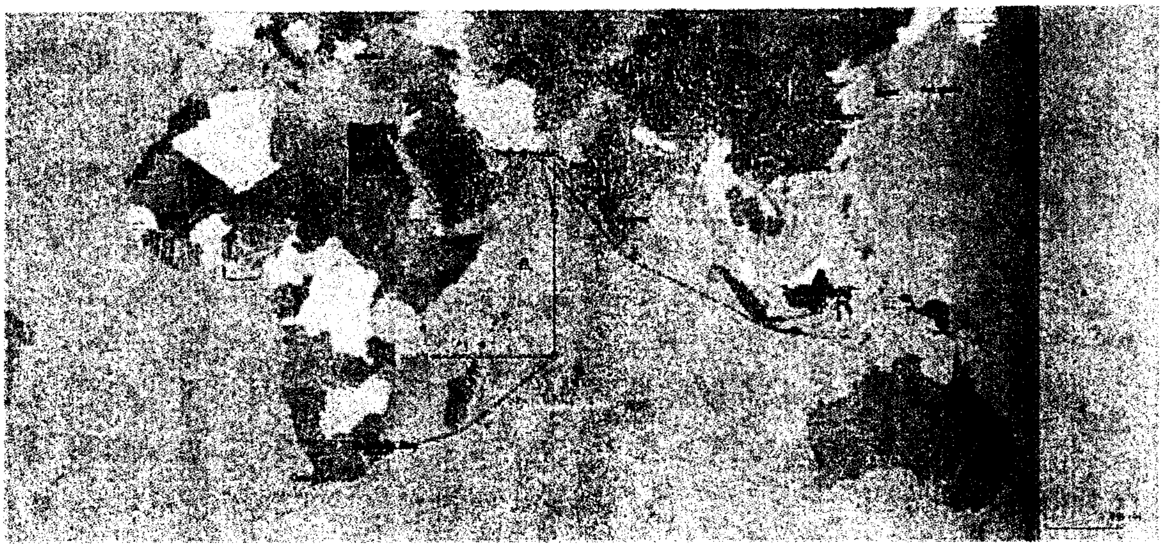

Figure 3 - Marine Shipping Route

The Project plans to make use of the existing jetty and equipment at the Gwadar Port. The jetty is approximately 40 km from the Site. A temporary stack yard will be built to store the coal before transportation to the Site.

There is no dedicated special coal grab to unload the coal, therefore, the existing gantry crane on the jetty will be used. Coal will be unloaded on to mobile hoppers. For the purposes of the Project, four (4) mobile hoppers of 60 m^3 will be added. Bucket-wheeling loaders and mobile belt conveyors are considered for stacking operation. A temporary stack yard will be arranged on the reclaimed land to the southeast of the jetty; to prevent impact of coal dust to the environment, the temporary stack yard will be located as close to the rear hill as possible and a net will be put around the stack yard. The stack yard will have a total area of 2.5 ha. A ring road will be arranged around the stack yard, and a road will be built to connect with the existing road of the harbour.

After transported to adjacent jetty by sea, the thermal coal shall be transported to the Site by truck. Heavy trucks with a maximum unit loading capacity of 30 to 50 MT will be used to transport the coal from the stack yard to the to the Site coal yard. The annual coal unloading demand of about one million tons has been considered for the in-plant coal unloading device.

2.13.2 Coal Procurement Strategy

Due to the insufficient chemistry of the local coal and the limited annual output, Pakistan needs to import large amounts of coal to meet increasing domestic demand. Therefore, given the constraints, the Project has envisaged using imported coal as the primary fuel source.

South Africa is the sixth (6^{th}) largest coal producing country and the second (2^{nd}) largest coal exporter. Most of the coal exported from South Africa is done via the Richards Bay Coal

Terminal ("RBCT"), through a dedicated coal railway. Only a small amount of coal is exported via the docks at Maputo and Durban. Most of the coal production is controlled by the big coal companies such as the Anglo Coal Group, the BHP Billiton Group, the Sasol Group, the Exxon Group and the Strata Group. The coal output of these five (5) groups accounts for approximately 90% of the total coal output of South Africa. Customs data shows that in 2014, South Africa exported approximately 77.42 million MT of coal; India took the biggest share at 30.45 million MT; Pakistan received approximately 3.37 million MT from South Africa.

The coal from South Africa has the properties of medium to high heating value, low moisture content, low to medium ash content, low sulfur content and medium volatility. The coal quality indicators range of main coal producers: LHV as received basis 5,200-6,300 kcal/kg, total moisture content 7%-10%, ash content 10%-23%, total sulfur content 0.5%-0.85%, and volatile component 22%-29%.

The proven coal reserves in Indonesia are mainly distributed over two (2) islands: central, eastern and southern Kalimantan and central and southern Sumatra. 91% of the coal is sourced from Kalimantan and the rest is sourced from Sumatra. Most coal mines in Indonesia have been open pit, however, in recent years, with an increase in production, open coal mines are becoming scarce.

The coal from Indonesia has the properties of medium heating value, high moisture content, low ash content, low sulfur content and high volatility. The coal quality indicators range of main coal producers: LHV as received basis 4,200-5,500 kcal/kg, total moisture content 21%-38%, ash content 6%-10%, total sulfur content 0.3%-0.85%, and volatile component 37%-48%.

The coal source and quality is similar to that of HUBCO Power Plant of Pakistan as reference, whereby South African coal will be used as primary fuel and the Indonesian coal will be used as supplement and backup. According to the coal export proportion of South Africa, it is suggested to take the most popular steam coal RB3 (LHV is about 5,371kcal/kg) at the coal yard of Richards Terminal as the design coal for coal quality indicators, with the check coal as 50% RB3 of South Africa + 50% NAR4700 of Indonesia.

The sponsors will negotiate with coal supplier and sign long-term supply agreement for competitive price.

2.14 Project Technical Studies

2.14.1 Interconnection and Load Flow Study

Interconnection study is under the purview of NTDC and is yet to be provided.

2.14.2Topographic Survey

The Site is 1,384m long and 993m wide, and the land area is about 134.1hm^2. The land is mainly wasteland, without basic farmland and villages, and its original terrain elevation is 2.5m to 55.7m.

CCCC-FHDI Engineering Co., Ltd has been engaged by the Sponsors to carry out survey and investigation for the feasibility study phase of the Project. The main task is finding out the terrain, geomorphology and geological structure at site.

The survey coordinate system: The Independent Coordinate System of Gwadar (GPPCS). Elevation system (datum): starting from CD base plane.

The data source for this control point is provided by FHDI's measuring department. The data of the control points are shown in the table below.

Table 3 – Control Points of Topograhic Survey

POINT	POINT	E (m)	H (m)	Mark
PP1	2796003.470	456463.125	7.752	
PP2	2795472.212	459533.873		
PP3	2795005.935	456577.492	5.598	
PP4	2795039.371	457922.464		
PP5	2795410.118	457861.942	4.505	
BM			4.330	

This Project is located near the Makran coastline in the Kawart district of Gwadar. The west side is an existing decommissioned desalination plant. There is an existing road connecting the desalination plant to the Makran Highway. From the desalination plant a temporary road was built to the project area.

The coastal line of Gwadar belongs to the marine geomorphy with the following main landform features:

(1) Coastal bluffs: The coastal bluffs can be seen in the south part.

(2) Scarp foot: The scarp foot means the low part of precipice. The boulders from the collapse of stone layer on top of the cliffs by weather erosion and under the action of waves scatter around the foot.

(3) Beach: The beach, a gentle stretching topography running parallel to it, is mainly composed of littoral sediment.

(4) Plain: The west and north side of the site is a large relatively flat area and a distribution of small mud mound.

2.14.3 Geotechnical Investigation

Boreholes layout is based on the grid pattern with the two lines spacing 250-300m, and 20 boreholes are arranged.

The depth of the boreholes was designed not be less than 25 to 30 meters. Each borehole would exceed no less than 15 meters into the hard soil or highly weathered bedrock, or no less than 3-5 meters into moderately weathered bedrock.

Samples were taken from each stratum of all the controlling boreholes according to the "*Code for Geotechnical Investigation of Fossil Fuel Power Plant (GB/T 50131-2014)*", The sampling spacing is 1.5m~2.0m. The field standard penetration test was carried out strictly in accordance with the Code for Geotechnical Investigation of Fossil Fuel Power Plant (GB/T50131-2014), The testing spacing was less than 2.0 meters. Laboratory tests have been done for soil, rock and water samples.

A total of 20 boreholes with the number ZK01~ZK20 were completed in the geotechnical investigation work. The terrain fluctuated greatly, some boreholes are arranged by the designer at the places where steep cliffs or drilling devices are difficult to position, so some boreholes were adjusted to the right place according to the investigation designer's permission. The final total drilling length was 4497.5 meters, and 5 disturbed sand samples, 186 rock samples, 9 groups of water samples (8 groups of seawater, 1 group of groundwater) were obtained, totally 117 standard penetration tests have been done. For the details, please refer to the geotechnical report in Table 1: Summary of Borehole. The samples of soil rocks have been sent to the site geotechnical laboratory set up by FHDI in Karachi for physical and mechanical properties test. Water samples have been sent to geotechnical laboratory in China and local laboratory in Karachi Soilmat Engineers for testing.

According to Pakistan's Building Code of Pakistan (Seismic provisions of 2007), the Gwadar area belongs to the earthquake zone 3. Under the SB site conditions, the peak ground acceleration is 0.24g-0.32g, and the corresponding seismic intensity is 8 degrees.

(I) Topography and landform

The project site is located in the coastal area, the Site area topography is mainly sea landforms, consisting of coastal cliffs, cliffs, beaches, and marine plains. The site elevation reduces from about 60m at the southeast corner northward and westward gradually to about 2.0m. The landform is relatively steep, with relatively large changes.

(II) Stratum lithology

According to the geotechnical investigation data at the feasibility study stage, the geotechnical layers exposed in the project site are: Quaternary Holocene (Q4) marine deposit (layer number: ②) and Early Miocene Parkini mudstone (Tm) (layer number: ⑦). The rock and soil strata can be divided into six sub-layers according to its lithology and physical and mechanical properties, shown as follows:

$②_1$ Fine sand: greyish yellow, yellow, wet, loose-medium dense, poor grain gradation. The layer is mainly distributed in the southern coastline area.

②$_2$ Coarse sand: yellow, saturated, dense, better particle gradation, with more broken shells, only locally exposed, mainly distributed in the southern coastline area.

⑦$_1$ Strongly weathered mudstone: grey, very soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, fragmented core, fragile by hand.

⑦$_2$ Moderately-weathered mudstone: grey, very soft rock-soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, fragmented core. The natural state uniaxial compressive strength average is 5.76MPa.

⑦$_3$ Moderately-weathered mudstone: grey, very soft rock-soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, stumpy core. The natural state uniaxial compressive strength average is 9.53MPa.

⑦$_4$ Slightly weathered mudstone: grey, soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, column core. The natural state uniaxial compressive strength average is 11.34MPa.

According to the site geological investigation, the project site is free from large-scale debris flow, collapse, ground subsidence, ground fissures, mined areas and other adverse geological actions and geological disasters, or human activities impacting the site and foundation safety.

At the south side of the site by the coast, there are steep cliffs. At the high tide level, seawater washes the cliffs. The cliff bedrock is soft mudstone, easy to soften after soaking. There is the phenomenon of collapse, so the developer shall consider the necessary protective measures.

Loose-medium dense powder fine sand ②$_1$ and saturated dense coarse sand ② is distributed in the coast in the project site. According to the blow counts of SPT, it is judged that fine sand ②$_1$ is the liquefiable soil layer, and the liquefaction level is slightly ~ medium. Coarse sand ②$_2$ is not liquefied soil.

2.14.4 Marine Study

The marine study for water temperature, sand sediment, ocean current, etc. is still on going by professional research institute entrusted by the Sponsors. At present, all the data related to the marine study is reference to the Gwadar Port which emanates from the east bay of Gwadar marine area.

2.14.5 Sea Water Sampling

A total of two groups seawater samples were taken from the survey in the Site area.

Groundwater has strong corrosion on concrete construction both in alternating wet and dry conditions and long-term immersion conditions.

CCCC-FHDI ENGINEERING CO.,LTD.

Appendix 3 -1 The Report of Water Quality Analysis

Project name: GWADAR 300MW IMPORTED COAL POWER PLANT,PAKISTAN   Management Number: FHDI2014-2-21-30-A

Delegation Number:SH201704-1-BJST   Report Number: FHDI-SH-2017-BJST-1

Lab number: S1	Field number:S1(East of the site)		Sampling Depth: \		Report Date: 2017/4/19	
Analysis items	unit	Content	Analysis items		Content (mg/L)	Content(mg/kg)
PH	3.26		Cation	$K^{+}+Na^{+}$	\	
Total alkalinity	mg/L	\				
Total hardness	mg/L	\		NH_4^{+}	\	
Temporary hardness	mg/L	\				
Permanent hardness	mg/L	\		Ca^{2+}	614.37	
Negative hardness	mg/L	\		Mg^{2+}	1348.74	
Free carbon dioxide	mg/L	0.00		In total	\	
Aggressive carbon dioxide	mg/L	0.00	Anion	Cl^{-}	15101.70	
Total mineralization	mg/L	\		SO_4^{2-}	2346.63	
Total acidity	mg/L	\		NO_3^{-}	\	
Acidity of strong acid	mg/L	\		HCO_3^{-}	106.11	
Blank below				CO_3^{2-}	19.76	
				OH^{-}	\	
				In total	\	
			In total		\	

Notes:

1. The report was carried out in accordance with DL/T5152-2001
2. Please contact us if you have any query on the report.
3. The report is only responsible for provided samples, and the tested samples only be kept for 7 days.
4. The report should not be copied without our permission.(Except full copy)

Figure 4.1 – Water Quality Analysis

CCCC-FHDI ENGINEERING CO.,LTD.

Appendix 3 -2 The Report of Water Quality Analysis

Project name: GWADAR 300MW IMPORTED COAL POWER PLANT,PAKISTAN   Management Number: FHDI2014-2-21-30-A

Delegation Number:SH201704-1-BJST   Report Number: FHDI-SH-2017-BJST-1

Lab number: S1	Field number:S2(West of the site)		Sampling Depth: \		Report Date: 2017/4/19	
Analysis items	unit	Content	Analysis items		Content (mg/L)	Content(mg/kg)
PH	8.26		Cation	$K^+ + Na^+$	\	
Total alkalinity	mg/L	\				
Total hardness	mg/L	\		NH_4^+	\	
Temporary hardness	mg/L	\				
Permanent hardness	mg/L	\		Ca^{2+}	581.26	
Negative hardness	mg/L	\		Mg^{2+}	1504.00	
Free carbon dioxide	mg/L	0.00		In total	\	
Aggressive carbon dioxide	mg/L	0.00	Anion	Cl^-	15824.88	
Total mineralization	mg/L	\		SO_4^{2-}	5201.59	
Total acidity	mg/L	\		NO_3^-	\	
Acidity of strong acid	mg/L	\		HCO_3^-	140.65	
Blank below				CO_3^{2-}	14.10	
				OH^-	\	
				In total	\	
			In total		\	

Notes:

1. The report was carried out in accordance with DL/T5152-2001
2. Please contact us if you have any query on the report.
3. The report is only responsible for provided samples, and the tested samples only be kept for 7 days.
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Figure 4.2 – Water Quality Analysis

2.14.6 Bathymetric Survey

The bathymetric study of 250m from seaside is finished, according to the data, the water depth is about at a distance of 250m. The large scope of bathymetric study is still on going by professional research institute entrusted by the Sponsors.

According to the situation of the sea area near site, it is assumed that water depth of 8 meters under the lowest tide level is about 1.3km away from the shore. During the bidding phase, the potential EPC Contractors shall develop a reasonable water intake and discharge scheme depending on his engineering experience and the Site features.

2.14.7 Logistics and Transportation Study

In this project, the required equipment and materials adopt the combination of bulk transportation, containerized transportation and rented special ships and shall be shipped via the land- sea-land to the Site. Project supplies can be grouped into three types: main equipment, auxiliary equipment and auxiliary equipment materials.

According to the goods characteristics and the supplier's experience, goods will be stuffed in the container at the supplier's factory or in the port dock.

Special transportation scheme will be developed for over-sized and over-weight equipment.

2.15 Environment

2.15.1 Enivronmental and Social Imact Assessement

EMC Pakistan Pvt. Ltd is undertaking the ESIA work. The company is well-known consultant firm who has undertaken many coal-fired power plant project. They are familiar with the coal-fired plant process and emission, so the ESIA study report and conclusion is expected to form a reliable basis to addresses all the environment related concerns.

In order to determine the environmental specifications for the project, following standards were referred to:

- National Environmental Quality Standards of Pakistan (NEQS)
- IFC Standards
- Ambient Air Quality Standards published by Government of Pakistan
- Pakistan Environment Protection Agency, PEPA
- Balochistan Environment Protection Agency, BEPA

2.15.2 Key Findings of the Environment Studies

- High efficiency electrostatic precipitators will be adopted after further analysis; meanwhile, whereas soot and dust shall be further removed and scrubbed in desulfurization uni. After these multiple processes to scrub the exhausts, the Project is expected to meet the requirement that emission capacity does not exceed 30mg/Nm^3.

- Seawater desulfurization system will be used for SOx control. The scrubbing process shall enable to system to meet the requirement that emission concentration of SO_x shall be $\leq$100mg/Nm^3.

- For NOx control the Project intends to adopt low-nitrogen combustion technology and to construct Selective Catalytic Reduction, SCR unit synchronously. The NO_X concentration in flue gas thus shall meet the environmental emission requirements, i.e., $\leq$100mg/Nm^3, after denitration.

- A 180m-high steel sleeve stack is designed to adequately disperse the exhausts flue gases.

- This project will be provided with automatically continuous monitoring system of flue gases. The items to be monitored include soot and dust, CO, SO_2 and NO_x, as well as applicable flue gas parameters such as oxygen content, flue gas rate, flow, flue gas temperature and the like.

- Ash transport system will be made to store dry ash in silo(s) for loading trucks for transportation to the on-site ash pond.

2.15.3 Environmental and Social Management Plan (ESMP)

A fundamental aim of the Environmental Management Plan (EMP) is to ensure that potentially damaging effects are avoided or minimised and the beneficial aspects enhanced. This process usually takes place in a continuous cycle, as the development proposals are refined.

This EMP provides information pertaining to the:

- Implementation of the proposed project
- Regulation of the implementation of the proposed project
- Methods and means through which mitigation measures will be implemented
- Ways in which environmental restoration will be achieved.

The EMP shall be included in all relevant contract documentation for contractors undertaking work to ensure they are aware of the environmental requirements. Regular (e.g. annual) Independent Environmental Auditor services are recommended to be commissioned by the Sponsors to monitor the progress of the EMP and ensure that specific items are adequately put into place and effectively managed.

The project stage describes the stage of the overall project in which the impacts are expected. A project typically follows four clear stages throughout its lifetime, namely:

- Design phase
- Construction phase
- Operational phase
- Closure and decommissioning phase

Every stage of the project is expected to have a unique set of predicted impacts and related mitigation measures.

The management objective describes the specific goals to be achieved. Some goals are crucial for the success of the project, and have very clear thresholds. Non-compliance with the objectives will result in technical difficulties for the operations and/or non-compliance with Pakistan laws and guidelines.

Other objectives have thresholds that are less clearly defined. In practice, these objectives are sometimes perceived as less important. It is crucial to the success of the implementation of the EMP that all parties involved in the project fully understand that these objectives are equally as important as objectives with clear thresholds, for successful implementation of the project.

The thresholds for management objectives will be further set out in the Monitoring Plan, which will be developed as part of the ESIA.

The mitigation measures recommended aim are to minimise the expected negative impacts, and maximise the expected positive impacts. For a single management objective, there is usually a set of recommended mitigation measures. The maximum result from the mitigation measures will be achieved when the full set or combination of measures will be implemented.

It is therefore important that mitigation measures be implemented in totality and with similar levels of propriety, to minimize the negative impacts and maximize the positive effects.

Sanitary facilities to be provided at site consist in minimum of a designated place for ablutions, hand washing, accommodation for clothes changing and storage.

Fuels, oils and chemicals at the camp shall be stored on impermeable bases fitted with containment kerbs.

All routine maintenance of equipment shall be done in the designated areas in the contractor's camp.

Employment from local communities must be maximized.

2.15.4 Conclusion

The developer shall ensure full compliance with this EMP during all stages of the Project, through design to decommissioning phase. A designated community liaison shall be appointed to liaise with impacted communities and to keep records of conflicts and resolutions. Liaison must be undertaken with all property owners prior to entering their property.

The Project can and shall meet emission standards through a series of measures and emission control system, and it will minimise the expected negative impacts and maximise the expected positive impacts.

2.16 Site Security Plan

Gwadar is located in Balochistan, situated in the west of Pakistan. It borders Iran in the west, Afghanistan in the northwest, Khyber Pakhtunkhwa province in the northeast, Punjab province in the east, Sindh province in the southeast, and the Arabian Sea in the south. Project area is located about 40 kilometres northeast of the Gwadar port and south of the N10 national highway. Towards the south of the Project Site lies the Arabian Sea. Balochistan is the largest province of Pakistan but in terms of population is the smallest. The majority of the people are Baloch, but the second largest group are Pashtun (40 %). The provincial capital Quetta is also the home of a large part of the Hazara community in Pakistan.

Terrorism is expected to continue pose a serious threat in the context of extensive combing operations being conducted nationwide. The terrorists, thus, are expected to resort to attacks likely to appear in the shape of targeted ambushes, suicide attacks and hit and run attacks on high profile targets or high impact attacks on soft targets. Moreover, risk emanating from crime is also expected to remain high.

The Concept of Security System is combining of physical security with help of electronic security equipment. Perimeter will be monitored by tower guards in watch towers and patrol guards, together with CCTV and intruder detection system. Entry control points will be permanently operated by a security personnel accompanied by K-9 dog teams and equipped with modern scanning and screening equipment, such as metal detectors, x-ray machines etc. B&R will implement all existing experience and practices developed in different hostile environments.

Security personnel performing security tasks will preferably be local nationals who have been properly vetted by B&R and who have the necessary qualifications and experience to perform entry control point duties, guard tower operations, static and roving patrols and overseen by onsite expatriate managers.

Guards will be assigned in two, twelve-hour shifts per day along with an expat Guard Force Supervisor (GFS) performing one shift per day overlapping the security shifts, and supervision provided each day through shift leaders. The number of security personnel assigned to this task is based on the current general risk/threat profile for Pakistan, and the physical size of the camp and the number of personnel to be protected. The solution is scalable and can be increased or decreased dependent on the security needs of the human contingent at Site, their mobility, and asset security requirements.

While on duty, security personnel will be equipped with PPE and other security equipment such as two-way radios, flash lights, under vehicle viewing mirror, etc. Security personnel will properly qualified in relation to the use of security equipment.

Scope of Security Systems will cover:

- Physical Security
    - Tower Guards
    - ECP Guards
    - ECP K-9 teams
    - Patrol Guards
- Electronic Equipment
    - CCTV Surveillance system
    - UAV monitoring (optional)
    - Intruder Detection System
    - Explosive Detection equipment

Surveillance Systems, Vehicle detection system, Remote monitoring by the means of Unmanned Aerial Vehicle (UAV), Automatic Access Control and ID Management, Intruder Detection System, Entry Control Points and Hostile Vehicle Mitigation, Pedestrian Screening, Perimeter Protection, Maritime Security Measures, Blast Considerations and Design and so on shall be considered.

More detailed in chapter 10.

2.17 Project Operations and Maintenance

Once the Project is put into commercial operation, the operation and maintenance of this Project will be managed by an experienced team.

Before the construction of the Project is completed, about six months before completion date, the operation and maintenance team will begin to take over the power plant from the EPC team. Training regime shall encompass training regarding all equipment and major assemblies till the operation of all equipment of the power plant is completely turned over according to operation and maintenance agreement.

With the development of the test-run of the Project, the project company will provide operation and management services itself or may employ other specialized authorities to provide the same.

The operations of the power plant will be executed according to the OEM's and EPC Contractors guidelines, prudent utility practices as practised in the best markets, operation and management agreement, including operation budget control, contractor management, insurance maintenance. Necessary training will be provided to ensure labour safety and to protect environment.

Operation and management personnel shall hire experienced and trained personnel and wherever and when possible Pakistani nationals preferably locals will be employed; some critical positions may be assumed by expats; however, in the medium to long run all staff will be from Pakistan.

2.18 Project Agreements

In typical project finance transactions, project lenders and investors look towards project documentation and the interlinkages between various project agreements and coverages provided under such documentation to cover any project related risks which may affect its feasibility and bankability. For this purpose, the Project Company has finalized or is in the process of finalizing agreements typical to such projects e.g. PPA, land lease, EPC contract(s), O&M contract, government guarantees etc. which will come together to form a security package making the project bankable to the lenders and feasible for the investors. Details of the various agreements are below in Section 17.

2.19 Project Tariff and Financials

The total Project Tariff is currently worked out at USD ¢ 7.7426 per kWh (based on an 85% availability factor), and is the sum of Energy Payments and Capacity Payments. Energy Payments can be further divided into Fuel Component, Ash and Desulfurization, and Variable O&M cost. Capacity Payments can be further divided into Fixed O&M, Insurance, Working Capital, Return on Equity and Debt Servicing. Energy Payments are variable in nature and are payable on per kWh dispatched basis. Capacity payments are fixed payments subject to the availability of the Plant and are payable irrespective of plant dispatch.

2.20 Estimated Project Cost

The total Project Cost has been estimated at USD 492.94 million for a gross capacity of 300 MW. A summary of the Project Cost is as follows.

	Cost (USD million)
Capital Cost (incl. custom duties & withholding taxes)	412.71
Other Costs	52.54
Interest during Construction	27.69
Total Project Cost	**492.94**

2.21 Project Funding

The Project is expected to be financed at a debt to equity ratio of 75:25 on a non-recourse basis. Equity will be subscribed to by the Sponsors i.e. CCCC and Tianjin. Long-term debt will be in the form of China Export and Credit Insurance Corporation ("Sinosure") backed Long Term Debt equivalent to a maximum of 85% of EPC Cost. Below is a summary of the project funding plan:

Funding Source	**USD million**
Equity	123.24
Long-term Debt	369.71
Total Funding	**492.94**

3. Pakistan Power Sector

3.1 Overview

Historically, the power sector in Pakistan has been owned and operated by government entities, primarily the Water and Power Development Authority ("WAPDA") until the drive to unbundle started in the early 1990s. Since then the sector has evolved much with private sector involvement primarily in generation and more recently in transmission and distribution as well. The generation, transmission, distribution and retail supply of electricity in Pakistan is presently undertaken by several public and private sector entities comprising of one (1) national transmission company; nine (9) regional public sector-owned distribution companies; four (4) public sector thermal generation companies; one (1) public sector hydropower generation company and several Independent Power Producers ("IPPs"). These entities enable the supply of power to the entire country except for Karachi. The metropolitan city of Karachi and some of its surrounding areas are supplied power by K-Electric, which is a vertically integrated utility owned by the private sector responsible for the generation, transmission and distribution of electricity in its region. The total installed capacity of the entire country in 2015 was 24,823 MW of which 16,814 MW (67.74%) was thermal, 7,116 (28.67%) was hydroelectric, 787 MW (3.17%) was nuclear and 106 MW (0.43%) was wind.

Table 4 – Pakistan Generation Capacity

As on 30th June	2011	2012	2013	2014	2015
Thermal	15,910	15,969	15,941	15,719	16,814
Hydropower	6,645	6,730	6,947	7,116	7,116
Nuclear	787	787	787	787	787
Wind	0	1	50	106	106
Total	**23,342**	**23,487**	**23,725**	**23,728**	**24,823**

All figures in MW; Source: NEPRA State of Industry Report, 2015

More recently the CPPA-G, previously residing within NTDC, has been converted into an independent body acting as a central counterparty to power purchase transactions. The present form of the power structure in Pakistan is presented below:

2.22 Funding Parameters

Facility Type	Senior Secured Long-term Facility
Facility Provider	Industrial & Commercial Bank of China
Amount	85% of EPC, Custom Duties, Sinosure Fee and Construction Interest
Term	Up to 15 years (including 2.5-year grace period)
Reference Rate	6-month London Interbank Offered Rate
Margin	4%
Payment Frequency	Semi-Annual
Export Credit Insurance	Sinosure

2.23 Project Revenue and Other Operating Assumptions

Based on an 85% plant load factor and a net capacity of 272.1 MW, the Project is expected to generate approximately 2,026 GWhs annually. Based on the un-indexed Project tariff, the Project Company's annual revenues are expected in the range of USD 168 million.

Based on a net efficiency of 37%, annual generation of approximately 2,026 GWhs, annual coal consumption is expected to be approximately 950,000 MT. This translates into a fuel cost of approximately USD 74 million per annum.

Project O&M Costs have been estimated based on projects of similar in nature, i.e. capacity, technical parameters, etc. O&M Costs have been estimated at USD 12 million per annum. 75% of O&M cost has been assumed as fixed and rest as variable. Given the above parameters, annual Fixed O&M costs are USD 8 million and annual Variable O&M Costs are USD 4 million.

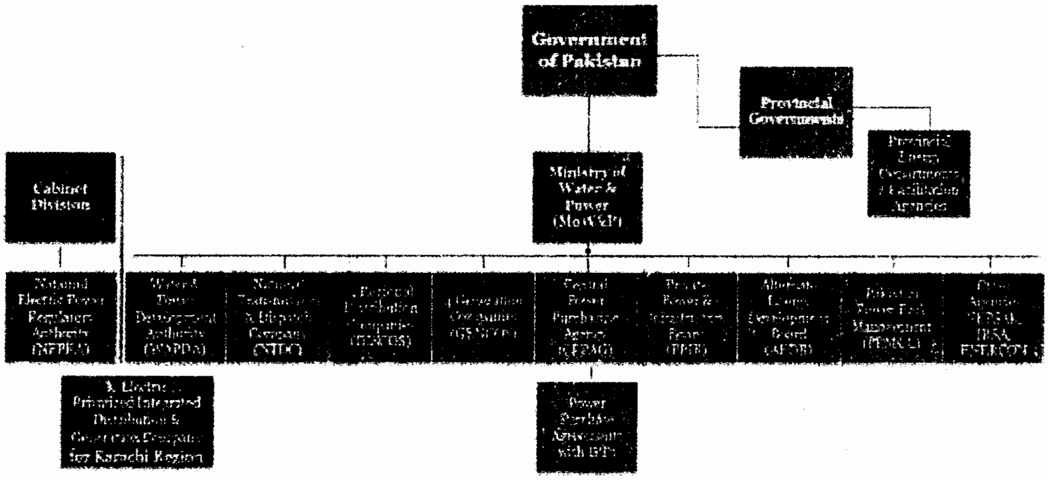
Details and Projected Financial Statements have been presented in the Section 20.

The Project is expected to be compliant to all the lender's related covenants in term of the typical financial ratios like Equity Internal Rate of Return, Debt Service Coverage Ratio and Loan Life Coverage Ratio.

The base case financial ratios and key profitability determinants of the Project are as follows:

Project Internal Rate of Return	11.12%
Equity Internal Rate of Return	17.00%
Long-term Debt Service Coverage Ratio	1.74
Loan Life Cover Ratio	1.98

Figure 5: Pakistan Power Structure



3.2 Structure of Pakistan Power Sector

3.2.1 Key Players

National Electric Power Regulatory Authority ("NEPRA")

In order to promote fair competition in the industry and to protect the rights of consumers as well as producers/sellers of electricity, the GOP enacted the Regulation of Generation, Transmission and Distribution of Electric Power Regulation Act, 1997 ("NEPRA Act"). Under this Act, the NEPRA Policy for Power Generation Projects was established for regulating electric power generation, transmission and distribution in Pakistan. In performing its functions under this Act, NEPRA is required to, as far as reasonably possible, protect the interests of consumers and companies providing electric power services in accordance with the guidelines laid down by the government. One of NEPRA's most prominent roles is tariff approval for the Project.

NEPRA's role in the power business, inter alia, is to issue licenses for companies and to regulate their operations per NEPRA rules and regulations. The prospective applicants will be required to comply with all NEPRA rules/procedures, inter alia, for grant of license before security agreements are concluded for any project.

Private Power and Infrastructure Board ("PPIB")

PPIB provides a one-window facility to IPPs for implementation of projects above 50 MW capacity and issues the Letter of Interest ("LOI") and Letter of Support ("LOS"), prepares pre-qualification and bid documents, pre-qualifies the sponsors, evaluates the bids of pre-qualified sponsors, assists the sponsors/project companies in seeking necessary consents / permissions from various governmental agencies, carries out negotiations on the Implementation Agreement ("IA"), assists the power purchaser, fuel supplier, government authorities in the negotiations, execution and administration of the Power Purchase Agreement ("PPA"), fuel supply agreement and water use license respectively, issues and administers the GOP guarantee backing up the power purchaser, fuel supplier and follows up on implementation and monitoring of projects.

Central Power Purchasing Agency (Guarantee) Limited ("CPPA-G")

CPPA-G, a company created by Government of Pakistan, is a non-profit independent company established under the Companies Ordinance, 1984 and solely responsible for implementing and administering the "Single Buyer Plus" market mechanism (ultimately leading to competitive market operations). CPPA-G purchases power on behalf of Distribution Companies ("DISCOS") from IPPs. The Project shall be entering into negotiations with CPPA-G for the sale of energy to the national grid and shall enter into a PPA in this regard.

National Transmission and Despatch Company Limited ("NTDC")

NTDC was formed in 1998 to take over all the properties, rights and asset obligations and liabilities of 220 KV and 500KV Grid Stations and Transmission Lines/Network owned by WAPDA. It is responsible for the operations and management, planning, design and expansion of the transmission network.

3.3 Demand for Electricity

For the past decade or so, Pakistan has been suffering from an acute energy crisis due to rising demand exacerbated by structural flaws within the sector. Some of the major reasons contributing to this crisis include:

1. Inefficient transmission and distribution
2. Increasing demand
3. Inefficient use of energy
4. Expensive energy mix
5. Improper pricing

Installed capacity in the country grew at an average rate of 5.51% during the period 1990-2015. However, this increase in capacity has been unable to meet the demand of electricity leading to a demand-supply gap, which can go as high as 6,600 MW during peak hours. In 2015, the maximum generation capability remained at 19,132 MW, while the maximum peak demand reached 24,757 MW, resulting in a 5,625 MW gap between supply and demand.

Table 5 - Pakistan Historical Supply and Demand of Power

Year	Generation	Peak Demand	Surplus/(Deficit)
2011	15,430	21,086	-5,656
2012	14,483	21,536	-7,053
2013	16,846	21,605	-4,759
2014	18,771	23,505	-4,734
2015	19,132	24,757	-5,625

All figures in MW; Source: NTDC

Projections by government agencies depict that this shortfall is not going to end till 2018. The tables below show the actual and projected surplus/deficit in demand during system peak hours:

Table 6 - Pakistan Projected Supply and Demand of Power

Year	Planned Generation	Projected Peak Demand	Surplus/(Deficit)
2016	20,303	25,666	-5,363
2017	23,445	27,185	-3,740
2018	28,751	28,678	73
2019	33,545	30,154	3,391
2020	35,590	31,625	3,965

All figures in MW; Source: NTDC

Shortage of electricity has become the most critical challenge for Pakistan; it not only causes social disruption, but also affects the economic growth of the country. According to estimates, energy shortages in the country have resulted in approximately 2% reduction in the annual GDP. Therefore, resolving the energy crisis is amongst the top priorities of the government and steps are being taken to attract new investment in the power sector. Moreover, steps are being taken to optimize the generation mix by adding coal and indigenous energy sources.

3.4 Electric Power Generation

Historically, Pakistan has relied on hydropower generation to meet its electricity demands, as the ratio of hydel to thermal installed generation capacity in the country in 1985 was about 67% to 33%. However, with the passage of time, the energy mix has shifted towards thermal power generation, which now generates approximately 65% of total power produced in the country. Electrical energy generated in recent years by fuel type is presented in the table below:

Table 7.1: Pakistan Energy Generation by Source

As on 30th June	2010-11	2011-12	2012-13	2013-14	2014-15
Thermal	65,169	64,478	64,034	68,082	69,988
% Share	*64.79*	*65.94*	*64.91*	*64.41*	*64.17*
Hydel	31,990	28,643	30,033	32,239	32,979
% Share	*31.80*	*28.85*	*30.44*	*30.50*	*30.24*
Nuclear	3,130	4,872	4,181	4,695	5,349
% Share	*3.11*	*4.91*	*4.24*	*4.44*	*4.90*
Import	295	296	375	419	443
% Share	*0.29*	*0.30*	*0.38*	*0.40*	*0.41*
Wind	0	6	32	263	300
% Share	*0.00*	*0.01*	*0.03*	*0.25*	*0.27*

Total	100,584	99,295	98,655	105,698	109,059

All figures in GWh; Source: NEPRA State of Industry Report, 2015

Given the acute gas shortage in the country, thermal generation has relied mostly on expensive fuels such as Furnace Oil and High-Speed Diesel. Increased dependence on expensive thermal fuel sources has not only led to high cost of generation but has also resulted in large amounts of foreign reserves to be spent on the import of fuel. Thermal generation breakdown in the country in recent years is given in the table below:

Table 7.2: Pakistan Thermal Generation Mix

	2010-11	2011-12	2012-13	2013-14	2014-15
Gas	37,076	30,162	28,190	30,769	31,196
% share of thermal generation	56.89	46.06	44.02	45.19	44.57
FO + HSD	27,984	35,250	35,804	37,201	38,690
% share of thermal generation	42.94	53.83	55.91	54.64	55.28
Coal	109	66	40	112	102
% share of thermal generation	0.17	0.10	0.06	0.16	0.15
Total	65,169	65,478	64,034	68,082	69,988

All figures in GWh; Source: NTDC

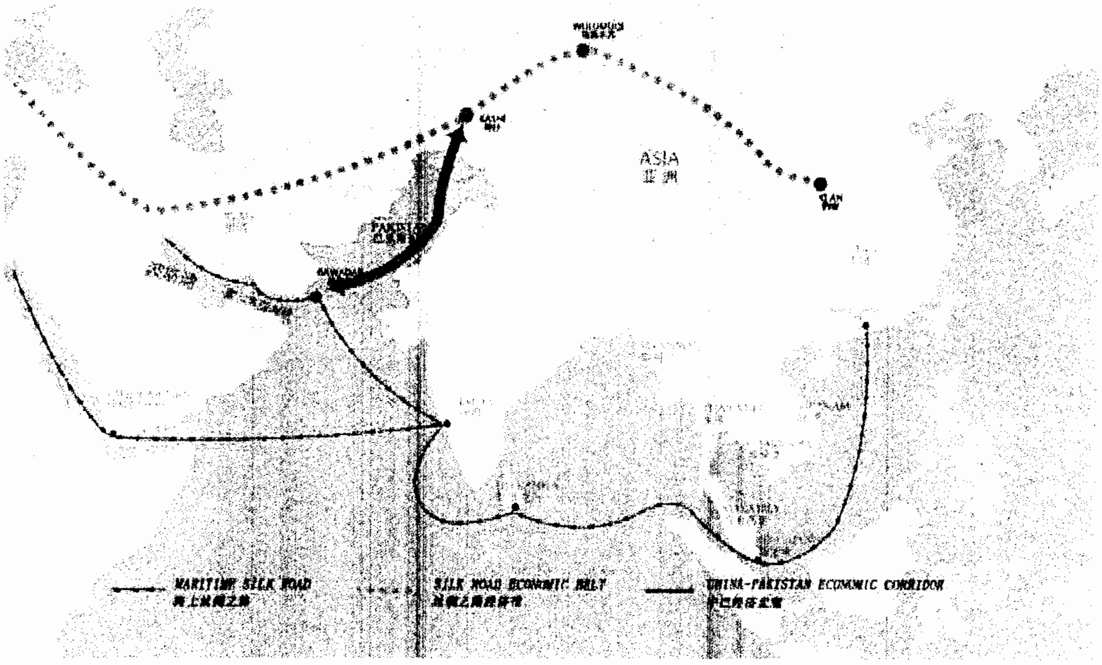
Due to this skewed energy mix, it has now become imperative upon the power sector in Pakistan to move towards generation technologies that are sustainable and rely on stable sources of energy.

4. Project Site

4.1 Project Site location

The Project is located in Gwadar (Coordinates: 25.11 °N, 62.34 °E) in the Southwest of Balochistan. It will be the only sea outlet in the CPEC, connecting Xinjiang 2,940 kilometres ("km") north of Gwadar, to the Arabian Sea. The Project will be located within the jurisdiction of the GDA, near the Surbundar area and will require a total of 330 acres of land, which the Sponsors will acquire with the assistance of the GoB.

Figure 6 - Geographic Location of Gwadar, Balochistan



4.1.1 Site Selection Criteria

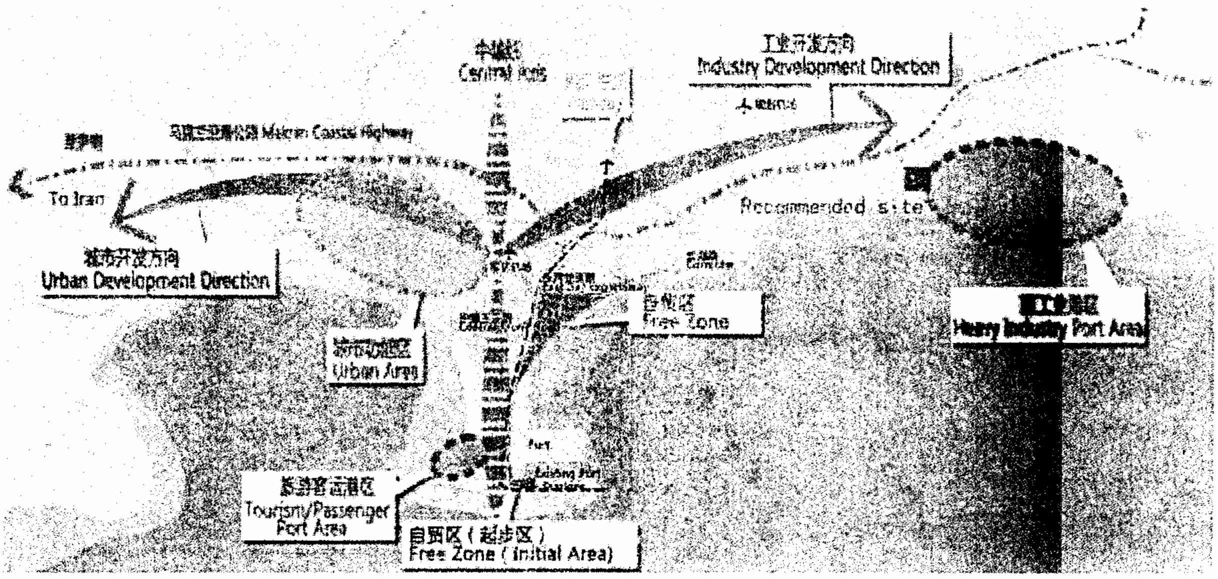
The main factors that are being considered for site selection for the Project are as follows:

- Government guidance
- Construction cost
- Fuel transport
- Site access
- Interconnection scheme and location
- Water source
- Geological condition
- Resettlement and environmental concerns

4.1.2 Site Alternatives

The GoB proposed several sites near the Port. The Main Sponsor conducted a site survey in January 2017 and based on the findings of the survey, Site 3 was chosen as the recommended Project Site. Summary of findings for each site is listed below.

Figure 7 - Location of Recommended Site (Site 3)



Site 1

Site 1 is located approximately 37 km from the Port along the coast. Towards the south of Site 1 is the Arabian Sea, towards the north is the N10 National Highway and towards the east and west are undeveloped lands. There are no villages near the site. The site is mainly wasteland and weeds; streams of water pass through each of its east and west sides. The site is flat land and landform elevation varies between five (5) to nine (9) metres ("m").

Site 2

Site 2 is located approximately 20 km from the Port and 17 km west of Site 1. Site 2 also has the Arabian Sea in the south, N10 National Highway in the north. Towards the east of Site 2 is the Meer Gurab military base and Sur Bandar Town and towards the west is the Kohemehdi mountain. The military base is about is about three (3) km away while the Arabian sea is about two (2) km away. The site is mostly wasteland and weeds and unsuitable for farming. The site is flat land and landform elevation varies between eight (8) to fifteen (15) m.

Site 3

Site 3 is located about 2 km east of Site 1. Its conditions are similar to that of Site 1. Towards the west of Site 3 are seasonal streams and towards the east there is a hill. The site is flat land and mostly wasteland, east side is mostly low-rise mountain, unsuitable for farming. The landform elevation is approximately three (3) to fifty-five (55) m.

Figure 8 - Relative Location of the Three Sites

4.1.3 Transport

Road Access

As of now, there is the N10 National Highway which is to the north of all the site alternatives. The highway can connect to the Port and will become the main access for all the sites. There is a branch road to the east of Site 2 which leads to the Sur Bandar town. A port expressway has been planned for the east bay of the Port which will connect to the N10 National Highway. Moreover, there is a plan for a new railway line which can also be used for the power plant in the future.

Sea Access

Towards the southwest of the three sites lies the Port. Construction on the Port started in March 2002 and Phase I of the construction was completed in February 2015. Currently, the Port has three (3) 20,000t berths and can also be used to dock two 50,000t vessels. Phase II of the construction process is underway. The port is managed and operated by the China Overseas Port Holding Co. Ltd. (the "Port Operator"). The port was formally opened for navigation on 13th November 2016.

Airport Access

The Gwadar Airport, at present, is a small airport located in the central axis of Gwadar, about 15 km from the Port. Gwadar International Airport is planned near Darabele about

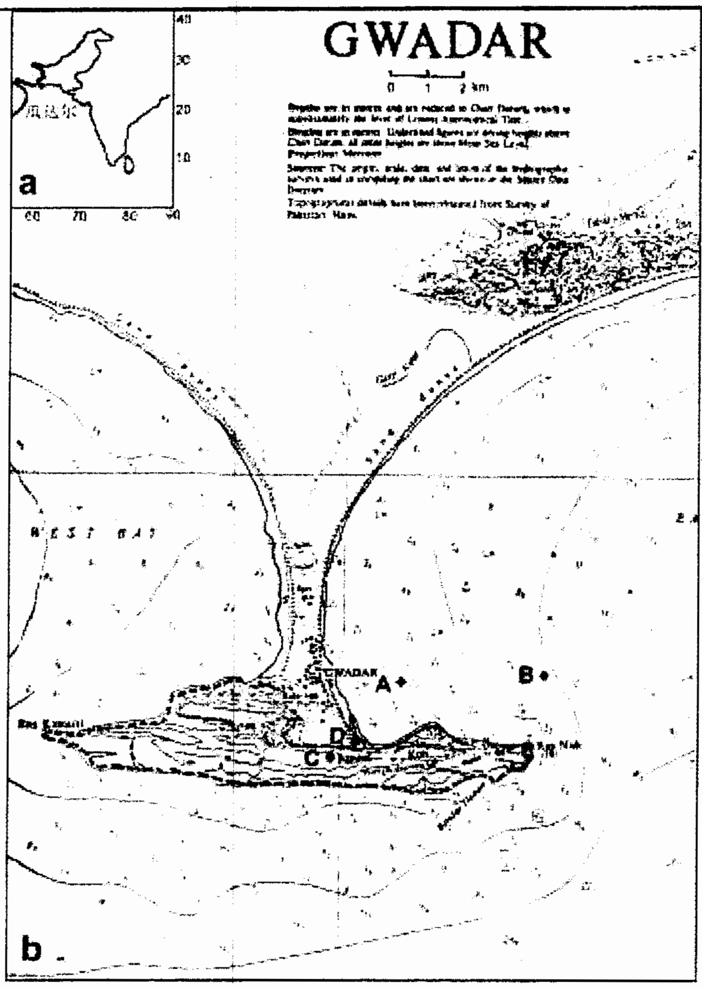
10.5 km from Site 3 and 12 km from Site 2. According to the runway direction of the existing Gwadar Airport and the wind speed and direction in the region, it is expected that the runway direction of the new airport will be southwest-northeast. All the sites are located on the southeast side of airport take-off and landing route. According to the obstacle limitation and management regulations of MH5001-2013 "Technical Standards for Airfield Area of Civil Airports", Site 3 and Site 2 are located outside the obstacle limitation surface and more than 10 km away from the airport runway centreline on the two sides. The power plant will use flashing lights atop the tall structures as per the standard requirements to meet the airport flight safety requirements.

4.1.4 Hydrometeorology

4.1.4.1 Meteorological Conditions

The Port is located along the Arabian Sea coast in the southwest of Pakistan. This region has a tropical desert climate given its proximity to the sea and its geographic coordinates. This results in high temperatures and little rain throughout the year. The meteorological conditions are mainly based on the observational and statistical data that was available for the period November 2002 to October 2003 collected from FHDI. Due to lack of local recording data, extreme wind speed data of the Karachi Airport Weather Station from 1979 to 2009 has been used as a reference.

Figure 9 - Location of Meteorological Observation Station (Point C)



Rainfall

Gwadar belongs to the subtropical desert climate zone resulting in annual average rainfall of 69 millimetres ("mm"). There is no rainfall in February, March, May, June and October. Statistical results of monthly average rainfall are shown below.

Table 8.1 - Monthly Average Rainfall Statistics (mm) (Nov 2002 – Oct 2003)

Month	Nov	Dec	Jan	Feb	Mar	Apr	May
Rainfall	4.4	7.5	27.7	0	0	1.5	0
Month	Jun	Jul	Aug	Sep	Oct	**Annual Average**	
Rainfall	0	23.9	2.5	1.5	0	**69.00**	

Air Temperature

Monthly average air temperature of Gwadar ranges from 20.4 °C to 28.4 °C and annual average air temperature is 24.8°C. Air temperature is the lowest in January and highest in July. Minimum air temperature recorded is 13.7°C and maximum air temperature recorded is 35.6°C.

Table 8.2 - Monthly Average Air Temperature (°C)

Month	Average	Maximum	Minimum
Nov 2002	24.0	30.4	19.3
Dec 2002	21.0	26.9	13.7
Jan 2003	20.4	26.4	14.1
Feb 2003	21.4	27.7	16.0
Mar 2003	22.9	29.7	13.7
Arp 2003	26.2	35.6	22.4
May 2003	27.3	34.5	22.0
Jun 2003	28.3	32.7	25.4
Jul 2003	28.4	31.6	24.3
Aug 2003	26.9	30.5	24.2
Sep 2003	25.6	32.9	21.5
Oct 2003	25.3	33.5	20.2
Annual	24.8	35.6	13.7

Wind

The Arabian Sea is significantly affected by monsoon winds, which bring heavy rain. The southwest wind is the control wind direction in the Arabian Sea area and prevailing wind direction is SSW-WSW with occurrence frequency being 48.9%. Below is the wind direction and wind velocity joint distribution table.

Table 8.3 - Wind Direction and Velocity Joint Distribution (Nov 2002 – Oct 2003)

Wind Scale	0	1-3	4-5	6	>6	Total	Avg Wind Speed	Max Wind Speed
Wind Speed	0.0-0.2	0.3-5.4	5.5-10.7	10.8-13.8	≥13.9			
Wind Direction	%	%	%	%	%	%	m/s	m/s
N	0	1.99	0.18	0	0	2.16	2.7	7.3
NNE	0	4.54	0.02	0	0	4.56	2.3	6.4
NE	0	4.59	0.55	0	0	5.14	3	10.7
ENE	0	3.72	0.12	0	0	3.83	2.8	8.8
E	0	1.7	0.01	0	0	1.71	2.6	5.6
ESE	0	1.68	0.08	0	0	1.77	3.2	8.6
SE	0	2.76	0.35	0	0	3.11	3.9	7.2
SSE	0	4.07	0.55	0	0	4.62	3.6	7.5
S	0	7.33	1.62	0	0	8.95	3.9	8.2
SSW	0	10.53	6.94	0	0	17.48	5	9.6
SW	0	11.14	8.46	0.05	0	19.65	5.2	12
WSW	0	6.84	4.7	0.22	0	11.76	5.4	13.8
W	0	4.31	1.58	0.12	0.01	6.02	4.6	15.1
WNW	0	2.88	0.4	0	0	3.27	3.7	9.8
NW	0	3.21	0.79	0	0	4.01	4	9.4
NNW	0	1.51	0.44	0	0	1.95	3.7	7.6
Annual	0	72.8	26.81	0.39	0.01	100	4.3	15.1
Gale (days)			≥strong breeze: 8		≥near gale: 1		fresh gale: 0	

Below is the statistics of measured monthly average wind direction and wind speed.

Table 8.4 - Monthly Average Wind Speed and Direction

	Prevailing Wind Direction		Sub-Prevailing Wind Direction		Monthly Avg Wind Speed
	Wind Direction	%	Wind Direction	%	m/s
Nov 2002	SW	16.8	NE	11.9	3.6
Dec 2002	NNE	13.6	NE	12.5	3.6
Jan 2003	SW	12.8	NW	10.2	3.9
Feb 2003	WSW	17.1	SW	16.8	4.6
Mar 2003	SW	16.7	SSW	14.2	4.4
Apr 2003	WSW	21.0	SW	19.7	5.3
May 2003	SSW	28.6	SW	27.7	4.6
Jun 2003	SSW	32.6	SW	24.4	4.8
Jul 2003	SW	27.9	SSW	17.8	4.5
Aug 2003	SSW	43.7	SW	22.7	4.3
Sep 2003	SW	25.0	SSW	22.9	4.3
Oct 2003	WSW	17.1	SW	15.6	4.0
Annual	SW	19.7	SSW	17.5	4.3

The following table shows the wind observation data (at height of 10 m, 3 min average wind speed) for the past 31 years from 1979 to 2009 at the Karachi Airport Weather Station. The statistical results indicate that the wind speed of 100-year return period in this sea area is 25.29 metres per second ("m/s").

Table 8.5 - Extreme Wind Speed Statistics at Karachi Airport Weather Station

Return Period	Wind Speed (m/s)
2	10.91
5	14.76
10	17.31
25	20.53
50	22.92
100	25.29

The statistical results of tropical cyclones occurring in the Makran Coastal region and Sindh from 1989 to 2010 are as follows:

Table 8.6 - Statistics of Tropical Cyclones over the period 1989-2010

Month	Makran Coast	Sindh	Total
Jan	0	0	0
Feb	0	0	0
Mar	0	0	0
Apr	0	0	0
May	1	4	5
Jun	4	5	9
July	0	0	0
Aug	0	0	0

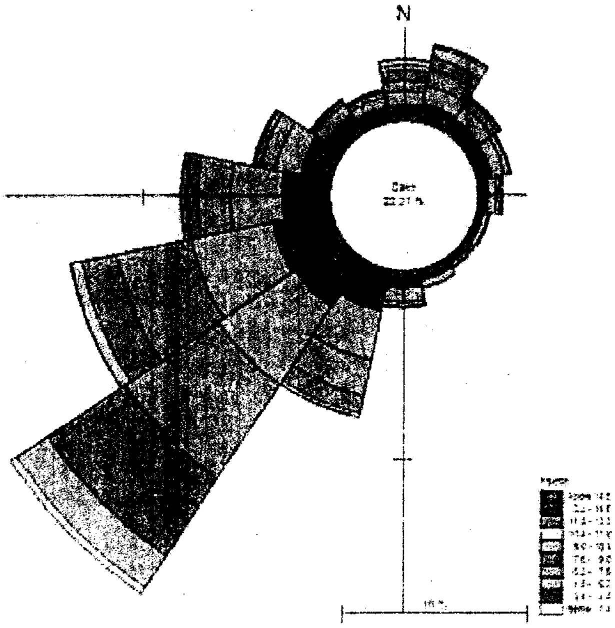
Sep	1	2	3
Oct	0	2	2
Nov	0	1	1
Dec	0	0	0
Total	**6**	**14**	**20**

According to the European Centre for Medium-term Weather Forecasting ("ECMWF"), wind data from 1979-2010, indicates that strong wind direction in the sea is NNE and the probability of >15 m/s wind speed is very low. Below is the offshore wind speed and direction joint distribution table.

Table 8.7 - Offshore Wind Speed and Direction Joint Distribution

Wind Direction	Wind Speed (m/s)								Frequency Total (%)
	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-18	
N	0.39	1.10	1.10	0.85	0.58	0.34	0.06	0.00	**4.43**
NNE	0.42	1.38	1.34	1.21	0.82	0.33	0.03	0.01	**5.54**
NE	0.32	1.32	1.17	0.54	0.19	0.02	0.00	0.00	**3.57**
ENE	0.39	1.15	1.10	0.39	0.05	0.00	0.00	0.00	**3.08**
E	0.31	0.81	0.73	0.36	0.11	0.00	0.00	0.00	**2.32**
ESE	0.31	0.56	0.47	0.09	0.03	0.02	0.00	0.00	**1.49**
SE	0.33	0.67	0.41	0.09	0.02	0.01	0.00	0.00	**1.52**
SSE	0.30	0.89	0.69	0.05	0.02	0.00	0.00	0.00	**1.94**
S	0.35	1.25	1.23	0.33	0.01	0.00	0.00	0.00	**3.17**
SSW	0.38	2.02	3.67	2.67	0.78	0.05	0.00	0.00	**9.56**
SW	0.49	2.54	6.16	8.54	4.87	0.74	0.01	0.00	**23.35**
WSW	0.50	2.96	5.83	5.45	1.62	0.20	0.00	0.00	**16.56**
W	0.52	2.74	4.06	2.37	0.53	0.06	0.01	0.00	**10.28**
WNW	0.57	2.10	2.27	1.02	0.25	0.05	0.02	0.00	**6.28**
NW	0.49	1.70	1.25	0.29	0.08	0.02	0.00	0.00	**3.82**
NNW	0.45	1.27	0.86	0.36	0.11	0.02	0.00	0.00	**3.07**
Frequency Total (%)	**6.52**	**24.44**	**32.36**	**24.60**	**10.06**	**1.87**	**0.12**	**0.01**	**100.00**

Figure 10.1 - ECMWF Offshore Wind Rose Diagram



Relative Humidity

The annual average relative humidity in Gwadar is approximately 72%. The monthly relative humidity statistics are shown below.

Table 8.8 - Monthly Average Relative Humidity

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
Avg	60.9	57.1	61.9	67.1	69.0	67.4	79.9	84.4	81.5	80.0	77.2	77.2	72.0
Max	91.5	93.9	91.5	91.8	94.8	95.7	95.7	96.4	96.4	95.6	96.0	97.3	97.3
Min	9.6	6.0	14.1	18.2	7.9	11.7	11.3	64.3	63.3	61.8	7.3	12.1	6.0

Visibility

Given Gwadar's climate and geography, there is seasonal variation and diurnal variation in visibility. The probability of visibility being less than 1 km is only 0.53%. Below is a statistical table of different visibility occurrence frequencies.

Table 8.9 - Visibility Statistics

	Nov	Dec	Jan	Feb	Mar	Apr	May
<5 km	0.0	4.3	0.0	6.3	3.2	1.7	3.2
5-9 km	39.0	61.3	30.6	19.6	14.5	1.7	7.3
≥10 km	61.0	34.4	69.3	74.1	82.3	96.6	89.5
	Jun	Jul	Aug	Sep	Oct	Annual Average	
<5 km	0.8	0.0	16.9	14.2	15.3	5.5	
5-9 km	1.7	8.1	50.8	40.8	23.4	24.9	
≥10 km	97.5	91.9	32.3	45.0	61.3	69.6	

Note: Sampling frequency is 6 h

4.1.4.2 Hydrological Conditions

Mean sea level rise

In the past 10 years, mean sea level has risen by 1–5 mm every year. Based on the assumption of global warming, the mean seal level rises by 0.5 mm per year. Based on this assumption, the mean sea level rise for the Project is projected to rise by 25 mm in the next 50 years.

Tide

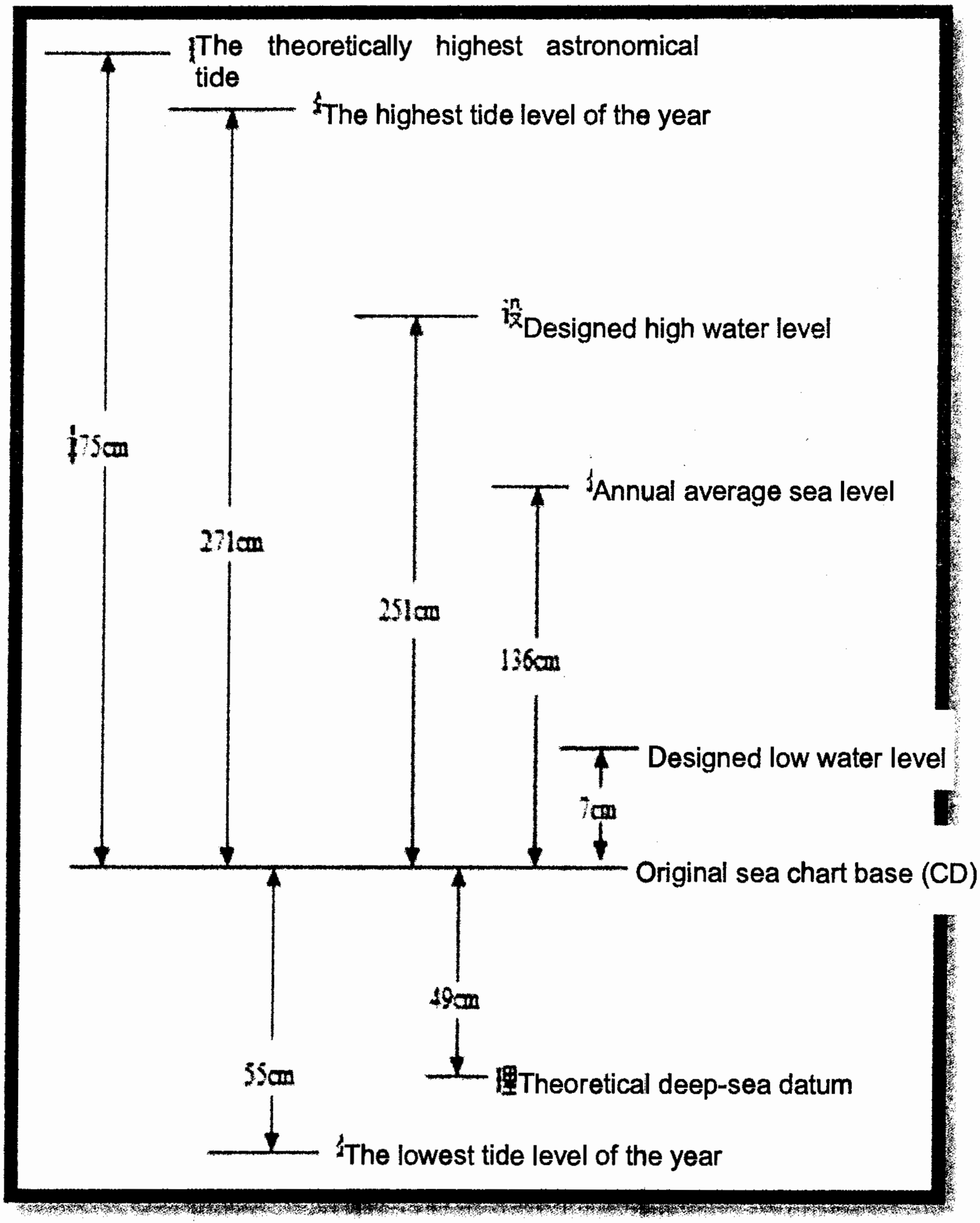
The sea at the Gwadar area has an irregular semidiurnal tide. According to a one-year tide observation data from November 1, 2002 to November 7, 2003 at Gwadar station, the tidal characteristic values are as follows.

Table 8.10 - Tidal Characteristic Value (starting from theoretical depth datum)

Mean sea level	Highest tide level	Lowest tide level	Mean tide range	Extreme tide range	Mean high tide level	Mean low tide level
185	320	-6	141	308	257	116

All figures in centimetres ("cm")

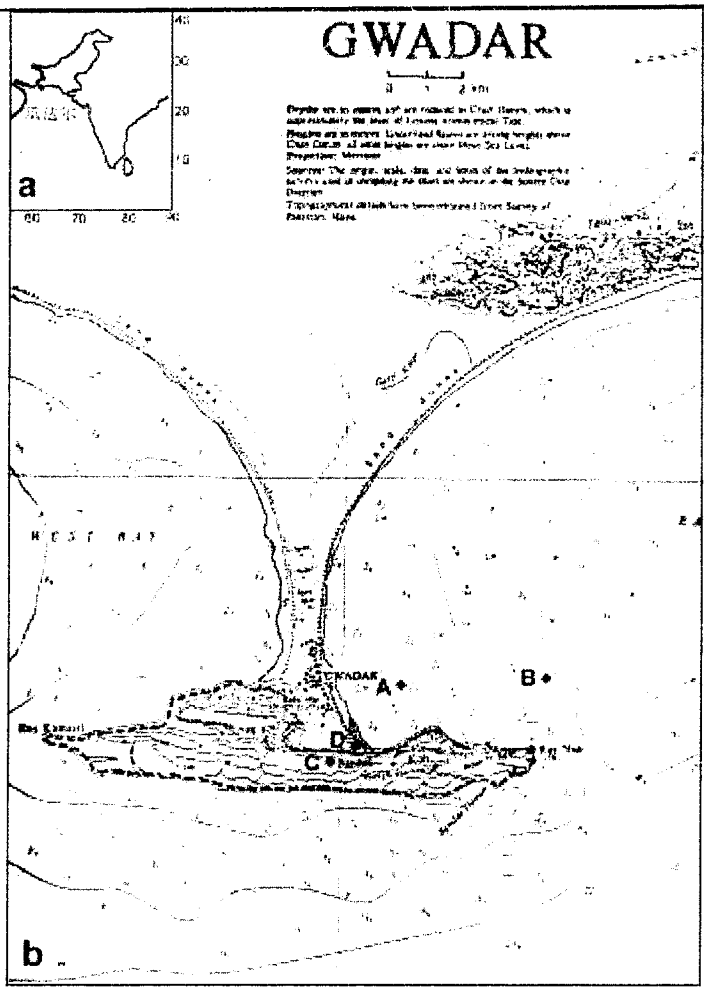
Figure 10.2 - Datum Relation Diagram



With reference to the characteristic values of water levels in nearby Gwadar Port project, extreme water levels are as follows:

- Design high water level: 300 cm
- Design low water level: 56 cm
- High water level of 50-year return period: 412 cm
- High water level of 100-year return period: 439 cm
- Low water level of 50-year return period: -30 cm

Figure 10.3 - Location of Water Level Observation Station



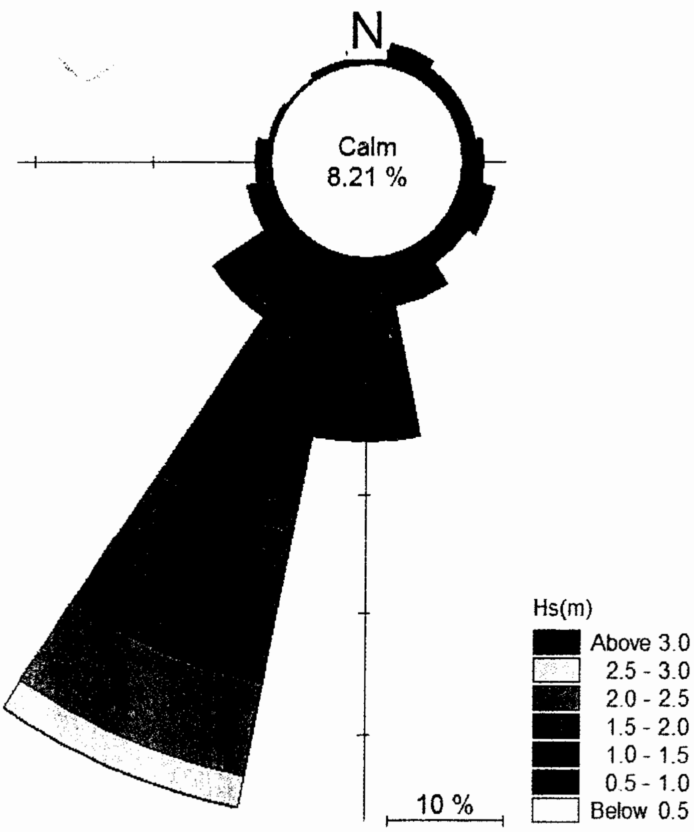
Wave

The wave contents of this section are based on the results of monographic study on wave numerical simulation for nearby Gwadar Port projects.

1. Offshore wave condition

According to ECMWF wave data, the offshore wind rose diagram indicates that the prevailing wind direction in this sea area is SW-S, strong wind directions are SSW and N and the maximum significant wave height is >3.5m.

Figure 10.4 - ECMWF Offshore Wave Rose Diagram



2. Offshore extreme wave elements

Table 8.11 - Offshore Effective Wave Height of Different Return Periods

Return Period (Year)	NE	ENE	E	ESE	SE	SSE	S	SSW	SW
100	2.60	4.02	4.13	4.01	3.27	3.22	3.66	3.04	4.04
50	2.40	3.76	3.79	3.53	2.95	2.88	3.33	2.71	3.73
25	2.18	3.07	3.32	3.05	2.62	2.53	2.98	2.37	3.49
2	1.25	1.12	1.27	1.23	1.17	1.06	1.54	1.05	2.32
1	1.06	0.75	0.94	0.85	0.88	0.76	1.23	0.73	2.10

**All units in m*

Table 8.12: Offshore Effective Wave Period Values in Different Return Periods

Return Period (Year)	NE	ENE	E	ESE	SE	SSE	S	SSW	SW
100	6.51	7.52	7.48	7.18	7.17	7.17	13.12	11.90	13.86
50	6.41	7.39	7.29	7.06	7.04	7.03	12.47	11.25	13.25
25	6.13	7.20	7.10	6.93	6.91	6.89	11.78	10.59	12.78
2	5.35	6.40	6.38	6.36	6.33	6.32	8.96	8.00	10.49

1	5.20	6.27	6.23	6.24	6.25	6.20	8.36	7.38	10.06

**All units in seconds ("s")*

3. Project Location Design Wave Lengths

According to the design calculation results of CCCC Fourth Harbour Design Institute and the monographic study results of wave numerical simulation for site 3 coal jetty projects, the design wave elements of the plant site location are estimated as follows.

Figure 10.5 - Wave Calculation Point for Plant Site 3

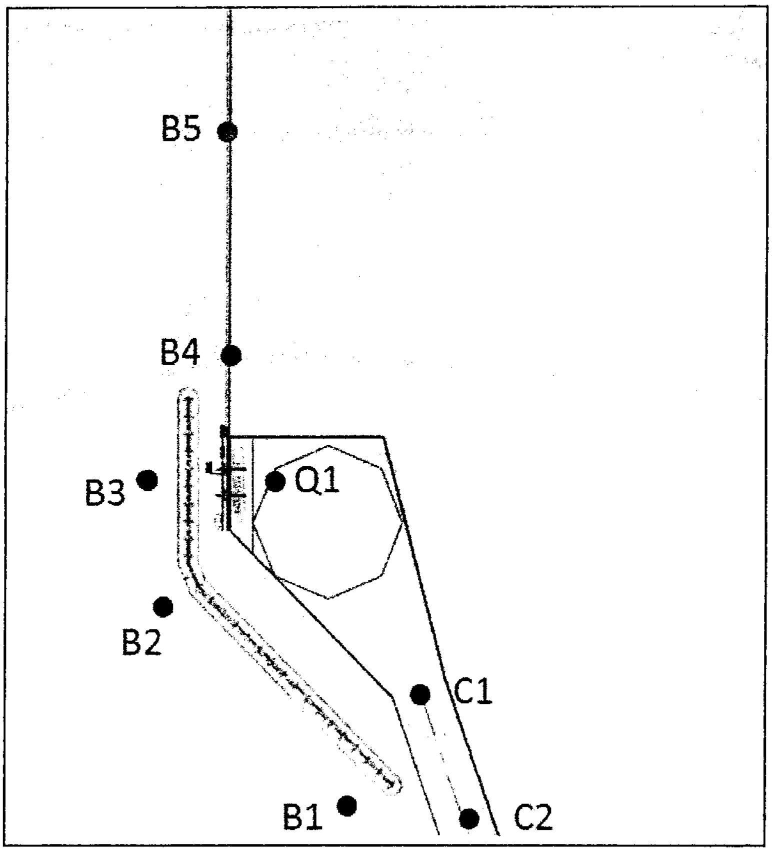


Table 8.13 - Design Wave Elements of Site 3

Location	Return Period (Year)	Wl (m)	$H_{1\%}$ (m)	$H_{4\%}$ (m)	$H_{5\%}$ (m)	$H_{13\%}$ (m)	H_m (m)	T_m (s)	L_m (m)	Dir.
B1-B2-B3	100	4.4	6.0	5.0	4.8	4.0	2.5	12.1	118.9	SW
	50	4.1	5.6	4.7	4.5	3.7	2.3	11.5	110.9	
	2	3.0	3.5	2.9	2.8	2.3	1.4	9.1	81.1	
B4	100	4.4	5.4	4.5	4.4	3.6	2.2	12.1	111.1	
	50	4.1	5.0	4.2	4.0	3.3	2.0	11.5	103.7	
	2	3.0	3.2	2.6	2.5	2.1	1.3	9.1	75.4	
B5	100	4.4	3.8*	3.8*	3.8*	3.6	2.2	12.1	93.0	
	50	4.1	3.7*	3.7*	3.7*	3.3	2.0	11.5	86.3	

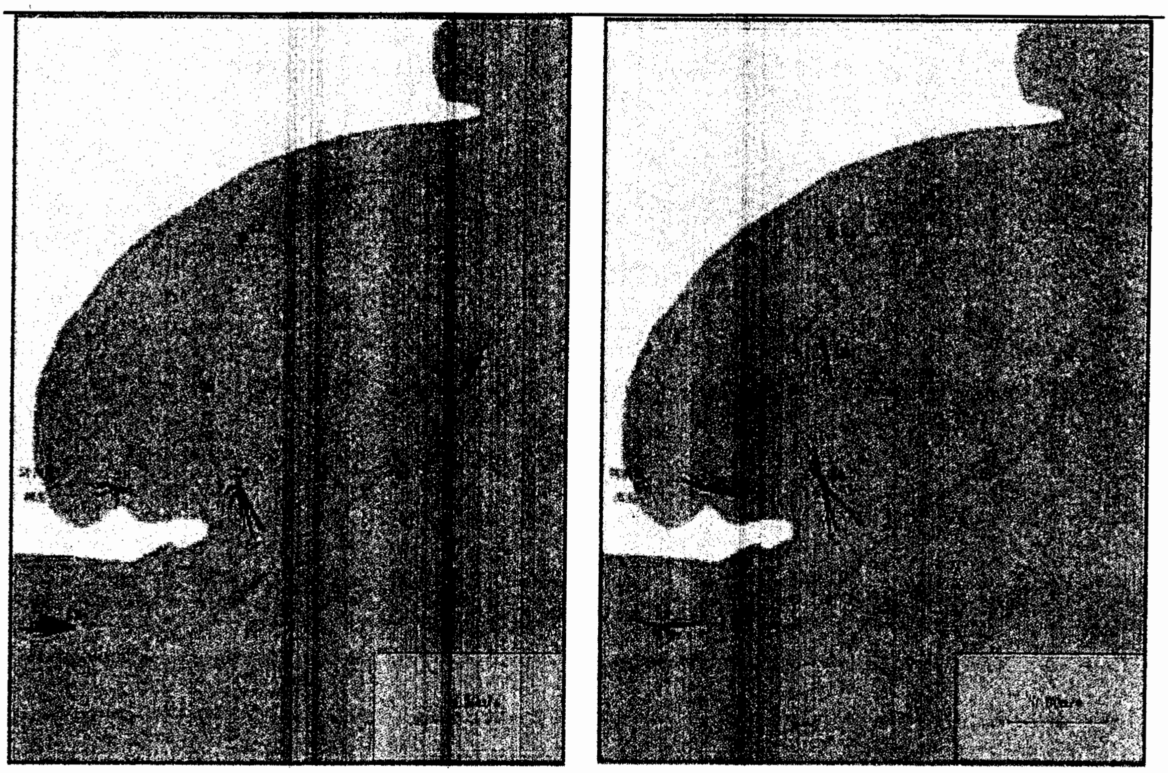
	2	3.0	3.0*	2.6	2.5	2.1	1.3	9.1	61.1	
Q1	100	4.4	5.0	4.2	4.0	3.3	2.0	6.2	58.1	SE
	50	4.1	4.5	3.8	3.6	3.0	1.9	6.1	56.3	
	2	3.0	1.8	1.5	1.5	1.2	0.7	5.5	46.4	
C1	1	3.0	1.8	1.5	1.5	1.2	0.7	5.5	46.4	
C2	1	3.0	3.5	2.9	2.8	2.3	1.4	9.1	81.1	SW

**indicates that wave is broken*

Analysis of Tidal Current, Sediment and Siltation

Tidal and sediment observation has not yet been finished for the Project. However, tidal and sediment observation was carried out in Gwadar Port area near the site in the large and medium tide period from November to December 2001. For the purposes of this feasibility study, that observation result is referenced. The observation result shows that the mean velocity in vertical ranges from 0.04 m/s to 0.27 m/s, average flood flow ranges from 230° to 342° and average ebb flow ranges from 84° to 197°.

Figure 10.6 - Tidal Current Vector Diagram of 27-28 November 2001 (Left) and 1-2 December 2001 (Right)



The bottom sediment of the project sea area is mainly silt sand, median particle size D50=0.02-0.08 mm and it is easy to suspend under the action of wave and current. Sediment concentration above -3 m water depth is 0.14 kilograms per cubic metre ("kg/m^3"), sediment concentration of water within -3 m to -10m is 0.126 kg/m^3 and sediment concentration under -10 m water depth is 0.085 kg/m^3.

No serious sediment accumulation was found in the operation of the Gwadar Port. In the present phase, Sediment siltation intensity of the water area in the port is considered for 0.4 m/a and average siltation intensity of approach channel is considered for 0.2 m/a. Due to lack of sufficient data, sudden siltation in severe winds needs to be further analysed.

Water Temperature

According to the National Institute of Oceanography's ("NIO") observation of surface seawater temperature in Gwadar Port area, the highest seawater surface temperature is 31°C, occurring in July and the lowest is 23°C, occurring in January. Annual average seawater temperature is about 28°C. The water temperature data can be used for reference at present, detailed design shall be adjusted according to the latest observing data which is ongoing by specific study institute for this Project.

4.1.5 Water Source

The only freshwater source near the plant site is the Swad Dam Reservoir and the Shadi Dam Reservoir, both at distance of more than 50 km from the site alternatives. Moreover, water flow here is minimal due to the utilization by the Gwadar region. Therefore, for the Project, the water will be used from the seawater desalination system.

4.1.6 Ash Yard

The ash yard is proposed to be constructed in phases and will eventually have a total storage capacity for 30-year ash piling. No additional land will be required for the ash yard; there will be space allocated within the land acquired for the Project., The ash yard is proposed to be at the north end of the plant site, occupying 60 hectares ("ha"). Ash yard location and size has been determined after taking into consideration coal profile, its usage overtime and the prevailing environmental endowment like wind direction, geology etc.

The ash yard designated area will be levelled; 3 m will be excavated to make ash piling bottom surface. The ash dam top will be 8 m above the ash piling bottom surface. Ash yard will be broken down in three phases: Phase I with a storage capacity for ash piling requirement for approximately 12 years. Phase II will have a storage capacity enough about 8 years and Phase III will meet ash piling requirement for approximately 10 years. A road will be built connecting the ash yard to the power plant.

To prevent ash slag and water seepage, 300 mm covering sand gravel cushion, HDPE geomembrane and 200mm sand gravel cushion will be laid inside the dam and at the reservoir bottom. Flood protection surface for the outer slope of ash dam will be block stone and inner slope will be cement mortar surface. At the bottom of the slope, geomembrane will be enclosed with sand bags. Given the tropical desert climate, ash water in the storage area will dry out and a chance of a flood will be minimal. A blind ditch will be arranged for drainage. The drainage system will comprise of one (1) main blind ditch and several branch blind ditches at several points in the ash yard which will drain the water to the ash water clarifying basin and the resulting clarified water will be delivered by the lift pump to the ash yard for spraying.

4.1.7 Site Selection

No.	Item	Site 1	Site 2	Site 3
1	Geographic location	• 37km from the Port • South is the Arabian Sea; North is the N10 National Highway; East and West are undeveloped lands	• 20km from the Port • 17km from Site I; South is the Arabian Sea (2km); North is the N10 National Highway; East is the Meer Gurab military base (3km); West is Kohemehdi mountain	• 2km from site I • Abandoned small seawater desalination plant between Site 1 and site III
2	Urban Planning	• Planning data has not been received as of now	• Same as site I	• Same as site I
3	Transport	• N10 Highway to North • Port evacuation planned that will connect the Port and the N10 Highway • Railway line is also planned	• N10 Highway to North • Branch road to Sur Bandar Town to East	• Same as site I
4	Fresh Water Source	• Fresh water source: Swad and Shadi Dam Reservoir (50km away) • Already being utilized by Gwadar region so cannot be relied upon • Instead water will be used from the seawater desalination system	• Same as site I	• Same as site I
5	Circulating Cooling Water	• Cooling water to be seawater • Through diversion box culvert into the forebay of the circulating water pump room • Connected with steel pipe to siphon well • Reinforced concrete	• Same as site I	• Same as site I

		gravity flow box culvert used to lead water in aeration basin • Drainage outlet		
6	Ash Storage Yard	• Total storage capacity for 30 years.	• Same as site I	• Same as site I
7	Fuel Transport	• The Port to site I: 40km by road • Coal may be transported by truck • New highway and railway planned	• The Port to site II: 20 km by road • Coal may be transported by truck • New highway and railway planned	• Same as site I
8	Topography	• No village near site • Not suitable for farming • Stream on each of the west and east sides • Elevation: 5 to 9m	• Southeast of site there is a village • Not suitable for farming • Elevation: 8 to15m	• Not suitable for farming • Seasonal streams on west side • Gentle hill on east side • Elevation: 3 to 55m
9	Geology	• Foundation soil: tertiary deposit • Soil type: medium soft • Design peak ground acceleration (10% probability of exceedance in 50 years): 0.32g • Earthquake intensity: 8th degree • Pile foundation needed: 30-35m bored pile recommended • Groundwater effect on construction needs to be considered	• Foundation soil: tertiary deposit • Soil type: medium hard • Design peak ground acceleration (10% probability of exceedance in 50 years): 0.32g • Earthquake intensity: 8th degree • Natural foundation can be used • Groundwater effect need not be considered	• Foundation soil: tertiary deposit • Soil type: medium soft – soft rock • Design peak ground acceleration (10% probability of exceedance in 50 years): 0.32g • Earthquake intensity: 8th degree • Natural foundation can be used • Groundwater effect on construction only needs to be considered by the sea
10	Power Evacuation	• Outgoing line: northwest • Two 220 kV to be used • Outgoing line along road and line will be connected to new substation	• Outgoing line: northeast • Two 220 kV to be used • Outgoing line along road and line will be connected to new substation	• Outgoing line: northwest • Two 220 kV to be used • Outgoing line along road and line will be connected to new substation
11	Environmental Impact	• Mostly undeveloped land nearby • No significant	• Large fishing villages nearby • May have some	• Same as site I

		impact on residents	impact on residents	
12	Construction	• Phase III ash yard land to be used to civil construction and construction living area	• Same as site I	• Same as site I
13	Land Occupation and Relocation	• Land for power plant formed by backfiling • Land construction involves some relocation	• Same as site I	• Same as site I
14	Living	• Employees will live in planned living area • Employees on duty will be housed in the admin building	• Same as site I	• Same as site I
15	Peripheral Major Influencing Factors	• No cultural relics, mineral resources, military facilities or nearby airports	• Same as site I	• Same as site I
16	Plant Layout	• Plant site will be able to meet requirements for construction • Total land area	• Same as site I	• Same as site I
17	Vertical Arrangement	• High tide (50-year return period): 4.12m • Elevation: 5-9m • Plant floor elevation considered to be 8.25m • Fill: 550,000m^3	• High tide (50-year return period): 4.12m • Elevation: 8-15m • Plant floor elevation considered to be 8.25m • Fill: 850,000m^3	• High tide (50-year return period): 4.12m • Elevation: 3-55m • Plant floor elevation considered to be 8.25m • Fill: 2000,000m^3

As per the above analysis, Site 2 has some impact on residents and the circulating water pipe is relatively long. Site 1 and Site 3 have similar characteristics, however, Site 3 requires less earth fill and excavation. Therefore, the recommended site is Site 3 (the "Project Site").

4.1.8 Regional Geology and Geotechnical Engineering at Site

Regional Geology and Earthquakes

As per the seismic zoning of Pakistan, Gwadar and its surrounding area are in the fore-arc basin of tectonic unit. As per the regional geology, Gwadar and its surrounding area is mainly composed of sediments and volcanic rocks of the tertiary system; the upper soil layer consists of silty soil, sand and cohesive soil.

According to the "Pakistan Building Code and Earthquake Risk Evaluation and Study" (2007), seismicity in most areas of Pakistan is medium to high, mainly caused by collision of the Eurasian continental plate and manifested by orogenic revolution of the Himalayas and other mountain ranges. No fracture passes through the Site; instances of earthquakes have been few. According to the seismic zoning map (as shown in Figure 12-1) in "Pakistan Construction Code" (BCP SP-2007), the Site is in seismic zone 3, peak ground acceleration ("PGA") with 10% probability of exceedance in 50 years is 0.32g (as shown in Figure 12-2) and the corresponding basic earthquake intensity is of the eighth degree. Seismic safety evaluation for the Site is suggested and the final seismic fortification parameters are subject to the seismic safety evaluation report.

Figure 10.7 - Basic Seismic Zoning Map

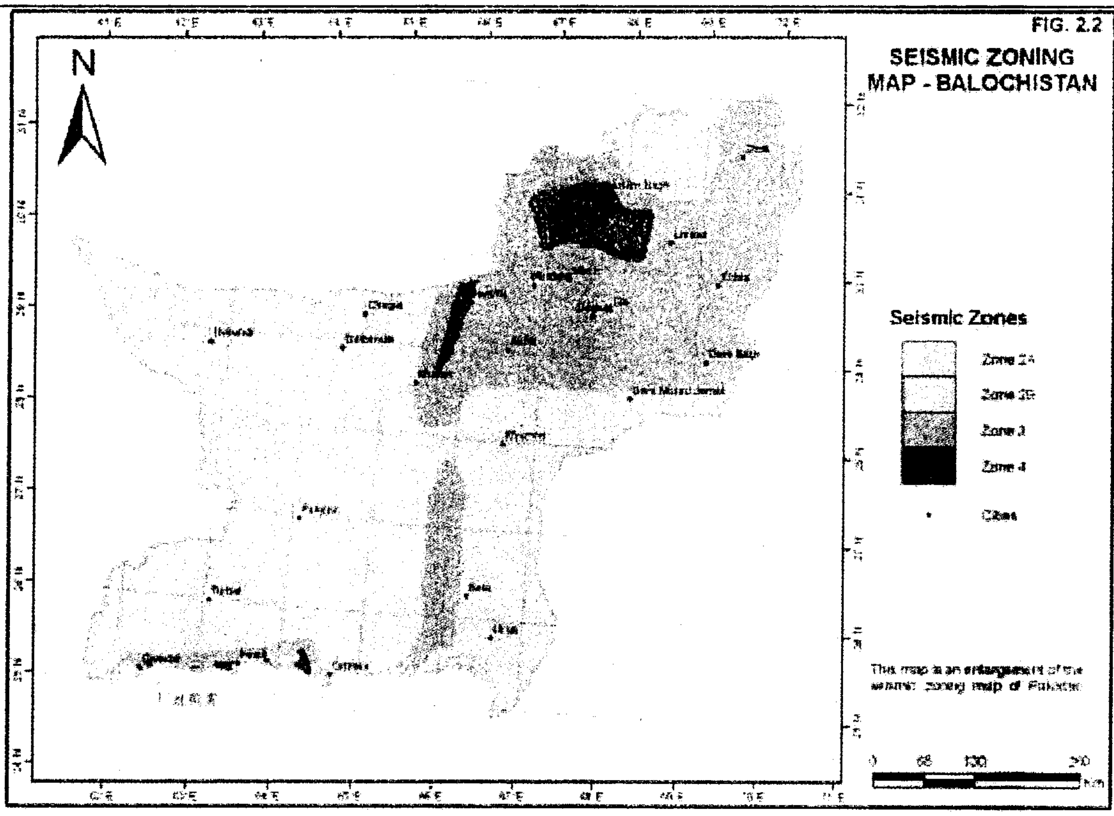
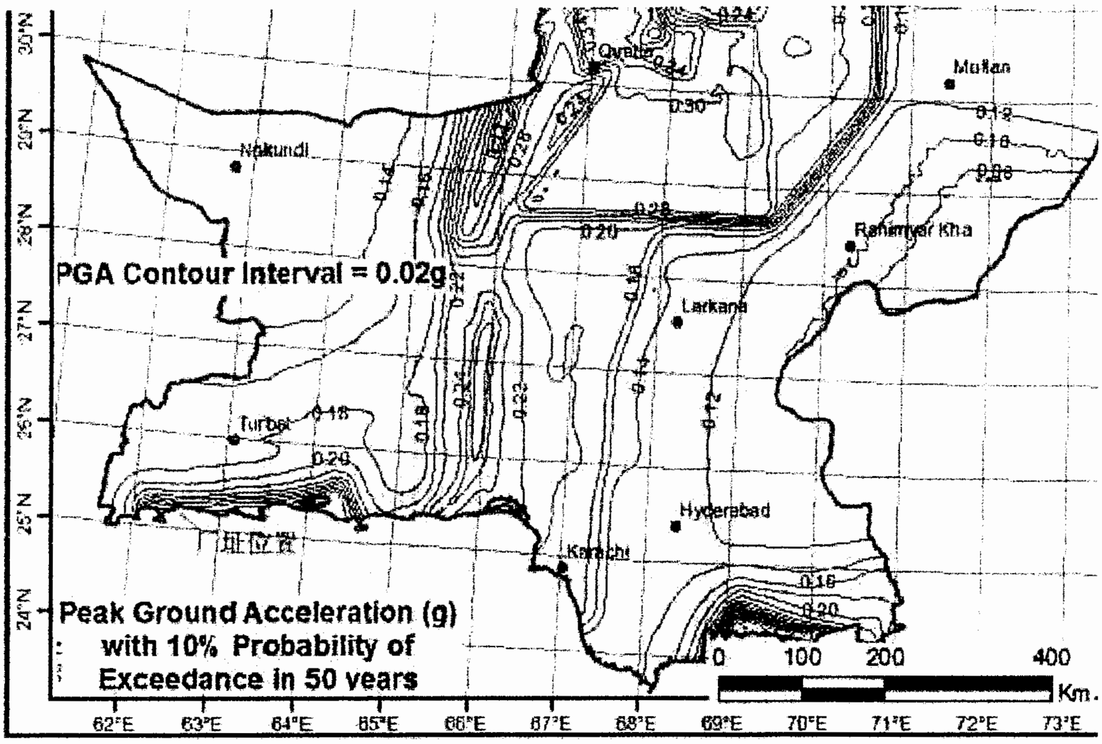


Figure 10.8 - Basic Seismic Acceleration Map



Geotechnical Engineering

The terrain at the Site and site alternatives is flat. Terrain elevation ranges from three (3) to 55 m for the Site.

The preliminary geotechnical investigation and survey for feasibility study of the Site has been finished. According to the geotechnical report, the foundation soil layer of the site alternatives is mainly tertiary deposit. The Site's soil type ranges from soft to medium hard. Soil layers from top to bottom are clayey silt, silty clay, sand and gravel layer and their characteristic value of bearing capacity ranges from 100 to 250 kPa; bedrock is mudstone. Surface foundation strength is low and soft soil layer thickness usually ranges from six (6) to 10 m.

The Site will require minimal excavation for site levelling. As per a survey report of Sur Bandar fish Port projects, the bearing capacity of a 30m long 1000 mm diameter filling pile near Gwadar Port is about 3,447 kilonewton ("kN") (Factor of Safety taken as 2.5). Therefore, a bored pile is recommended for the Site (low areas); pile foundation bearing stratum can be hard-bottom clay layer or bedrock; pile length is expected to range from 30 to 35 m. Most of the Site has good foundation conditions. In the excavation area, the exposed stratum is mainly weathered and moderately weathered mudstone. The construction of the building (structure) can use the natural foundation, strong weathering and medium weathering mudstone as foundation bearing layer. It is suggested that main heavy load building (structure) be distributed in the excavation area. In filling area, because of the thick layer of newly backfill, the foundation is suggested to be treated so that strength and deformation can meet the requirements. The foundation bearing layer, if it does not satisfy the requirement, is recommended to use pile foundation, the different weathering degree of rock can be used as the pile bearing layer.

Since the Site is adjacent to seaside, surface stratum is moderately permeable and there is a certain hydraulic relationship between groundwater and seawater infiltration. As seawater is generally highly corrosive, the inference is that groundwater is weak to medium corrosive. Therefore, corrosion protection measures for building structures need to be taken. Due to two-way recharge of stream and seawater for groundwater, groundwater level is predicted to be high. Thus, water table lowering and drainage measures need to be considered during foundation pit excavation.

Adverse geological effects of sand liquefaction, landslide, collapse and underground cave etc. have not been found at or near the Site. No valuable cultural relics have been found in the range of plant site and there are no covered mineral resources of exploitation value.

Summary

1) Terrain at the proposed project Site is flat. No fault structure passes through the Site and site alternatives. As per the preliminarily data available, there are no adverse geological effects and the sites are suitable for construction.
2) The design peak ground acceleration with 10% probability of exceedance in 50 years is 0.32g and the corresponding earthquake intensity is eighth degree. Seismic safety evaluation for the site is suggested for the next stage and the final seismic fortification parameters are subject to the seismic safety evaluation report of the site. Foundation soil layer is mainly tertiary deposit. Site 3 category belongs to.
3) The Site has relatively better conditions of the foundation, as compared to other site alternatives, it is preliminarily judged that natural foundation can be adopted.
4) Groundwater effect may need to be considered for its impact on construction and building material for the selected Site.

5. Project Fuel

5.1 Market Analysis

5.1.1 Export Coal Supply

The Site is approximately 690 km from Quetta, the capital city of Balochistan Province, and approximately 500km from Karachi. As per the current configuration, the annual coal consumption will be approximately 950,000 metric tons ("MT") (LHV as received basis over 5,371kcal/kg) at 85% plant availability.

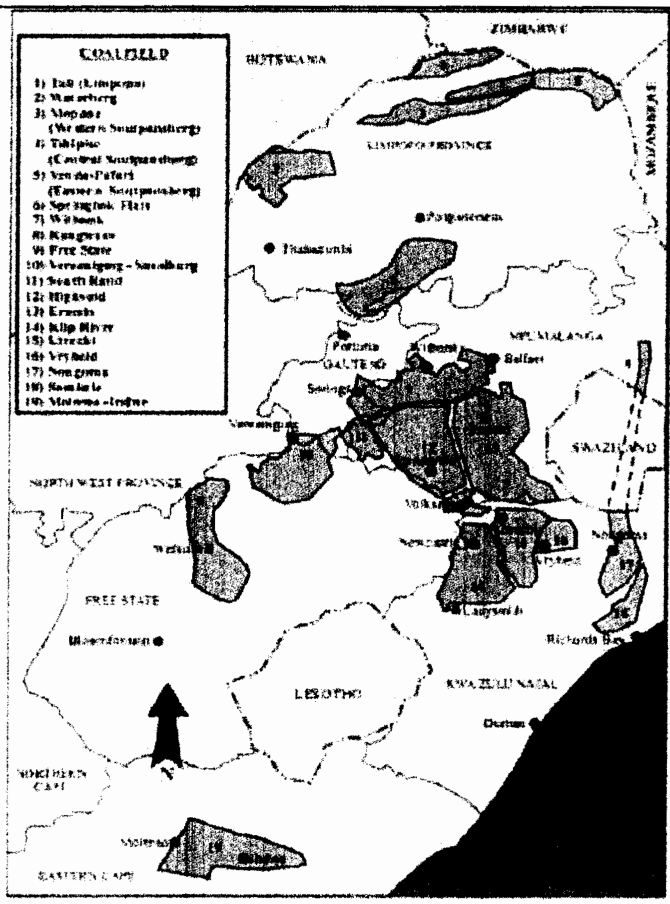
Pakistan has coal reserves of approximately 186 billion MT making it the seventh (7^{th}) largest in the world; in terms of lignite, it ranks number one in Asia. Most of the coal reserves are in Sindh: 184 billion MT (175.5 billion MT in Thar, 1.3 billion MT in Lakhra and 3.7 billion MT in Sonda-Thatta). Most of the coal mined in Pakistan is lignite, which falls between bituminous and peat. The sulfur and ash content is too high which is why it cannot be used by industrial users. The annual coal output is 4.5 million MT of which approximately 90% is used in brick kilns. Due to the inadequate chemistry and other attributes of the local coal and the limited annual output, Pakistan needs to import large amounts of coal to meet domestic demand for thermal coal. Therefore, given the constraints, the Project has envisaged using imported coal as the primary fuel.

The selection of coal is mainly based on heating value requirements, ease of transportation and stability. Given the size of the Project, shipping distances and costs, South Africa and Indonesia have been shortlisted as potential sources.

South African Coal

South Africa has coal reserves worth 205.7 billion MT, two-thirds of the total coal reserves in Africa, ranking fifth (5^{th}) in the world behind the United States, China, Russia and Australia. The coalfields in South Africa are of Permian and Triassic periods, mostly located in the Mpumalanga Province in the east, Free State and Natal Province. The carbon content of coal increases gradually and the coal layers become thinner from west to east. There are 19 coal fields distributed over an area of 700 km from north to south and 500 km from east to west in the Karo series stratum in Mpumalanga Province and north Natal.

Figure 11.1 - Distribution of Coal Fields in South Africa



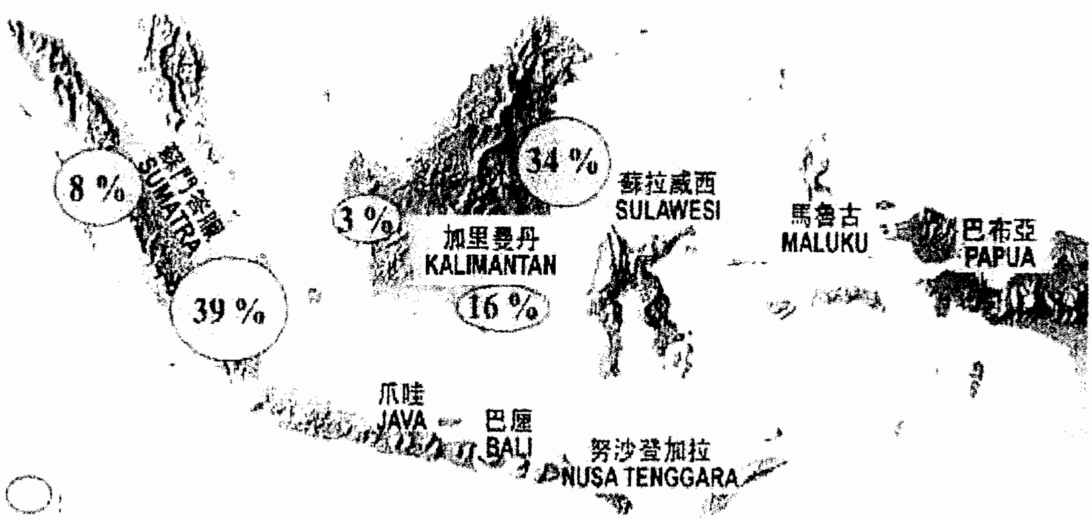
South Africa is the sixth (6th) largest coal producing country and the second (2nd) largest coal exporter. Most of the coal exported from South Africa is done via the Richards Bay Coal Terminal ("RBCT"), through a dedicated coal railway. Only a small amount of coal is exported via the docks at Maputo and Durban. Most of the coal production is controlled by the big coal companies such as the Anglo Coal Group, the BHP Billiton Group, the Sasol Group, the Exxon Group and the Strata Group. The coal output of these five (5) groups accounts for approximately 90% of the total coal output of South Africa. Customs data shows that in 2014, South Africa exported approximately 77.42 million MT of coal; India took the biggest share at 30.45 million MT; Pakistan received approximately 3.37 million MT from South Africa.

The coal from South Africa has the properties of medium to high heating value, low moisture content, low to medium ash content, low sulfur content and medium volatility. The coal quality indicators range of main coal producers: LHV as received basis 5,200-6,300 kcal/kg, total moisture content 7%-10%, ash content 10%-23%, total sulfur content 0.5%-0.85%, and volatile component 22%-29%.

Indonesian Coal

According to the Ministry of Energy and Mine of Indonesia, the coal reserves are estimated at 58 billion MT with proven reserves of 19.3 billion MT. Since reserves have not been proven in many areas, some estimates for coal reserves go as high as 90 billion MT. Anthracite coal accounts for 0.36% of the total reserves, bituminous coal for 14.38%, sub-bituminous coal for 26.63% and lignite for 58.63%.

Figure 11.2 - Distribution of Coal Fields in Indonesia



The proven coal reserves in Indonesia are mainly distributed over two (2) islands: central, eastern and southern Kalimantan and central and southern Sumatra. 91% of the coal is sourced from Kalimantan and the rest is sourced from Sumatra. Most coal mines in Indonesia have been open pit, however, in recent years, with an increase in production, open coal mines are becoming scarce.

The coal from Indonesia has the properties of medium heating value, high moisture content, low ash content, low sulfur content and high volatility. The coal quality indicators range of main coal producers: LHV as received basis 4200-5500 kcal/kg, total moisture content 21%-38%, ash content 6%-10%, total sulfur content 0.3%-0.85%, and volatile component 37%-48%.

Comparison

The properties of coal from South Africa and Indonesia are compared as follows:

1. South African coal is mainly bituminous coal while Indonesian coal is mostly lignite. Both are suitable for electricity production.

   According to the coal classification of China, coal is first classified by volatile content into lignite, bituminous, and anthracite coal. Lignite is further classified into two (2) sub-categories, old lignite with particulate matter greater than 30-50% and young lignite with particulate matter lower than or equal to 30%.

   Bituminous coal can be further classified into low (10%<volatile content≤20%), medium (20%<volatile content≤28%), medium high (28%<volatile content≤37%) and high volatile (>37%) bituminous coal. Bituminous coal can also be classified by it cohesiveness index (G): non-cohesive and minor cohesive (0<G≤5), weak cohesive (5<G≤20), medium weak cohesive (20<G≤50), medium strong cohesive (50<G≤65) and strong cohesive (G>65). Gas coal is the bituminous coal with the highest degree of coalification, with very high volatile content and medium cohesiveness, mainly for coking and power generation.

   Lignite is the mine coal with the lowest coalification. It is a low-grade coal in brownish black colour and no gloss. It has a strong chemical reaction, can easily weather in air and it is difficult to store or transport over long distance.

2. Heating Value: higher heating value mean lower shipping cost per unit of heat. South African coal has a higher heating value compared to that from Indonesia, hence making it more cost effective when just taking heating value into account.
3. Moisture Content: Indonesian coal has high moisture content, hence poor flowability which may cause blockage of the coal pipe. On the other hand, South African coal has low moisture content, conducive to the normal operation of coal conveying systems.

4. Ash Content: Indonesian Coal features low ash content while South African coal has a relatively higher ash content which can affect the ash handling and slag removal systems.
5. Volatile content: Indonesian coal has high volatile content compared to South African coal. High volatile content can increase the possibility of dust deposit and explosion in the pulverizing system, and also lead to excessive loss of heating value and spontaneous combustion of coal when stored over a long time in the coal yard.
6. Sulfur content: South African coal has high sulphur content when compared to Indonesian coal, which may result in insufficient output of desulfurization system.
7. Indonesian coal has a higher tendency to explode than South African coal which makes it riskier to ship.
8. Shipping distances to the Port are approximately the same from the RBCT in South Africa and the Balikpapan Port in Indonesia, 4,350 nautical miles ("nm") and 4,060 nm, respectively.
9. According to the report of China Coal Resources Net on May 23, 2013, Indonesia has planned to impose an export tax on coal which may impact coal prices in the future. On the other hand, South Africa has no plans of adding an export tax on coal.

Given the above analysis, the Project envisages using South African coal as the primary fuel and the Indonesian coal as back-up fuel. The coal type of HUBCO Power Plant of Pakistan (the engineering design coal is South Africa coal RB3, and the check coal is 50% RB3 of South Africa +50% NAR4,700 of Indonesia) will be used first as design input, and later, it will be firmed up upon the signing of the coal supply agreement.

5.1.2 Export Coal Quality

The coal source and quality of HUBCO Power Plant of Pakistan is to be used as reference, whereby South African coal will be used as primary fuel and the Indonesian coal will be used as a supplement and backup. According to the coal export proportion of South Africa, it is suggested to take the most popular steam coal RB3 (LHV is about 5,371kcal/kg) at the coal yard of Richards Terminal as the design coal for coal quality indicators, with the check coal as 50% RB3 of South Africa + 50% NAR4,700 of Indonesia. The following tables provide the quality indicators of design coal and check coal.

Table 9.1 – Quality Indicators of Coal

Indicator	Unit	Design Coal (RB3 of South Africa)	Check Coal (Mixed South Africa – Indonesia Coal)
Industrial Analysis			
Total Water Content	%	9.27	17.29
Moisture content air dried basis	%	4.44	9.84
Ash content (as received basis)	%	17.56	11.25
Volatile content as dry and ash free basis	%	32.42	41.33
Fixed carbon	%	49.45	41.93

Others			
LHV (as received basis)	kcal/kg	5,371	4,991
HHV (as received basis)	kcal/kg	5,591	5,254
HGI		53	48
Element Analysis			
Carbon (as received)	%	59.2	55.59
Hydrogen (as received)	%	3.46	3.66
Oxygen (as received)	%	7.98	10.05
Nitrogen (as received)	%	1.49	1.24
Sulfur (as received)	%	1.04	0.88
Ash Analysis			
Silicon dioxide	%	53.39	50.82
Aluminium oxide	%	22.65	22.39
Iron trioxide	%	6.56	8.18
Calcium oxide	%	6.92	6.92
Magnesium oxide	%	2.23	2.29
Sodium oxide	%	0.19	0.3
Potassium oxide	%	0.66	0.82
Titanium dioxide	%	1.06	1.04
Manganese dioxide	%	0.5	0.41
Sulfur trioxide	%	5.22	6.11
Phosphorus pentoxide	%	0.62	0.53
Ash Softening Point			
Deformation temperature	°C	1,240	1,140
Softening temperature	°C	1,270	1,160
Hemisphere temperature	°C	1,290	1,170
Flowing temperature	°C	1,310	1,240
Granularity	%	99.2	95.87

5.1.3 Coal Price Forecast

In view of the characteristics of coal affected by moisture and volatile content, in the long-distance maritime transport process of transport losses or even spontaneous combustion, coal trade is only part of the CIF, generally only provide FOB contract, that is only to ensure that commercial coal in the departure In line with the customer's coal quality requirements, for the subsequent transport process in the heat value of the situation is not responsible for the reduction.

Generally, coal procurements are covered under long term contracts, indexed to some benchmark(s), medium term contracts and spot purchases. The judicious mix of such contracts and purchases is a function of the coal procurer's perception about the market and his view about the power purchaser's demand profile, among other things. Usually to ensure comfort for the lenders, it is considered essential that a 10-year CSA, at least for bulk of projected annual requirements, is signed with one or more reputable coal suppliers.

The coal pricing is based upon the following main components:

FOB Price: FOB price is linked to a benchmark such as API-4 which represents the 6,000 NCV coal at Richards Bay Coal terminal in South Africa. The current price of the benchmark of 5,500 NCV (RB-3) is around USD 68 per tonne. The current FOB price of 4,700 NCV coal from Indonesia is around USD 54 per tonne.

Shipping and Insurance: Shipping which varies from shipment to shipment but can be estimated at around USD 9~10 per tonne for the purpose of this feasibility.

Port Handling: The port handling charges at Gwadar Port are around 5 USD per Tonne.

Local Freight: Local Freight can be assumed at around USD 4 per Tonne for transportation from port to Site.

Coal price forecast is as follows:

Table 9.2 – Coal Price Analysis

Export Country	Coal heat value (LHV)	FOB Price USD/t	Shipping Fee USD/t	Port Handling	Local Freight
South Africa	5500kcal/kg	65~70	9	5	4
Indonesia	4700 kcal/kg	53~58	7	5	4
Description: Sea freight is Panama ship type, to India West Coast route price.					

5.2 Project Coal Requirements

As per the design quality parameters provided in the preceding table, the coal assumption is the following:

Table 9.3 – Coal Consumption

Item	Unit	2x150 MW	
		Design Coal	Check Coal
Coal Consumption	tons/hr	122.8	132.2
	tons/day	2,947.2	3,172.8
	tons/yr	914,368.8	984,361.2

Notes: Daily availability based on 24 h, annual availability based on 7,446h

5.3 Coal Transport

5.3.1 Sea Transport

The coal will be transported to the coal terminal at the exporting port from where the coal will be transported via ocean going vessels to the Port, i.e., Gwadar. Shipping distances to the Port are approximately the same from the RBCT in South Africa and the Balikpapan Port in Indonesia, 4,350 nautical miles ("NM") and 4,060NM, respectively. The types and grade of vessels selected will meet the requirements of the loading and unloading ports. Vessels will have a dead weight tonnage ("DWT") of 40,000 to 60,000 and will be equipped with booms and grabs. Given a draught of approximately 12m, the super Handysize Panamax with a loading capacity of 50,000 DWT is recommended. The total shipping time to Gwadar will be approximately 20 days: 2-3 days for coal loading at the Richard Bay Terminal; 15 days at sea and 2-3 days for coal unloading at the Port.

The Project plans to make use of the existing jetty and equipment at the Port. The jetty is approximately 40 km from the Site. A temporary coal stack yard will be built to store the coal before transportation to the Site by trucks.

There is no dedicated special coal grab to unload the coal, therefore, the existing gantry crane on the jetty will be used. The coal will be unloaded on to mobile hoppers. For the purposes of the Project, four mobile hoppers of 60 m³ will be added. Bucket-wheeling loaders and mobile belt conveyors are considered for stacking operation. A temporary stack yard will be arranged on the reclaimed land to the southeast of the jetty. To prevent coal dust's escape to the environment, the temporary stack yard will be located as close to the rear hill as possible and a mesh will be put around the stack yard. The stack yard will have a total area of 2.5 ha. A ring road will be arranged around the stack yard, and a road will be built to connect with the existing road of the harbour.

5.3.2 Inland Transport

Heavy trucks with a maximum unit loading capacity of 30-50 MT will be used to transport the coal from the stack yard to the coal yard at Site. Given the annual requirement of approximately 950,000 MT, and a carrying capacity of 50 MT, 50 trucks will be required daily to transport the coal daily from the stack yard at the Port to the coal yard at the Site.

6. Plant Technology

The Project considers a 300MW imported coal-fired power plant as the total installed capacity. Given the current grid conditions, the demand profile, the configuration has been decided as 2x150 MW.

6.1 Layout of Power Plant

Drawing provided as Annexure – 4.

6.2 Boiler

Boiler will be ultra-high pressure, once intermediate reheat, natural circulation, single furnace, π-type layout, four-corner tangential combustion, balanced ventilation, all-steel cradle, dry-bottom pulverized coal fired boiler.

Boiler is optimized for the South African bituminous coal. Boiler will be of open-air or semi-open layout; boiler operation floor will have an island-style layout, with one-unit one-boiler system.

The boiler model, its parameters and main technical specifications are as follows:

Table 10.1 – Boiler Specifications

Maximum continuous evaporation of boiler	t/h	471.1
Superheater outlet steam pressure	MPa(g)	14.42
Superheater outlet steam temperature	°C	541
Reheat steam flow	t/h	389.3
Reheat steam inlet steam pressure	MPa(g)	2.94
Reheat steam inlet steam temperature	°C	359
Reheat steam outlet steam pressure	MPa(g)	2.74
Reheat steam outlet steam temperature	°C	541
Economizer inlet water supply temperature	°C	247
Exhaust temperature	°C	135
Boiler guaranteed efficiency (TRL)	%	92.1
Air preheater type	Three-position rotary type	
Steam temperature adjustment mode	Superheated steam adopts two-stage water-cooled way to adjust the steam temperature, and the reheater adopts flue gas bypass baffle to adjust the steam temperature which is supplemented by micro-sprinkler	

6.3 Turbine and Generator

Steam Turbine

Table 10.2 –Turbine Specifications

Type	High pressure, once intermediate reheat, single axis, double cylinder double exhaust, single back pressure condensing steam turbine	
Model	N150-13.73/538/538	
Rate power	MW	150
Rated speed	r/min	3,000
Guaranteed heat consumption	kJ/kWh	8,233
Direction	Clockwise	
Main steam quantity	t/h	446
Main steam valve steam pressure	MPa.a	13.73
Main steam valve steam temperature	°C	538
High pressure cylinder exhaust pressure	MPa.a	2.82
High pressure cylinder exhaust temperature	°C	322.4
Reheat steam quantity	t/h	369.2
Combined reheat valve pressure	MPa.a	2.54
Combined reheat valve temperature	°C	538
Exhaust steam pressure	kPa	7.80
Cooling water temperature	°C	Designed: 28; Max: 31
Regenerative heating series	7 grades (2 high + 1 deoxygenation + 4 low)	
Feedwater temperature	°C	245.3

Generator

Table 10.3 – Generator Specifications

Model	QF-150-2	
Rated power	MW	150
Rated voltage	kV	15.75
Rated current	A	6,873
Rated power factor	0.80 (lagging)	
Rated speed	r/min	3,000
Cooling method	Air cooling	
Excitation mode	Self-shunt excitation system	

6.4 Combustion and Thermal System

The design scope of the system includes: cold and hot air systems, powder delivery systems, milling systems and flue gas systems.

6.5 Pulverized Coal Preparation System

Pulverization System

This study is based on opposed firing or corner tangential combustion. The type of mill and pulverizing system will be direct-fired milling system based on the coal quality characteristics, the possible coal variation range, the nature of the load, the mill application conditions, in combination with the furnace structure and the burner structure types, etc.

The Project is envisaged to use bituminous coal which is very volatile and has potentially explosive properties; the design coal's Hardgrove Grindability Index ("HGI") is 53, with moderate grindability. As per previous available data, the erosion wear index K_e is about 0.95, which is a slight wear. Keeping in view the volatility of the design coal, the grindability index, moisture and ash, and the possible coal varying range, the Project shall adopt a medium-speed coal mill with positive pressure primary air fan direct blowing coal pulverizing system. The pulverizing system is described below.

The primary air will be supplied by two primary fans, and will enter the mill through two routes; one route will be heated through the air preheater as the hot primary air, and the other will serve as the pressure cold primary air. And then through the automatic adjustment by mill inlet hot primary air adjusting damper and the cold primary air conditioning damper, the mill inlet can obtain a satisfactory mixture of air temperature and flow. The mill will be equipped with air flow measuring device to measure the amount of primary air and adjust the wind and coal ratio.

The raw coal will be transported to the medium-speed mill by the coal feeder, dried and milled, and then separated from the desiccant (primary air) into the mill outlet separator. The fine pulverized coal enters the furnace for combustion, and the dis-qualified pulverized coal will return to the mill to continue milling, and the alien debris which is hard to mill enters the reject collection system.

Coal Mill

The coal mill will be sourced from China and will be HP-type, medium-speed, bowl-type coal mill produced in China. Medium-speed coal mills produced by Chinese manufacturers have been used before for 150MW to 350MW units. Each boiler will be equipped with four HP-type mills, of which one will be the spare unit.

Primary Air Fan

Since the cold primary air fan has such characteristics as little wind volume, high pressure, high speed, high requirements for the manufacture of materials, the Project will use double suction support centrifugal fans.

Raw Coal Hopper and Feeder

Four raw coal buckets are equipped with four coal feeders and four medium-speed mills; except the raw coal bucket corresponding to the spare mill. The total effective coal storage of the three raw coal buckets will range from 8 to 12 h coal consumption at BMCR.

6.6 Flue Gas and Air System

The boiler will be equipped with balanced ventilation; each boiler flue system will be configured with two (2) 50% capacity double suction support centrifugal blowers, two double-chamber five-electric field electrostatic precipitators (interim) and two static-blade axial flow fans or centrifugal fans.

Blower

Each flue gas and air system will be equipped with two 50% capacity centrifugal blowers.

Electrostatic Precipitator

The Electrostatic Precipitator ("ESP") will be selected to keep in line with the prevailing local environmental standards in Pakistan and to optimize efficiency, investment, land requirments, etc. The selected ESP will be able to achieve efficiency under the following conditions:

1- In the design conditions, meteorological and geographical conditions of the Project;
2- A power supply area does not work (small partition power supply is equivalent to in-operation of two small partitions);
3- Flue gas flow is calculated according to the dust collector inlet flue gas in the maximum continuous evaporation of boiler, and the margin should be 10%;
4- Flue gas temperature is the design temperature plus 100°C.

Induced draft fan

The medium induced by the fan will be dust-laden gas, at a temperature of approximately 120°C. At this point, tentatively two sets of centrifugal fans, have been recommended with no spare.

Chimney

Chimney type and height will be designed to meet the environmental requirement, chimney corrosion requirements and restricted by the power plant geological conditions, seismic intensity and other factors; it is currently proposed that the Project can adopt a sleeve chimney with a height of 180m, this is subject to the final ESIA report.

Desulfurization and Denitrification

The desulfurization and denitrification equipment shall be provided as per the local emission standards; the desulfurization shall adopt seawater desulfurization process, to control sulphur oxide ("SO_x") emission concentration at less than the local standard, and simultaneously set SCR denitrification facilities for effective control of nitrogen oxide ("NO_x") at emission concentration less than required under the local laws.

6.7 Thermal System

Main steam and reheat steam system

The main steam and reheat steam system will adopt the unit double control system; in order to improve the unit, start performance and recovery quality, and to meet the minimum flow requirements in minimum load operation, While achieving FCB function, each unit has a set of high pressure and low pressure two-level series of turbine bypass systems, Capacity is tentatively set at 100% BMCR high pressure bypass + 65% BMCR low pressure bypass, final capacity will be determined in the basic design phase combined with the manufacturer's proposal.

Main water supply system

The main water supply system is equipped with two 100% capacity electric water supply pumps, one electric water supply pump is running, and the other electric water supply pump in spare. Water supply console main line does not have a control valve, and the regulation is realized through the feed pump speed changes. DN100 electric bypass is set, and a water supply control valve is provided to meet the start and low load operation adjustment. Two high pressure heaters share a big bypass.

Regeneration system

The unit has seven sections of extraction steam for heating by the regenerative system, of which the first two extraction steams are connected to two high-pressure heaters, the third section used for the heating by the deaerator, the last four connected to four low pressure heaters one of which is mounted on the condenser throat. When the deaerator pressure drops to the constant pressure working pressure, its steam source is switched from the three-stage extraction to the auxiliary steam system.

Auxiliary steam system

The steam source of the auxiliary steam header is made up of three routes, in which one route is supplied by three-section steam extraction, and the other route by two-section steam after extracted by the pressure relief valve, and the last route by the start boiler.

Condensate system

The Project uses titanium tube condenser, and the condensate pumps are two 100% rated capacity pumps, one used and the other in spare. After the condensate passes the shaft seal heater, the main line passes through No. 1, 2, 3, 4 low pressure heaters and then into the deaerator; each low-pressure heater will adopt a separate bypass system.

Heater drain system

Regeneration system consists of 7 levels, including two high-pressure heaters, a deaerator, and four low-pressure heaters. The steam turbine has seven sections of steam extraction for heating by the regenerative system. The first two sections are connected to two high-pressure heaters, the third for the deoxygenation heating and auxiliary steam, and the latter four to four low-pressure heaters. High-pressure heaters, low-pressure heaters use a systematic flow of drain, of which No. 2 low pressure drain is sent to the condensate pipeline at the heater outlet with drain pump.

Circulating cooling water system

The circulating water adopts the open circulation system, and the circulating water inlet and outlet pipes are respectively equipped with electric butterfly valves, the circulating water inlet pipes with rubber ball cleaning units. Water heat exchanger, water ring vacuum pump and other cooling water from the circulating water inlet lead. Turbine generator oil cooler, generator air cooler and other auxiliary cooling water using closed circulatory system, cooling water through the closed pump boost, through the water heat exchanger cooling and sent to the cooling equipment.

6.8 Electrical

6.8.1 Overview

The Project has been currently assumed to have access to the power grid with primary 220 kV voltage and the access plan is as follows: Power plant has two 220kV outlet lines, that is, the two new outlet lines get access to the new 220 kV substation as per the requirements of the Grid Code. Final access system program shall be subject to the demonstration results in the access system subject report.

6.8.2 Main Electrical Wiring

Both units get access to the system via 220 kV voltage, with 2 circuits of outlet lines; 220 kV indoor GIS distribution device is provided in the power plant. The main wiring adopts the form of double bus connection and the generator-double coil transformer unit wiring to get access to 220 kV electrical distribution device.

Generator lead-out line adopts full-chain off-phase closed bus, and the generator outlet temporarily considers the installation of circuit breakers. The generator outlet circuit breaker is installed between the generator and the main transformer, which can reduce the switch of auxiliary power when the unit starts and stops, improve the reliability of the plant power, prevent the expansion of main transformer and high voltage transformer, reduce the hazard of main transformer high-voltage side non-full-phase running negative sequence current on the generator rotor, reduce the high-side circuit breaker operating frequency and operation impact on the system as well as the trend changes.

This Project each unit set up a non-excitation voltage double-winding transformer as a high-voltage work to change. Two units together set up a start / standby change as the unit start, standby power. The main transformer temporarily considering the on-load regulator, high-voltage auxiliary transformer considering non-excitation voltage regulator, whether the main transformer or high voltage auxiliary transformer should be adopted on-load regulation will be concluded in the next stage, according to the system to conduct a detailed calculation. The unit start standby power supply can be sent through the main transformer to the high Voltage auxiliary transformer, it can also through the start/standby transformer.

220 kV system adopts the direct grounding, which is achieved through the direct grounding of the neutral point of the main transformer high-voltage side. The neutral point of the generator adopts the grounding transformer and the secondary side series resistance to reduce the damage of the ground fault current to the iron core and suppress the transient voltage no more than 2.6 times of the rated phase voltage. Main transformer and start standby high voltage side neutral point is directly grounded, and 6.6kV system adopts the un-grounding mode.

6.8.3 Selection of Major Electrical Equipment

220 kV power distribution unit is currently assumed to be of the indoor GIS layout, double bus wiring, with a total of 8 intervals, including: two (2) main transformer incoming line interval, one (1) start-up transformer incoming line interval, two (2) outgoing line intervals, a bus interval and two (2) bus equipment intervals. 220 kV GIS equipment is SF6 insulation type, with the rated current of 4,000 amperes ("A"), short circuit current of 40 kiloamperes ("kA"). The rated current of 220 kV circuit breaker and isolation switch is 3,150 A, and is ultimately subjected to Pakistan NTDC access system report and approval advice.

The main transformer adopts three-phase double-winding low-loss forced oil circulation air-cooled transformer, with the capacity temporarily of 190 Mega Volt Amp ("MVA"), however, depending upon the generator, and the exact number will be determined after the main unit is ordered, and the main transformer adopts the on-load regulator; Generator circuit breaker is the imported SF6 circuit breaker.

6.8.4 Electrical Equipment Layout

The overall electrical plan is of the conventional arrangement, and the main transformer and the high-voltage auxiliary transformer are arranged outside the main power house's column A. According to the 6kV auxiliary power system high-voltage auxiliary transformer setting program, each unit has a high voltage auxiliary transformer installed in front of Column A of the turbine hall after the main transformer, in order to reduce the length of the auxiliary branch closed bus at the generator outlet. High-voltage auxiliary transformer and main transformer are equipped with firewalls.

220kV power distribution device is close to the transformer area, with double bus wiring, indoor GIS layout, and a total of eight intervals. The two (2) main transformer and one start/standby transformer's incoming lines are connected by GIL, and two (2) 220kV outgoing lines are connected to power distribution device by the overhead line and. 220kV network control room is arranged near the 220kV power distribution device.

6.8.5 Auxiliary Power System

Connection of auxiliary power

The unit normal high-voltage power supply is connected from the generator outlet circuit breaker and the main transformer low-pressure side, and the high-voltage plant start/standby power supply is led from the plant 220kV system or start/standby transformer; each unit in this phase sets a high-voltage auxiliary transformer, temporarily no-load regulator three-phase split transformer. And the use of a split transformer or a two-coil transformer as the auxiliary transformer will be determined in the next stage according to the determined process load through calculation.

The access to the power grid around Gwadar is weak, hence the Project shall have its own black start capability.

High-voltage auxiliary electrical wiring and arrangement

Each unit is provided with one HV unit auxiliary transformer with two sections of 6.6kV unit bus. The load, common load and desulfurization load of the double-set auxiliary machine of the turbine and boiler are tapped onto the bus section A and B.

The HV side power supply of HV auxiliary transformer is connected as branches by the generator outgoing line of the unit, and the LV side is connected to two sections of 6.6kV operating bus for each unit.

Two units are provided with one common HV starting/standby transformer (on-load voltage regulation), of which the 6.6kV side is connected to two sections of 6.6kV operating bus for each unit as a standby power to ensure that the sufficient capacity of starting power supply is supplied to unit for start-up and the reliable spare capacity is also available.

"Fast switching device" is used between the incoming line power circuit breaker and the standby power supply circuit-breaker of the auxiliary working busbar, so as to support fast and smooth transition between the HV unit auxiliary transformer and the start-up/standby transformer.

The motor circuit of 1,000kW and above, and the transformer circuit of 1250kVA and above shall adopt the vacuum circuit breaker; the circuit requiring frequent starting and stopping, the motor circuit below 1,000kW and the transformer circuit below 1,250kVA shall adopt high-voltage fuse + vacuum contactor (F + C).

Integrated water pump is currently envisaged to be about 0.7km from the main power house, and two integrated water dedicated transformers are provided, with a total of two (2) low-voltage busbars, which are of the contact switches, and the two transformers are mutually spared.

Low-voltage auxiliary power wiring and layout

Low-voltage auxiliary power system adopts 400/230V, and the neutral point is the direct grounding system, PC-MCC, power and lighting are of separate power supply: The power is of three-phase four-wire power supply; lighting and maintenance network adopt the neutral point direct grounding mode and three-phase five-wire power supply.

In order to ensure the shutdown safety of unit in case of AC power outage and the emergent spare of important load, considering the actual local situations, two units will have two 400kW emergency diesel generators (the exact capacity will be confirmed by calculation in the next stage) as the security power supply in alternating current accident. Diesel generator sets are the mobile container type.

Low-voltage auxiliary power distribution devices are in the steam engine room and boiler room load centre, to achieve physical dispersion. The main power house inside and outside 400/230 V power centre (PC) and motor control centre (MCC) use the extraction and drawer switchgears.

DC system and AC uninterruptible power supply

The DC system of the unit control room is equipped with a 220 V DC system for each unit as a reliable power supply for such loads as the unit control, signal, relay protection, automatic device, accident lighting, DC oil pump and AC uninterruptible power supply, etc. Each unit 220 V DC system sets a group of 220 V battery, which are valve-regulated, sealed, lead-acid batteries, and no terminal battery is provided.

DC system wiring adopts single bus section, and the battery is connected to the two buses; in the normal condition, the two buses run at the same time. Two units are equipped with three sets of charging equipment, in which # 1 unit is equipped with two sets of charging equipment, one as a dedicated charging device of the unit, and the other as the public backup charging equipment of two units; the public charging device output knife switches are chained.

In order to ensure the uninterrupted and reliable power supply for the automation device, a 40 kVA AC uninterruptible power supply ("UPS") is set up for each unit in the current project. The device is composed of rectifier, inverter, and static switch and so on, with voltage and frequency stabilization performance; its working principle is that, in normal condition, the working power is connected from the auxiliary power, converted into direct current after rectification filtering, and then converted into alternating current by the inverter to supply power to loads. When the input AC power is lost, the inverter is powered by the 220 V DC system, and a bypass power supply is used as the power frequency AC power continuously to loads during the maintenance of converter.

Electrical system control and protection

A unit system unit boiler power centralized control mode is proposed; temporarily a control building is set according to the scale of one control centre for two units. The separate network control room is set, and the network control equipment is set locally in the 220kV network control room. The new central control building will be arranged between the two (2) boilers after the steam room.

6.9 Coal Transportation and Ash Handling System

6.9.1 Coal Transportation System

Installed Capacity (MW)	Hourly Coal Consumption (t/h)	Daily Coal Consumption (t/d)	Max Daily Coal (t)	Max Daily Trucks	Annual Coal Consumptions ($x10^4$ t/a)
300 (Design coal quality)	122.8	2,947.2	3,536.7	118	91.44
300 (Check coal quality)	132.2	3,172.8	3,807.4	127	98.44

- The daily use hours are calculated as 24 hours
- Annual use hours are calculated as 7,446 hours
- Maximum amount of coal:

$$\text{Max Daily Coal} = \frac{\textit{Annual coal quantity} * \textit{number of hours used per day} * \textit{coal unbalanced coefficient}}{\textit{Annual use hours}}$$

- Coal unbalanced coefficient: 1.2
- Truck capacity: 30 t

Sea Transport

Project Coal will be shipped via super Handymax/Panamax vessels from South Africa to Gwadar as per the design coal specifications. The total shipping time will be 20 days: 2-3 days for coal loading at the Richard Bay Terminal; 15 days at sea; 2-3 days for coal unloading at the Port.

Inland Transport

The coal will be either be unloaded and moved to the terminal yard for storage or loaded directly on to trucks through the loading system and transported to the site. The distance between the Port and the Project Site is about 40km.

Coal Receival System

The upper part of the vehicle unloading device is semi-open, with a span of 15m and a column spacing of 10m. Each column spacing has two unloading lots. Unloading parking spaces are designed to accommodate five (5) trucks at one time. There will be two (2) shifts a day, and each shift will span over five (5) hours. The hourly unloading frequency will be approximately 13 trucks.

The lower part of the coal unloading unit is a double seam sewer. Under the sewing coal slot are the dual belt conveyors; each belt conveyor is equipped with two bridge impeller coal feeders with an output ranging from 100 to 500 t/h.

The coal unloading device is equipped with vibrating coal levelling grate to remove the accumulated coal. In order to prevent the coal chute from blocking, the coal tank wall is equipped with the polymer wear-resistant liner.

Coal Storage

The Project plans to set up an open bar bucket wheel stacker reclaimer coal field given the annual coal requirement. Given the Project Site is affected by the monsoon, the coal field is designed to accommodate that; the annual integrated number of days affecting the terminal coal unloading operation is 65 days, and the number of consecutively-affecting days is not more than 45 days. Keeping that in mind, the plant coal yard is designed based on 60 days storage. There will be two coal piles in the coal yard, each with a length of 350 m, a width of 45 m, a height of 14 m and a total storage capacity of 17.7×10^4 t. Wind dust restraining measures shall be put in place around the coal yard.

The coal yard envisages a bucket wheel stacker with rated pile material output of 400 t/h, rated reclaim capacity of 200 t/h and one (1) road belt conveyor. Bucket wheel stacker reclaimer has the shunt function, to shunt coal about 200 t/h to the coal warehouse, and the rest shunted to the coal field for storage. The coal yard is equipped with two coal briquettes and a loader, which, as the coal storage site transport and underground coal hopper coal supply auxiliary equipment, can improve the utilization of the coal field.

To ensure the safety of coal system, the coal field also has an underground coal bucket for emergency coal supply, and the coal can be supplied by coal pusher and coal loader. The underground coal hopper sets a vibration feeder, with rated output of 200 t/h; under the vibration feeder, a single belt conveyor is set with rated output of 200 t/h.

Screening System

The crusher room is arranged after the coal field, and two (2) sieving and crushing equipment are set to match with the two-way belt conveyor system. One will be running and the other will be used as a spare, or in certain cases the two will be running simultaneously but only for a short period of time. The ring hammer crusher is used with output 150 t/h, feed particle size ≤ 300 mm, and discharging granularity ≤ 30 mm. The roller screen is used with the output of 200 t/h, feed size ≤ 300 mm, and discharging granularity ≤ 30 mm.

Conveyor Belt

The conveyor belt in front of the coal yard is designed as: width= 800 mm, velocity= 2.5 m/s and quantity= 400 t/h. The conveyor belt after the coal yard is designed as: width= 800 mm, velocity= 1.6 m/s and quantity= 200 t/h. Similar to the coal yard ground belt, the belt conveyors are of two-way setting, one will be running and the other will be used as a spare.

The coal handling system is for three-shift operation, and will run approximately six (6) hours per shift. In the coal unloading system and the coal yard output and the transhipment into the main power house, there are the belt conveyor telescopic device or electric baffle tee, which can achieve cross-running. The bunker bay belt conveyor floor adopts the economical and reliable electric double-sided plow unloader for coal blending.

Control Mode

Coal handling system adopts two ways, program control and local control.

Ancillary Services

The project shall have the equipment for coals- entering the complex and the furnace-, sample preparation and measurement, calibration, deironing, and wastewater treatment etc. In order to prevent the coal yard dust from flying and coal from spontaneous combustion, water spray devices surround the coal yard. In order to prevent the coal dust in the bridge puddle (road) from flying, the spray dust removal device is set at the belt conveyor outlet. The transfer station, crushed coal room, coal warehouse and coal pushers are equipped with hangers for the lifting of equipment. Coal handling system is equipped with lighting, communications, fire, ventilation, dust and other facilities.

6.9.2 Ash Management System

Major Design Principles

The ash removal system takes the unit design (therein ash library, ash library gasification fan room, ash machine, etc. are shared by the two furnaces). System design principle are based on safety and reliability, sound economics, water preservation, efficient land utilization, and creating conditions for the comprehensive utilization of ash.

The plant ash removal system of the project adopts the ash and slag separated removal method. The ash and slag separation and removal systems, that is, mechanical slag removal system, dry ash pneumatic ash removal system, are applied.

The ash removal system consists of the following three parts:

- Fly ash part: Economizer ash bucket and dust collector ash bucket. Fly ash is collected into the ash silo by the dry ash concentrated phase pneumatic conveying system. Design range is from the economizer ash bucket and dust collector ash bucket flange outlet to the ash warehouse exit dry, wet ash loading external transport place.

- Boiler bottom slag part: the mechanical slag removal system is applied. The design range is from the boiler slag outlet to the slag outlet loading and transport place.
- Reject part: From the coal mill reject outlet flange as the design boundary line, to the moving reject bucket beneath the buffer reject bucket outlet, and the battery forklift transport to the loading point for external transport.

Ash Content

The ash content of the Project is calculated as follows:

Table 10.4 - Ash Content

Item		2 x 150 MW	
		Design Coal	Check Coal
Annual ash and slag amount	10^4 t/a	16.96	11.99
Annual ash amount	10^4 t/a	15.26	10.78
Annual slag amount	10^4 t/a	1.70	1.19
Annual reject amount	10^4 t/a	0.46	0.49

Assumptions:

- *Annual operation hours are calculated as 7,446 hours*
- *The amount of ash is calculated as 90% of the total amount of ash*
- *The amount of slag is calculated as 10% of the total amount of ash/slag*
- *The amount of reject is calculated as 0.5% of the boiler coal consumption*

Bottom Slag Handling System

The bottom slag handling system of the project will adopt a dry bottom slag handling system. The high-temperature slag will be sent out by the slag conveyor, cooled and then discharged into the slag storage. Strip slag machine will have a normal output of 2 t/h and a maximum output of 8 t/h. Stored slag will be loaded through the unloading device and transported outward for use or transported to the ash yard for rolling storage. Slag pit will have a mechanical seal. The slag storage will be able to store the design coal for about 18 hours; after humidification and stirring, the slag will be sent to the ash yard. Each furnace will be equipped with a steel strip conveyor, a slag crusher and a slag storage tank.

Fly Ash Handling System

The fly ash handling system will have a positive pressure pneumatic conveying system to concentrate the fly ash discharged from the economizer and electrostatic precipitator ash bucket to the ash silo; the dry ash, through humidification and mixing, will be sent to the ash yard with a sealed dump truck; in the future, it can be transported to the user for utilization.

Reject System

The Reject Processing System will consist of a total of eight (8) buffer reject buckets (by coal mill equipment) and eight (8) mobile reject buckets, and two (2) battery forklifts. The reject discharged from the buffer bucket will be transported by the battery cart to the vicinity of the slag storage and then transported to the ash yard or utilized.

6.9.3 Ash Yard

Design

According to the current actual development of Gwadar, not considering the comprehensive utilization of According to the current actual development of Gwadar, not considering the comprehensive utilization of ash, the planned ash yard shall have the capacity to accommodate entire ash production over the 30 years of the PPA. The ash yard will be located in the north of the site, covering land area about 60 ha. The geologic conditions of the ash yard area are consistent with the plant site area.

After the ash yard will be flattened, it will be excavated 3 m downwards as the ash silo bottom. The dam top is about 8 m from the bottom of the ash pile. The silo will be able to accommodate a maximum heap surface of 13 m from the bottom of the pile. A road will be constructed to connect the ash yard with the power plant. The outer slope of the dam is 1:2 and the inner slope is also 1:2. In order to prevent the ash from flowing out of the dam, a 300mm thick sand and gravel cushion, HDPE geomembrane and a 200mm thick sand and gravel cushion will be constructed on the inside of the dam and the bottom of the dam.

Given the climate, the reservoir ash water will naturally evaporate. The drainage system will be comprised of a main blind ditch plus several branch blind ditches to collect the rain from several points in the ash yard and discharged to the ash water clarification pool behind the dam; the clarified water is pumped to the ash yard for spraying.

Ash Yard Operations

The equipment to be used for the ash yard is the following:

Table 10.5 – Ash Yard Equipment

Item	Quantity
TYZ20 type crawler bulldozer	1
YZT-12 vibratory roller	1
Self-propelled hydraulic shovel	1
WX144AS type sprinkler	1
Yard spray gun	1

Environmental Protection

The environmental protection measures taken by the project ash yard are as follows:

- Ash yard seepage protection is achieved by laying polyethylene composite geomembrane (two cloth and a membrane), specifically as follows: After achievement of the required depth, the surface will be laid by 200mm thick gravel layer as a geomembrane support cushion, which is covered by the polyethylene composite geomembrane (two cloth and a membrane), and the 300mm thick sand and gravel layer is laid on the geomembrane and compacted to protect the geomembrane achieving the desired permeability coefficient.
- Ash yard has vehicle rinse area where the vehicles and machine going out of the ash yard shall wash the coal ash attached.
- Ash yard shall include about 10m wide isolation zone and takes measures to prevent fly ash according to the site conditions.
- Ash yard sets up environmental monitoring wells, and monitoring units should set up, not less than 3 monitoring wells under the ESIA requirements, for regular monitoring of groundwater conditions

6.10 Water Supply System

The water supply system is divided into fresh water supply and seawater water supply system. Fresh water is mainly used for chemical water treatment system supply water, industrial service water (including air preheater rinse water, coal field sprinkler and coal feeding system flushing water, ash removal system water, air conditioning supplementary water, etc.), fire water and domestic/potable water; seawater is mainly used for circulating cooling water.

6.10.1 Seawater Supply System

Circulating Cooling Water Volume

The circulating cooling water is intended to use a once-through cooling water supply system. The circulating water cooling magnification is selected according to 70 (determined after the next cold end is optimized); the circulating cooling water volume is shown in the following table:

Table 10.6 – Circulating Cooling Water Volume

Installed Capacity (MW)	Condensation volume (t/h)	Condenser cooling water volume (m^3/h)	Auxiliary water consumption (m^3/h)	Total water demand (m^3/h)
300	664	46,480	5,500	51,980

Note: the above volumes are tentative

Drainage System Layout

Circulating cooling water system water inlet and out layout basically follow the principle of "deep inlet and shallow outlet", and the power plant cooling water supply intends to use the once-through water supply system, regardless of the expansion of the site; water supply process is as follows:

Site sea area → inlet and diversion tank culvert → forebay → circulating water pump house → circulating water supply pipe → condenser → circulating water drain pipe → siphon well → drainage tank culvert →drain.

Seawater drain temperature requirements temporarily refer to the implementation of the Pakistan HUBCO project, the layout of the circulating water system structures should be adjusted and optimized according to the natural conditions and the ESIA opinion, and finally determined according to the numerical simulation of thermal discharge and physical modelling experiment while eliminating the recirculation risks.

Circulating Water Supply System's Main Equipment

Unit cooling adopts the unit direct flow water supply system, meeting the maximum calculation water volume of the unit, a 150MW unit warrants two circulating pumps. Considering the large number of hours available in the power plant, the two units set-up has a spare pump to improve the reliability of the circulating water system. Each pump unit flow channel is equipped with a rotating filter and a trash rack. The pump is equipped with an outlet valve; the pump room and the water inlet equipment are of open-air layout.

Water Supply System: Major Structures

A. Water intake and diversion culvert

According to the principle of "deep water abstraction", the water intake should be arranged near the 7m water depth line, which can meet the requirements of deep water abstraction, and can reduce the impact of the outer wave on the water intake. Intake intends to take the form of box type reinforced concrete head. The geometric parameters of the head are determined as follows:

Water intake window top edge elevation: -2.5m Orifice design flow rate: 0.59m/s

B. Diversion box culvert

The gravity flow box culvert connection is applied between the circulating cooling water intake to the circulating water pump forebay, Diversion box culvert project is designed according to the planned total installed capacity (2 × 150MW), and will open channel to the pool in front of circulating pump room with the length of about 700m.

C. Circulating water pump room

Power plant unit cooling water adopts the unit direct flow water supply system with machine equipped with two pumps; the Project's two 150MW units shall have a circulating water pump room where five vertical ramp pumps are provided. Pump and its ancillary equipment (outlet control butterfly valve, rotary filter, cleaning machine, maintenance lifting crane) are of open-air layout.

D. Circulating water pressure inlet pipe

Each unit circulating water pump outlet steel pipe is combined from 2 × DN1200 into a single DN1800mm unit water supply manifold, and the flow design flow rate is 2.84m/s. Two units shall also share a siphon well.

E. Circulating water drains

Circulating water drains are the cast-in-place, double-hole reinforced, concrete box culverts, a hole for a unit, the cross-section geometry of each hole with a design flow rate of 1.81m/s.

6.10.2 Freshwater Supply System

The Project envisages generating fresh water through desalination of seawater. Fresh water is mainly used for boiler water supply, industrial water, desulfurization system water, air preheater flushing water, coal field spray and coal handling system flushing water, ash system water, air conditioning water, fire water and domestic water, etc. The supplementary water consumption is estimated at 133m3/h.

The current project water purification station is designed in accordance with the requirements of the 2 × 150MW system, and the pre-treatment seawater coagulation, sedimentation, filtration, other facilities as well as storage tanks, integrated pump room are set accordingly. After purification or disinfection, the pure water is sent to the plant industrial water and living water pipe network for use by the relevant users of the system. Seawater desalination process is explained in the following section.

6.11 Chemical Water Treatment System

6.11.1Water Source and Quality

Water is taken from the sea, and the desalinated water will be used as the fresh water source. At the present stage, the water quality data will be used as the design input of the project. In the next stage, the developer shall perfect the water quality analysis data to serve further as the design input of the seawater desalination and desulfurization systems.

Table 10.7 - Water Quality Analysis

Analysis Item	Unit	Content	Analysis	Items	Content (mg/L)	Content (mg/kg)
PH	\	8.20	Cation	K^{+}+Na^{+}	\	
Total Alkalinity	mg/L	\				
Total Hardness	mg/L	\		NH_4^{+}	\	

Temporary Hardness	mg/L	\				
Permanent Hardness	mg/L	\		Ca^{2+}	551.26	
Negative Hardness	mg/L	\		Mg^{2+}	1,388.31	
Free CO_2	mg/L	0.00	Anion	In total	\	
Aggressive CO_2	mg/L	0.00		Cl^-	16,165.20	
Total Mineralization	mg/L	\		SO_4^{2-}	2,134.26	
Total Acidity	mg/L	\		NO_3^-	\	
Acidity of Strong Acid	mg/L	\		HCO_3^-	131.93	
				CO_3^{2-}	11.28	
				OH^-	\	
				In total	\	
			In total		\	

6.11.2 Water Vapour Quality Standards

The project is made-in-China ultra-high-voltage coal-fired advanced unit, and the quality of water vapor is 12.7-15.6 MPa steam drum steam quality as per the national standard *Thermal Power Units and Steam Power Equipment Water Vapor Quality* (GB/T12145-2016).

6.11.3 Various Water Loss of Power Plant

Normal water vapour loss of the Project is shown in the table below:

Table 10.8 – Water Vapour Loss

	Loss Category	Loss (t/h)
1	Loss of water vapour cycle in the plant (including cold water loss, etc.)	19
2	Loss of blast furnace blowdown	10
3	Total	29

6.11.4 Sea Water Desalination System

System Process Flow

Desalination system water is mainly used as industrial water, living water and boiler supply water. Both thermal and membrane processes are mature and can be applied to this project. Comparison of membrane and thermal desalination technology is shown in following table:

Table 10.9 - Membrane and Thermal Desalination Comparison

	Item	Reverse Osmosis Seawater Desalination (SWRO)	Multi-effect distillation (MED)
1	Pre-engineering water production conditions	Water can be produced when the water source is available	Steam and power are needed; in in the early commissioning, fresh water resources are needed; fresh water resources are not available near the site, so an RO desalination system is needed to produce fresh water.
2	Product water salinity	≤ 20mg/L (secondary reverse osmosis water)	3-10 mg/L
3	Working temperature	Room temperature	~70°C
4	Water quality requirements	SDI <5, turbidity <1NTU, the pre-treatment system is more complex	Turbidity <50NTU, pre-treatment system is relatively simple
5	Energy consumption	Power, low total energy consumption	Electric energy and heat, the total energy consumption is high
6	Raw water use efficiency	40-45%	20-40%
7	Operational flexibility	Separated running, high operation flexibility	50-110%
8	Operation and maintenance	Daily maintenance: The regular chemical cleaning on the membrane is needed, about once every 3-4 months; Replacement of main equipment: Need to regularly replace the membrane components, about once every 3 years; If the system is out of service for a long time, add disinfectant to the system. Regularly replace disinfectant.	Daily maintenance: Need to regularly clean the heat exchanger, once every 1-2 years. Replacement of main equipment: The main equipment is basically not replaced; If the system is out of service for a long time, no special maintenance is required. Simply rinse the equipment and vent it.
9	Influence of sea water temperature on system operation	There is a certain impact, as the temperature increases, the desalination rate decreases.	Less impact
10	Main equipment life	More than 20 years, but need to replace the membrane components every 3-5 years	More than 20 years

11	Cleaning cycle	3-4 times a year	3-4 times a year
12	Cost of investment	Low	High
13	Operation costs	Low	High (Large heat consumption)
14	Coverage	High	Low

This shows that the membrane method has small equipment investment compared to thermal method; the unit cost of water is low; based on comprehensive technical and economic considerations, the membrane seawater desalination process is recommended for this project.

The main process of desalination system is as follows:

Seawater booster pump → inclined plate sedimentation tank → seawater clean water pool→ ultrafiltration water pump → ultrafiltration self-cleaning filter → ultrafiltration device → ultrafiltration tank → seawater reverse osmosis water pump → seawater reverse osmosis security filter → seawater reverse osmosis high -pressure pump → seawater reverse osmosis device (with energy recovery device) → seawater reverse osmosis water tank → desalinated water reverse osmosis water supply pump → desalinated water reverse osmosis security filter → desalinated water reverse osmosis high-pressure pump → desalination water reverse osmosis device → pre-desalination tank → users

System Output

Seawater reverse osmosis system design output is 2 × 94t/h, one running and the other spare. Desalted water reverse osmosis system design output is 2 × 80t/h, one running and the other spare.

1. Seawater reverse osmosis system effluent quality: TDS:300~500mg/L
2. Desalted water reverse osmosis system effluent quality: TDS: ≤15mg/L
   Boron: ≤0.5mg/L

6.11.5 Boiler Make-up Water Treatment System

System Process Flow

The boiler make-up water treatment system intends to adopt the technological process as follows:

Desalination system feed water pump → fresh water reverse osmosis security filter → freshwater reverse osmosis high pressure pump → fresh water reverse osmosis device → fresh water reverse osmosis water tank → EDI feed pump → EDI security filter → EDI device → desalination tank → unit normal water pump / Unit start supply pump → main power house.

System Design Output

According to the whole plant water vapour loss and the system self-water consumption rate, the project boiler feed water treatment system design output is 2 × 30t/h, one running and the other spare.

System Effluent Quality

Conductivity (25 °C):	≤0.20μS/cm
Silica:	≤20μg/L
TOC:	≤400μg/L

6.11.6 Circulating Water Treatment System

In order to prevent the sea organisms' adhesion and growth in the cooling water system, thereby affecting the cooling system flow area, and reducing the heat transfer efficiency of the condenser and producing corrosion, the cooling water sterilization is needed. The design of the project adopts sodium hypochlorite produced by electrolytic seawater for sterilization and algae and other sea microorganisms' removal.

Electrolysis sea water chlorine system design output 2 × 32kg/h, the process is as follows: Circulating water pump master tube takes sea water → seawater pre-filter → seawater booster pump → automatic flushing filter → sodium hypochlorite generator → sodium hypochlorite storage tank → circulating water pump front pond. The sodium hypochlorite solution in the tank is gravity-fed to the circulating water pump forebay.

In addition, the solution also envisages usage of sodium hypochlorite solution dosing system spared for electrolysis sea water chlorine producing system.

6.11.7 Water Supply, Boiler Water Chemical Correction Treatment

Condensate, Feed Water Ammonization System

In order to prevent the acidic corrosion of the thermal system, the condensate and water ammonisation treatment is needed. Two (2) units share a set of condensates, water supply ammonia device, which is equipped with two (2) electric stirring solution boxes, three (3) condensate water ammonia metering pumps and three water supply ammonia metering pumps.

Water Supply, Cold Water Hydrazing Dosing System

The purpose of the feed water hydrazine treatment is to remove dissolved oxygen from the water and prevent the oxygen corrosion of the thermal system. Two (2) units set up a hydrazing dosing equipment, with a total of two mechanical mixing solution boxes, three (3) dosing pumps, and the hydrazing dosing point is the inlet of the feed pump. The device reserves the dosing port of the boiler stop protection device. The standby pump can be used as a closed circulating cooling water dosing pump.

Boiler Water Phosphate Dosing System

The purpose of the boiler water phosphate dosing treatment is to prevent the boiler heating surface pipe wall from generating calcium and magnesium scale, and extend the boiler chemical cleaning cycle. Two (2) units set up a phosphate dosing device, a total of two (2) mechanical mixing solution boxes and three (3) dosing pumps. Phosphate solution is directly dosed into the boiler drum, with the manual adjustment of dosage. Ammonia plant, hydrazine plant and phosphate plant are installed in the main power house.

6.11.8 Steam Water Chemical Sampling Monitoring

In order to supervise the water vapour quality of the thermal system and ensure the safe and economic operation of the unit, each unit shall have a water vapour centralized sampling and analysis device. It consists of high temperature frame and instrument panel (including artificial sampling plate). The sample water is cooled by closed circulating cooling water. Sampling points and instruments are configured according to requirements for the steam drum unit in *Technical Regulations for the Chemical Water Design in Thermal Power Plant* (DL 5068-2016). The water vapor centralized sampling analysis device of the two (2) units is arranged in the main power house.

6.11.9 Industrial Waste Water Treatment System

Effluent Requirements

The effluent quality of the industrial wastewater treatment system must meet the Pakistan National Environmental Quality Standard (NEQS) before discharge.

System Process Flow

Industrial wastewater treatment system process is as follows:

Figure 12 - Industrial Wastewater Treatment

Plant industrial wastewater →→ waste water storage tank →→ lift pump →→ pH adjustment pool - mixing pool - reaction pool

↑ ↑ ↑ ↑ ↑ ↑

Compressed air hypochlorite sodium acid, alkali acid, alkali, coagulant coagulant aid

↓ ↓

→→ Slant plate clarifier →→ filter →→ the final neutral pool →→ reuse pool →→ lift pump →→ reuse, discharge

↓ coagulant dehydrating agent return to the waste water storage tank

↓ mud ↓ ↓

Sludge thickening tank →→ sludge dewatering machine →→ dry mud transport

↓ effluent

Equipment drainage →→ intermediate pool →→ waste water storage tank

6.11.10 Transformer Oil Purification

The whole plant is equipped with a set of mobile transformer purification facilities to purify the transformer insulation oil.

6.11.11 Chemical Laboratory

The Project envisages a chemical laboratory equipped with a full set of water, coal, oil analysis equipment.

6.12 Black Start

Because of the unreliable power supply from the local power grid, the project shall set up its own black-start generator system to drive the self-starting of the unit of the Project without the grid power supply.

The self-starting power supply shall be provided by from a container type diesel generator set. The specific configuration of the black start capacity shall be based on the unit capacity of selected generator.

6.13 Start-up Fuel Storage and Supply System

Start-up Fuel Storage and Supply System shall be provided in the site, and will be integrated with the power supply for construction. Integrated tank and pump system design for start-up fuel storage and supply shall be considered.

The Project adopts low-oil-content ignition system to save oil. The fuel of boiler ignition and combustion supporting is light diesel oil. The light diesel oil is transported to plant by tanker lorries. Two centrifugal oil feed pumps with 50% capacity (one for operation, one for standby) are furnished.

The oil supply mains and oil return mains are installed with electromagnetic quick closing valve respectively to quickly cut off the boiler oil pipeline and ensure boiler safety.

The oil system is equipped with steam purge system to purge oil gun nozzle and fuel oil in the pipeline drawing steam from auxiliary steam system. It is provided by auxiliary steam system during start.

6.14 Thermal Automation

6.14.1 Control Mode

The Project uses the centralized control of machine, furnace and electricity. Two units are set up in a control room. A function of Fast Cut Back (FCB) is set for the units of the Project. The Project uses an automation network consisting of Plant-level management information system (MIS), Distributed Control System (DCS) and control system for balance of plant system. A design principle of control function distribution and information concentration management is implemented.

Distributed control system (DCS) is used for boiler, turbine, generator and electric system of the Project. The centralized control mode shall be conducted on the boiler, turbine, generator and electric system as well as balance of plant. Central Control Room (CCR) is set with the principle of "one CCR for two units". Operator can make monitoring and adjustment under normal operation condition of the unit and emergency treatment or shutdown under abnormal operation condition of the unit at central control room.

BOP control network shall be set for water, coal and ash area, which adopt the same hardware as unit DCS, is used to centralized data acquisition, sequential control, alarm, and other functions of monitor and control for all auxiliary workshops (systems). There is not provided other monitoring and control equipment and mimic panels respectively. Local control room for Water, coal and ash system shall be respectively set to complete monitoring for water, coal and ash system. Meanwhile, operator stations for BOP control network shall be set at CCR to monitor and control all auxiliary workshops.

Backup monitoring equipment and conventional display instrument are not required to set in central control rooms, and only a few of hard-wired control switches and button independent of DCS that are used for accident emergency operate are kept. Display wall shall be set in central control room to arrange industrial grade LCD flat panel display and LED display.

Control scope of unit Distributed Control System (DCS) covers unit process system, generator/transformer group and auxiliary power system. DCS shall at least include DAS, MCS, SCS, FSSS, and other functions. Bypass control system, boiler soot blowing system, slag removing system, SCR denitration system, generator/transformer group and auxiliary power system, circulating cooling water system, and other unit process systems shall be included in unit DCS system. Common DCS network is set, of which control scope cover common part of auxiliary power system, compressed air system, and other common auxiliary system. Common system can be monitored and controlled by either unit DCS operator station. Interlocking of two units operate should be set.

Steam turbine digital electro-hydraulic (DEH), steam turbine emergency trip system (ETS) and steam turbine supervisory instrumentation (TSI) shall be provided with turbine. ETS and DEH should adopt integrated design. Signal exchange between DCS and TSI are realized by hard-wired.

Each unit is equipped with vibration monitoring and analysis system (with one set of workstations) to complete vibration monitoring and fault diagnosis and analysis of steam turbine generator unit and main auxiliary engine (primary air fan, forced draft fan, induced draft fan, condensate pump, feed water pump and circulating water pump), and the analysis results and guide information shall be send to MIS by communication mode.

One set of flame detection system is set for each boiler to connect with DCS by hard-wired.

Controllers, communication modules, I/O cards and cabinets of control system involved in single unit and common parts in auxiliary network control system, such as ash removing and slag removing system, shall be respectively set at #1unit, #2unit and common system.

To make operator monitor important equipment in plant during system start-up, operation and shutdown, one (1) set of full digital closed-circuit television system is set for the whole plant in the Project. Surveillance camera points shall be set at unattended sites and important areas affecting unit safety and power plant security areas.

Simulation system shall be set for the Project to train operators.

6.14.2 Automation Level

1. The centralized control will have a high level of automation. In the centralized control room, the control system centred by the decentralized control system DCS will, in a variety of operating conditions, complete the main and auxiliary unit parameters control, loop adjustment, interlock protection, sequence control, display alarm, print records, analysis calculation and so on. With the cooperation of a small amount of local operations and tour inspection staff, the centralized control room can achieve

the start of the unit, the normal operation condition monitoring and adjustment, shutdown and accident handling.

2. Functional scope of the control system: DAS, MCS, SCS, FSSS, ECS functions and DEH function in DCS system are achieved by the same type of control system. This kind of scheme can reduce the hardware types, the spare parts types, the maintenance work amount and the system interface as well, but the DEH subsystem supplier shall have the experience of adopting DCS system. It will be studied and determined specifically in the engineering design stage.
3. When the DCS system fails, the unit has emergency backup safety shutdown measures, that is, retain the hard-backup operation of some important equipment (such as emergency boiler shutdown, emergency unit shutdown, steam turbine AC and DC oil pump start, generator-transformer circuit breaker emergency trip, etc.).
4. Thermal automation equipment: FSSS logic part is realized by the DCS, and FSSS local equipment will be supplied by experienced manufacturers. Actuators consider the equipment with successful use experience in China's power plants, such as Rotork, SIPOS, EMG, etc. Transmitters consider the use of products with good quality and reliable operation, such as: EJA, Rosemount, Honeywell, and other international brands.

6.15 Civil

6.15.1 Building

Main Powerhouse Layout Principles

The main power house follows the layout order of the steam room, deoxidization bunker bay and boiler room. The Project is intended to use the unit system unit-boiler-power centralized control mode; temporarily a central control building is set according to the size of one control building for two units; the new control building is arranged between both the boilers after the steam room.

Turbine generator units are arranged in a transverse direction. Between the two units, the equipment lifting and maintenance site is provided. The boiler is fully arranged outdoors. The top of the boiler is equipped with a rainproof cover. The main power house and boiler are made of steel frame structure.

Workshop Configuration

1. Steam room layout

Steam turbine room is of the closed type. The turbine is arranged in the transverse direction. From the unit 2 head, the heater is arranged on the left side of the unit.

The steam engine room is arranged in three floors, in which the working floor is 9.00 meters, the heater platform is 5.0 meters and the bottom floor is 0.00 meters. The motor-driven variable speed feedwater pump is arranged on 0.00 m ground in the middle of the two units; oil cooler, filter, lubricating oil pump are arranged on the 0.00 m ground outside of the two units. 2 high-pressure heaters, 4 low-pressure heaters and steam heaters are arranged on the 5.00m heater platform inside the two units.

The maintenance site is set on 0m floor in the middle of the two units; two variable speed feedwater pumps are arranged on the maintenance site by column B; the main engine tank arranged on 5m floor nearby by column A, which is far away from the high temperature pipeline in order to prevent fire.

Steam engine room selects a 75/20t crane, rail top elevation of 20.57m, driving crane lifting limit height is 18.994m for the big hook, and 20.95m for the small hook, which can meet the lifting requirements of turbo-generator equipment and ancillary installation maintenance. The turbine roof frame lower chord elevation is 24.50m.

2. Deoxygenation bunker bay layout

The deoxygenation bunker bay is of a single-span frame structure, span of 13.5m, column spacing of 8m, with a total of 7 columns spacing, total length of 56m, and the staircase is set at the fixed end. The deoxygenation bunker bay is divided into the bottom, coal feed machine floor (12.60m), deoxygenation floor, and coal belt floor.

3. Boiler room

The boiler is of open-air layout, steel frame structure with a small top cover, and a closed water room is set in front of the steam dome. Boiler 9.00m operation layer is the concrete floor, the part below the operating layer is not closed, and a passenger-and-freight elevator is provided. The bottom of the boiler room is arranged with primary fan and secondary fan. Each boiler is equipped with a passenger and cargo elevator, which can lead to the main floors of the boiler platform.

4. Central control building

The current project is intended to use the unit system unit-boiler-power centralized control mode; temporarily a central control building is set according to the size of one control building for two units; the new control building is arranged between 1# and #2 boilers behind the steam room.

5. Boiler rear

Behind the boiler there are regular discharge expansion tank, sewage cooling wells, electrostatic precipitator, pneumatic ash removal equipment, induced draft fan, flue and chimney, which are all arranged in the open air. Two boilers share a chimney. The flue is connected to the chimney from both sides. The chimney is of sleeve chimney, with a height of 180m, tentatively double inner tube structure, and the export diameter of 5m. This configuration is subject to ESIA report findings.

The locations of the main equipment in the main power house are shown in the "Main Power House Layout Plan" and "Main Power House Layout Plan."

Lighting and Ventilation

According to the *Architectural Lighting Design Standard*, the main power house is of the V-class lighting standards, which is based primarily on natural lighting and supplemented by artificial lighting. Steam turbine room adopts the ventilation of natural air inlet and mechanical ventilation. In the other rooms with equipment heating or staff concentration, the mechanical ventilation or air conditioning is adopted according to the technical and health requirements.

Living and Sanitation Facilities

The main power house and centralized control room, the central control building, shall be equipped with men and women bathrooms; in the appropriate parts, the washing pools and clean rooms are provided to meet the operational staff and maintenance personnel requirements.

Waterproofing and Drainage

The main power house underground facilities and channels shall have adequate waterproofing measures, where and when required; the drainage ditch and catchment wells are set in the appropriate location; if necessary, the self-starting pump can be started for timely discharge.

Fire and Explosion Resistance

The main power house fire hazard category is class D, and the fire rating shall not be less than II; the building components are generally non-combustion materials; the main power house fire safety measures, the layout of the evacuation stairs are subject to the current national standard *Architectural Design Fire Safety Norms, Thermal Power Plants and Substation Design Fire Safety Norm*; the control room interior decoration is subject to the current national standard Interior Decoration Design Fire Safety Norms.

The main power house explosion-proof measures lie in that primarily the deoxygenation floor adopts a solid overall framework and flooring. Turbine roof sets up the roof ventilator to discharge leaked hydrogen and hot air, to avoid the accumulation of flammable and explosive gases.

The gas fire rooms are designed according to the corresponding gas fire extinguishing system design specifications "protection zone settings".

Anti-Corrosion

In order to reduce the salt fog corrosion environment influence, construction component anticorrosion measures, specifically for this project, shall be adopted.

Typhoon Prevention Measures

The typhoon damages to power plant buildings mainly are as follows: windows and doors curtain wall damage, profiled steel plate outer wall plates, roof panel blow-off, building roof attachment equipment collapse, exterior seepage, rain water flow backward causing flooding in the indoor equipment, etc.; for this purpose, appropriate measures to protect, windows, doors shall be incorporated in the design. For main building facade shutters, including herringbone shutters, shall be considered to provide adequate protection. Equipment pieces out in the open shall be provided with adequate wind resistance architecture, supports, suspension etc.

6.15.2 Structure Design

The seismic fortification intensity is considered as 8 degrees, the horizontal peak ground acceleration(PGA) is 0.32g, and the basic wind pressure 0.6 kN/m^2.

According to the proposed plant area topography and collected geological data, the main plant building (structure) foundation shall be of natural type.

Other major producing building (structure) design is as follows:

1. Chimney: tube-in-tube stack, the outer cylinder shall be of cast-in-situ reinforced concrete structure, with the height of 180m; inner diameter of the outlets of the two steel inner tubes shall be consistent with the appropriate flue gas flow rate. The anti-corrosion material of steel inner tube should be titanium composite material. The elevator should be set inside the stack. The stack height shall be subject to ESIA report. The foundation type is natural foundation.
2. Flue bracket, induced draft fan, etc. are used steel structure. The foundation type is natural foundation.
3. Coal handling station, coal convey bridge using steel structure, pressure steel plate enclosure, connecting the main building section of the bridge is higher, the use of steel column + steel truss structure, pressure steel plate enclosure. Foundation type is independent foundation of natural foundation.

Other building structures are, in principle, steel structures, and are based on natural foundations.

The above foundation forms should be determined on the basis of a more detailed geological survey report. In case of a localized weak layer, the Project may consider appropriate adjustment to the form or the basis of the size of the natural foundation, or the use of gravel or concrete fill.

6.16 Fire Protection System

6.16.1 Main Principles for the Fire Design

The fire protection system is designed according to the NFPA standard.

Power plant fire protection system follows the main design principle of "prevention first, combining prevention and extinguishing"; according to its process characteristics, the choice of equipment and materials and process system layout shall consider the requirements of the fire protection, and corresponding measures are taken in all the system to prevent the happening of the fire, or prevent the spread of fire, which shall match the fire control facilities in the plant.

The power plant fire control facilities, according to different objects, respectively, adopt water firefighting system, gas fire extinguishing system and portable fire extinguisher, etc.; for the important buildings and equipment, the fire monitoring and automatic alarm system shall be set.

6.16.2 Main Fire Control System

Main elements of the fire control system, specific to specific locations and equipment pieces shall be deployed and are summarized below.

1. Water firefighting system
2. Fire hydrant extinguishing system
3. Automatic sprinkler system
4. Water spray extinguishing system
5. Water curtain fire isolation facilities
6. Gas fire extinguishing system
7. Foam fire protection system
8. Portable fire extinguishers
9. Fire alarm system

The fire detection alarm control system of power plant is envisaged to adopt the intelligent simulation system. The central control alarm system, shall be composed of the following main equipment: central fire alarm controller, fire linkage controller, regional fire alarm controller, fire emergency broadcasting equipment and fire communications equipment, CRT display device, detector, manual alarm button, sound and light alarm, and various modules, etc.

The central fire alarm controller, fire linkage control equipment, the CRT display device, fire emergency broadcasting equipment and fire communications equipment host shall be set in the control room of the centralized control building as the fire control centre of the project. The main power house operation floor and coal control room, respectively, set up regional fire alarm controllers and tripping devices.

6.16.3 Fire Engine Configuration

The project configures 2 foam/water fire engine according to 2 X 150 MW unit capacity.

6.17 Transmission and Interconnection

The existing Transmission voltage in and around Gwadar is 132kV, but the GoP has planned to build new 220kV substation and transmission line in Gwardar considering its rapid development, so the Project for this phase is proposed to be connected to the new 220kV substation with 220kV transmission line which will be provided by NTDC. An optional proposal envisages a connection to the existing 132kV substation locating in industrial park through 132kV transmission line. However, the final interconnection point and access method shall be determined by NTDC.

The two 150MW units for this phase are proposed to be connected with the GIS distribution unit in the new 220kV room in the power plant. The plant is connected to the planning 220kV substation with 220kV primary voltage. There are two loops of outgoing line of the 220kV distribution unit. Interconnection Point shall be at the outgoing gantry of the switchyard. The evacuation voltage and the ultimate evacuation infrastructure configuration is subject to the GIS findings and review / comments of the NTDC.

7. Flue Gas Desulfurization (FGD) and Selective Catalytic Reduction (SCR)

7.1 Flue Gas Desulfurization

7.1.1 Selection Process of Flue Gas Desulfurization

Following is a brief comparison between seawater desulfurization process and limestone / gypsum based wet method desulfurization processes as applicable to the Project:

1. Seawater desulfurization

Seawater from the seawater intake channel system is directly used for flue gas desulfurization, and no chemical substance is added during the desulfurization. The fundamental principle of the desulfurization can be expressed with the following equations. The sulfur dioxide in flue gas is absorbed with seawater, and is then converted into sulfuric acid after oxidation and aeration.

$$SO_2+H_2O+\frac{1}{2}O_2+=SO^2{}_{-4}+2H^+$$

$$HCO_3^-+H^+=CO_2 \text{ (gas and liquid) } +H_2O \qquad (2)$$

The reject water from the outlet of condenser is divided into two parts: absorber water and aeration water. Washing water flows to the water tank of seawater booster pump by gravity via diversion conduit from the rear of the siphon well of the Units; and then, the washing water is pumped to desulfurization absorber, where the washing water meets flue gas to scrub flue gas and to absorb its sulfur dioxide. The seawater with sulfur dioxide is piped to the aeration tank. Here the seawater that contains sulfur dioxide is mixed with another part of aeration water, from the reject water, in the aeration tank. The pH of seawater is restored to above 6.5 after oxidation and aeration treatment; and then, the seawater is discharged into sea via the discharge port.

The process equipment for seawater desulfurization mainly includes gas-gas heat exchanger, absorber, aeration tank, oxidation fan and seawater lifting pump, etc.

Seawater desulfurization process has major advantage for seaside power plants where seawater is available for cooling and its supply and drainage back into the sea is feasible with no or manageable environmental and recirculation issues. This process is characterized by simple process, reliable system and convenient operation and maintenance. The maintenance workload of system is little because this process uses seawater to absorb SO2, and other additives are not required.

The required desulfurization rate can be achieved under the condition that sulfur content of the coal is low and seawater salinity is suitable, etc., and so environmental protection requirements are met.

No solid wastes are produced, and there is no release of secondary pollution of waste slag, and, the occupation of stockyard and landfill is saved, thus minimizing the additional impact of FGD unit on environment.

However, the adverse sulfur content of coal, poor seawater salinity, the flow rate of reject water, water temperature, etc. could impair the efficacy of this option even when the power plant is located on the seaside. Similarly, the process, needs to blast air for aeration and aeration tank needs major area.

2. Limestone - gypsum wet method desulfurization

As for limestone-gypsum wet method desulfurization, limestone slurry is used to scrub and remove sulfur dioxide from flue gas, and to produce the by-product, gypsum.

The main process equipment for the limestone-gypsum wet method desulfurization includes gas-gas heater, absorber, slurry recycle pump, oxidation fan, etc. The process system mainly consists of absorbent preparation system, SO2 absorption system, flue gas system, process water system, gypsum treatment system, compressed air system and wastewater treatment system.

The range of application of this desulfurization process is wide and not necessarily restricted with the sulfur content of the coal and the capacity of plant. Desulfurization efficiency is high, inching above 95%.

This desulfurization process is characterized by a mature technology, wide application and reliable operations, and is the most extensively applied in the desulfurization process of coal-fired power plant in the world. Wet desulfurization accounts for about 90% of the total installed desulfurization capacity in the power sector.

As briefly described above the wet desulfurization system is complicated, with higher operation and maintenance workload. In addition to the body of desulfurizer and flue gas system, desulfurization process system includes accessory systems such as limestone storage, slurrying, gypsum recovery, discharge, wastewater treatment and the like. It consumes large amounts of limestone and fresh water resources.

Currently, desulfurization by-product, gypsum, is comprehensively utilized during. If this is impractical, then it must be stored or abandoned in ash yard or elsewhere, thus occupying valuable and generating dust emission, forming secondary pollution, which will need further management measures and costs.

Conclusions

Technically speaking, for the Project, both the options, sweater scrubbing and wed FGD are feasible. Since this project is on seaside, it is preliminarily judged that seawater parameters are suitable for seawater based desulfurization on the base of past engineering experience; for this reason, considering economic efficiency and maintenance performance, it is recommended to adopt seawater desulfurization. Subject, however, to any adverse findings by the ESIA, the final desulfurization process may be changed to wet FGD.

7.1.2 Source and Consumption of Desulfurization Absorbent

Desulfurization absorbent is the recirculating cooling seawater from the condenser. Seawater consumption is preliminarily estimated as follows:

Table 11.1 – Seawater Consumption

Seawater Consumption	Seawater Absorption System	Seawater Restoration System
Hourly Consumption (m^3/h)	14,000	35,000

Note: desulfurization efficiency is designed as 93%.

7.1.3 Seawater Drainage Quality

Design Basis Parameters: The temperature-rise of recirculating water, water with reject heat, resulted from seawater desulfurization is not expected to exceed 1.5°C. The recirculating water drainage is considered as per the following seawater quality:

Table 11.2 – Seawater Quality

pH	-	≥6.5
Dissolved oxygen (DO)	mg/L	>5

7.1.4 Assumption for Flue Gas Desulfurization Engineering

Table 11.3 – FGD Engineering (1)

Item	Unit	Design Coal	Check Coal
Sulfur Content as received basis (Sar)	%	1.04	0.88
Coal Consumption	t/h	61.4	66.1
Annual Coal Consumption (7,446 hrs)	$x10^4$t/a	45.72	49.22

Table 11.4 - FGD Engineering (2)

Item	Unit	Design Coal	Check Coal
Flue gas temperature at the discharge of induced draft fan	°C	124.17	122.26
Volume of wet flue gas at the discharge of induced draft fan (standard state, actual oxygen content on wet basis)	Nm^3/h	498,478	500,855
Volume of dry flue gas at the discharge of induced draft fan (standard state, actual oxygen content on wet basis)	Nm^3/h	460,097	458,859
Excess air ratio at the discharge of induced draft fan	-	1.422	1.407

Note: NO_x content after boiler economizer is lower than 350mg/Nm^3 (6% oxygen content in standard state and dry basis).

Desulfurization absorbent is the cooling seawater that leaves condenser. See the following sampling data on site as below regarding main water quality of inlet seawater:

Table 11.5 – Quality of Inlet Seawater

	Item	Unit	Value	Remark
1	pH	-	8.2	Tentative water temperature: 28°C
2	Alkalinity (carbonate)	Mg/L	11.28	
3	Alkalinity (biocarbonate)	Mg/L	131.93	

1. Desulfurization process system and equipment

Full flue gas desulfurization will be performed in this project, and the desulfurization system will adopt seawater desulfurization process, with desulfurization efficiency being no lower than 93%. The configuration of one boiler and one tower is adopted; the flue gas capacity to be treated is designed as per the flue gas capacity produced under the BMCR operation condition of boiler.

Flue gas system

The flue gas leaving dust precipitator is drawn out via the flue gas duct between the induced draft fan of the boiler and the stack; and then, the flue gas enters seawater desulfurization system. Flue gas passes through damper and gas-gas heater ("GGH") (if any); and then, flue gas enters the bottom of absorber and flows upward, where SO2 in the flue gas is removed. The clean flue gas leaving the absorber is discharged into atmosphere via outlet damper after being increased to certain temperature in GGH.

Advantages: minimize corrosion to stack; increase the uplift height of flue gas to reduce the ground concentration of pollutant; avoid the occurrence of "white smoke" generated in flue gas; prevent flue gas from producing condensate.

Disadvantages: increase resistance of FGD system; construction cost and operation cost are high; the long-term operation of GGH possibly results in corrosion issue; the system is complicated; GGH leakage rate may affect desulfurization efficiency; larger floor space is also a negative.

Based on comprehensive consideration and the Owner's opinion, it is tentatively considered that the desulfurization system is provided with GGH at this stage, and whether to install GGH will be determined after technical and economic comparison is performed at the preliminary design stage.

Absorption system

Each unit will be provided with a set of SO_2 absorption system, i.e., the configuration of one boiler and one tower is adopted.

The SO_2 absorption system is the core system of a desulfurization unit; a set of absorption system will be individually provided for a Unit. The flue gas to be treated enters absorber, where the flue gas meets sprayed seawater in a counterflow manner, to remove the SO_2 from flue gas; the entire absorption is accomplished in the absorber; the absorber is the main structure of this system.

Absorber can be of spray type empty tower or packed tower. Seawater absorbs the SO_2 from flue gas in the manner of one-off direct flow. Seawater enters spray bed from the upper part of the absorber, and is sprayed into the absorber via spray bed. Flue gas passes through the spray bed (packing bed) upward from the bottom of the tower, to fully come in contact with seawater; as a result, the SO_2 in flue gas is absorbed with seawater promptly. The scrubbed flue gas is removed of the water drop in the flue gas via the demister installed above the spray bed on the top of the absorber. This tower is tentatively designed as per spray system at this stage.

Seawater supply system

The seawater of the water supply system of desulfurization absorber comes from the drainage of the recirculating water of the Units. After the drainage of recirculating water passes through siphon well, a part of the drainage is pumped into the absorber with seawater booster pump to scrub the SO_2 in flue gas, and the acidic drainage produced in the scrubbing of flue gas flows to the seawater treatment plants (aeration tanks) of the two units by gravity from the bottom of the absorber; the remaining seawater directly enters aeration tank by gravity. Having absorbed the SO_2 from flue gas, the seawater flows to aeration tank by gravity from the bottom of the absorber; a great amount of the remaining seawater (the warm drainage of the recirculating water system) that does not participate in desulfurization directly flows to aeration tank to be further mixed and aerated with the acidic seawater from desulfurization absorber to restore seawater quality.

The seawater booster pump station is of indoor arrangement, and is arranged beside the absorber. The desulfurization seawater supply system of each Unit will include the water supply system of desulfurization absorber and the water supply system of seawater treatment (aeration tank).

Seawater restoration system

Cell-system seawater quality restoration system will be adopted for the Project. The seawater quality restoration system includes feedwater canal, water distribution tank, aeration tank, discharge canal and air-blowing aeration system. The front four parts will adopt combined reinforced concrete structure. The aeration tank is also divided into front mixing zone and tail aeration zone. A part of the alkaline seawater coming from the siphon well enters the front mixing zone of aeration tank via feedwater canal and water distribution tank, and is fully mixed and neutralized with the acidic, sulfurized water with pH being about

3; and then, the mixed seawater, sulfurized and non-sulfurized recirculating water, enters the tail aeration zone of the aeration tank.

Rows of porous aeration tube are provided at the bottom of the aeration zone, sending large volumes of air into the aeration tank with multiple aeration fans so as to produce a fine air bubble; the air bubble makes the dissolved oxygen in seawater in the aeration tank to be saturated, and oxidize decomposable sulfite into steady sulfate; the carbonate radical CO_3^{2-} and bicarbonate radical HCO3- in seawater can also be quickly neutralized with the H+ drained from the absorber by means of aeration, so as to release CO2; as a result, the pH in seawater can be restored and increased to be above 6.5, thus meeting the requirement of release standard. Overflow weir is also provided on the drainage side of aeration tank so that acceptable seawater can be overflowed into discharge canal. The seawater returns to the discharge canal of the recirculating water system and is finally discharged into sea, after its quality has been restored.

Process water system

The process water source for seawater desulfurization unit comes from the process water of the power plant, and is used for the low-pressure flushing of GGH and pipe flushing. A process water tank is provided inside Desulfurization Island, and is equipped with process water pumps.

Compressed air

With respect to instrument compressed air system, the source of instrument compressed air will be provided from the main part of project; the instrument compressed air coming from the main part of project is stored in pressure-stabilizing air storage tank, and is then used to provide compressed air for the purge of CEMS of FGD.

7.2 Flue Gas Denitration

Low-nitrogen combustion technology will be adopted in the boiler of this project, which will actually control and maintain the NOX emission concentration to at ≤350mg/Nm3 at the outlet of boiler, to meet the requirements of the local environmental laws. However, the Owner commits to build the Project as to stricter emission standards of China- because of the high profile of the Project; therefore, it is required that the NOX emission concentration of stack shall not exceed 100mg/Nm3. For this reason, flue gas denitration system shall be installed synchronously in this project, with denitration efficiency being not lower than 80%.

7.2.1 Denitration Process System

Selective catalytic reduction (SCR) unit is to be arranged in the high-temperature flue gas duct, in which flue gas temperature can reach the optimal temperature required for the reaction, between economizer and air preheater. The main process flow is as follows:

The flue gas coming from the outlet of boiler economizer enters a vertically-arranged SCR reactor, where flue gas enters catalyst bed via flow equalizer; the flue gas that has been scrubbed off NO_x enters air preheater, electric precipitator, induced draft fan and desulfurization unit sequence; and then, the flue gas is discharged into atmosphere via stack. An ammonia injection system is provided before flue gas catalyst; after flue gas is fully mixed with ammonia, the mixture enters catalyst for reaction to remove NO_x.

7.2.2 Main Equipment

The main equipment in the denitration system includes SCR reactor, catalyst and the like; the main equipment is described as follows:

SCR reactor

The SCR reactor is located in the downstream of the outlet flue gas duct line of boiler economizer. After ammonia is uniformly mixed with flue gas, the mixture enters the inlet of the reactor via the pilot valve of distributor. The denitrated flue gas enters electric precipitator and FGD systems and is discharged into atmosphere via stack after heat is recovered in the air preheater.

The reactor is of self-supporting steel structure, and is provided with the internal and external catalyst support structures of enclosure. An air-tight device is provided at the bottom of catalyst to prevent the untreated flue gas from being leaked.

Catalyst

The catalyst is arranged in three layers in the reactor, two layers of which are for operation, and the one layer is for standby when SCR efficiency is lower than desired value. Catalyst type mainly includes flat plate type catalyst and honeycomb type catalyst.

Catalyst is the main equipment in the SCR system, and its composition, structure, service life and relevant parameters will directly affect the denitration efficiency and operation condition of SCR system. When the ammonia concentration in exhaust flue gas rises to a certain level, it indicates that catalyst needs to be replaced.

The two types of catalyst have their advantages and disadvantages respectively. In terms of the selection of catalyst of this project, it is suggested that catalyst should be decided after comprehensive comparison is performed according to the performance and cost of the entire SCR system provided by SCR supplier.

Storage, preparation, transportation and supply of denitration reagent – Ammonia

The storage and preparation systems of liquid ammonia include liquid ammonia unloading compressor, liquid ammonia accumulator, liquid ammonia flash tank, ammonia buffer tank, ammonia dilution tank, wastewater pump, wastewater tank and the like. Liquid ammonia is transported with tank car, and liquid ammonia unloading compressor is used to unload liquid ammonia into liquid ammonia accumulator; the liquid ammonia leaving the accumulator is evaporated into ammonia in the liquid ammonia flash tank; and then, the ammonia is sent to SCR system via ammonia buffer tank. The ammonia that is discharged from the ammonia system under emergency condition is discharged into ammonia dilution tank, and is then discharged into wastewater tank after being absorbed with water; and then, ammonia liquor is transferred to wastewater treatment plant for treatment with wastewater pump.

8. Project Technical Studies

8.1 Interconnection and Load Flow Study

Interconnection study is under the purview of NTDC and is yet to be provided.

8.2 Topographic Survey

8.2.1 Scope of the Study

The site is 1,384m long and 993m wide, and the land area is about 134.1hm^2. The construction site is mainly wasteland, without basic farmland and villages, and its original terrain elevation is 2.5m to 55.7m.

8.2.2 Key Findings of the Study

CCCC-FHDI Engineering Co., Ltd was engaged by the Sponsors to carry out survey and investigation of the feasibility study phase of the Project. The main task is finding out the terrain, geomorphology and geological structure on site.

The survey coordinate system: The Independent Coordinate System of Gwadar (GPPCS).
Elevation system (datum): starting from CD base plane.

The data source for this control point is provided by FHDI's measuring department. The data of the control points are shown in the table below.

POINT	POINT	E (m)	H (m)	Mark
PP1	2796003.470	456463.125	7.752	
PP2	2795472.212	459533.873		
PP3	2795005.935	456577.492	5.598	
PP4	2795039.371	457922.464		
PP5	2795410.118	457861.942	4.505	
BM			4.330	

This project is located near the Makran coastline in the Kawart district of Gwadar. The west side lies an abandoned water desalination plant. There is an existing road connecting the desalination plant to the Makran Coastal Highway. The Project teams, after arriving at the desalination plant, built a temporary path to the project area.

The coastal line of Gwadar belongs to the marine geomorphy with the following main landform features:

1. Coastal bluffs: The coastal bluffs can be seen in the south part.
2. Scarp foot: The scarp foot means the low part of precipice. The boulders from the collapse of stone layer on top of the cliffs by weather erosion and under the action of waves scatter around the foot.
3. Beach: The beach, a gentle stretching topography running parallel to it, is mainly composed of littoral sediment.

4. Plain: The west and north side of the site is a large relatively flat area, with a distribution of small mud mound.

8.3 Geotechnical Investigation

8.3.1 Objectives of Geotechnical Survey

1: In line with the related regulations, completing plant horizontal control survey and vertical control survey with the corresponding grade, as well as the following topographic survey.

2: According to the existing layout, providing 1:1000 topographic maps of the site.

3: Providing the coordinate and elevation system transferring formula.

The purpose of the investigation was to help find out the distribution of rock and soil layer and its physical and mechanical properties and providing basic data and geotechnical parameters for the feasibility study of the Project

The main tasks of this investigation work are:

(1) Finding out the terrain, geomorphology and geological structures on the Site, and make further study of the fracture in the vicinity of the site.

(2) Finding out the adverse geological effects at the Site and the surrounding area, such as karst holes, soil holes, dangerous rocks and landslides, mudslides and so on. Make judgments about the extent of the damage and the development trend, make a preliminary plan for prevention and treatment if and when required.

(3) Finding out the origin, age and distribution of strata within the Site, and the main physical and mechanical properties of each layer of rock soil, and the burial conditions of groundwater, and also the corrosive effect of water and soil on building materials in the area.

(4) Provide the ground vibration parameters in the Site area, and determine the area category.

(5) Find out if the Site has mining activity and the impact of mining on Site stability and study and predict other environmental / geotechnical problems that may affect Site stability.

(6) Collecting geological data, and conduct engineering geological mapping and a limited amount of exploration and laboratory experiments, and evaluate the stability of slope.

(7) For the earthquake zone, division of the area into favourable or unfavourable areas for civil structures / buildings location. Where saturated sand and soil exist, the degree of liquefaction should be determined.

(8) For foundation pit engineering, preliminary determination of possible problems and the support measures according to geotechnical conditions.

(9) When the site and ground are processed, or pile foundation is adopted, the proposal shall be demonstrated and suggestion shall be given.

(10) The others should satisfy the requirements of the Code for Geotechnical Investigation of Fossil Fuel Power Plant (GB/T 50131-2014), Technical Code for Investigation of Geotechnical Engineering of Fossil Fuel Power Plant (DL/T5074-2006), and the Code for Investigation of Geotechnical Engineering (GB50021-2001(2009)).

8.3.2 Site Survey

Boreholes layout was based on the grid pattern with the two lines spacing 250-300m, and 20 boreholes were arranged.

A total of 20 boreholes, with the depth of the borehole at not less than 25 to 30 meters, and numbered at ZK01~ZK20 were completed in the geotechnical investigation work. The terrain has fluctuated greatly, some boreholes are arranged by designer at the places where steep cliffs or drilling devices are difficult to position, so some boreholes are adjusted to the right place according to the designer's permission. The final total drilling length was 4,497.5 meters, and 5 disturbed sand samples, 186 rock samples, 9 groups of water samples (8 groups of seawater, 1 group of groundwater) have been obtained, totally 117 standard penetration tests have been done. For the details, please refer to the geotechnical report in Table 1: Summary of Borehole. The samples of soil rocks have been sent to the site geotechnical laboratory set up by FHDI in Karachi for physical and mechanical properties test. Water samples have been sent to geotechnical laboratory in China and local laboratory in Karachi Soilmat Engineers for testing.

Samples were taken from each stratum of all the controlling boreholes according to the "Code for Geotechnical Investigation of Fossil Fuel Power Plant (GB/T 50131-2014)", The sampling spacing is 1.5m~2.0m. The field standard penetration test shall be carried out strictly in accordance with the Code for Geotechnical Investigation of Fossil Fuel Power Plant (GB/T50131-2014), The testing spacing shall be less than 2.0 meters. Laboratory Test has been done for soil, rock and water samples.

8.3.3 Key Findings of the Study

According to Pakistan's Building Code of Pakistan (Seismic provisions of 2007), the Gwadar area belongs to the earthquake zone 3. Under the SB site conditions, the peak ground acceleration is 0.24g-0.32g, and the corresponding seismic intensity is 8 degrees.

(I) Topography and landform

The project site is located in the coastal area, the site area topography is mainly sea landforms, consisting of coastal cliffs, cliffs, beaches, and marine plains. The site elevation reduces from about 60m at the southeast corner northward and westward gradually to about 2.0m. The landform is relatively steep, with relatively large changes.

(II) Stratum lithology

According to the geotechnical investigation data at the feasibility study stage, the geotechnical layers exposed in the project site are: Quaternary Holocene (Q4) marine deposit (layer number: ②) and Early Miocene Parkini mudstone (Tm) (layer number: ⑦). The rock and soil strata can be divided into six sub-layers according to its lithology and physical and mechanical properties, shown as follows:

②$_1$ Fine sand: greyish yellow, yellow, wet, loose-medium dense, poor grain gradation. The layer is mainly distributed in the southern coastline area.

②$_2$ Coarse sand: yellow, saturated, dense, better particle gradation, with more broken shells, only locally exposed, mainly distributed in the southern coastline area.

⑦$_1$ Strongly weathered mudstone: grey, very soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, fragmented core, fragile by hand.

⑦$_2$ Moderately-weathered mudstone: grey, very soft rock-soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, fragmented core. The natural state uniaxial compressive strength average is 5.76MPa.

⑦$_3$ Moderately-weathered mudstone: grey, very soft rock-soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, stumpy core. The natural state uniaxial compressive strength average is 9.53MPa.

⑦$_4$ Slightly weathered mudstone: grey, soft rock, layered structure, mud cementing, with the main mineral composition of clay minerals, horizontal bedding, more developed fissure, column core. The natural state uniaxial compressive strength average is 11.34MPa.

According to the site geological investigation, the project site is free from large-scale debris flow, collapse, ground subsidence, ground fissures, mined areas and other adverse geological actions and geological disasters, or human activities impacting the site and foundation safety.

At the south side of the site by the coast, there are steep cliffs. At the high tide level, seawater washes the cliffs. The cliff bedrock is soft mudstone, easy to soften after soaking. There is the phenomenon of collapse, so the bidder shall consider the necessary protective measures.

Loose-medium dense powder fine sand ②$_1$ and saturated dense coarse sand ② is distributed in the coast in the project site. According to the blow counts of SPT, it is judged that fine sand ②$_1$ is the liquefiable soil layer, and the liquefaction level is slightly ~ medium. Coarse sand ②$_2$ is not liquefied soil.

Table 12.1 - Classification of Soil Types

Stratum Name and No.	classification of layar
②1Silty Fine Sands	Weak Soil - Medium weak soil
②2Coarse Sand	Medium hard soil
⑦1 Strongly weathered mudstone	Medium hard soil
⑦2 Moderately weathered mudstone	Soft rock
⑦3 Moderately weathered mudstone	Soft rock
⑦4 slightly weathered mudstone	Soft rock

Table 12.2 - Characteristic Values of Foundation Soil

Stratum No	Stratum Name	Bearing capacity of foundation (kPa)	Standard value of ultimate end resistance of pile q_{pk}(kPa)		Standard value of ultimate side resistance of pile q_{sik}(kPa)	
			Precast concrete pile	Slurry Wall Bored Piles	Precast concrete pile	Slurry Wall Bored Piles
②1	Silty-fine sand	130			30	24
②2	Coarse sand	500			110	95
⑦1	Strongly weathered mudstone	400			200	160
⑦2	Moderately weathered mudstone	1000	7000	2100	220	170
⑦3	Moderately weathered mudstone	1300	9000		300	
⑦4	Slightly Weathered Mudstone	1500	10000		300	

Note: ⑦ 3 moderate weathered mudstone, ⑦4 slightly weathered mudstone rock block total resistance is recommended in accordance with the "Technical Code for Building Piles" 5.3.9 to determine, according to the pile diameter and rock depth, the use of uniaxial compressive strength values.

8.4 Marine Study

The marine study for water temperature, sand sediment, ocean current, etc. is still being carried out by a professional research institute engaged by the Sponsors. At present, all the data related to marine study is in reference to the Gwadar Port which falls within the east bay of the Gwadar marine area.

8.5 Sea Water Sampling

8.5.1 Scope of the Study

A total of two group seawater samples were taken from the survey from the Site.

The composition of the groundwater, (from Borehole ZK06), according to the results of the analysis, is consistent with the composition of the circulating water used, and the groundwater content in the borehole is limited and it is difficult to affect the muddy water composition in the borehole.

8.5.2 Key Findings of the Study

According to the water analysis results of laboratory test and engineering experience near Gwadar Harbour and combined with the requirements of Code for Investigation of geotechnical Engineering (GB 50021-2001) (2009), The evaluation corrosion results of seawater on the concrete structure, reinforced concrete structure are:

(1) Groundwater in this field is considered by type II environmental;

(2) Groundwater has a strong corrosive effect on the concrete construction both in alternating wet and dry conditions and long-term immersion conditions.

(3) Groundwater has strong corrosion to reinforced concrete construction both in alternating wet and dry conditions and long-term immersion conditions.

Referring to the relevant information and experience in the region, combining with the specific structure of the anti-corrosion requirements, appropriate anti-corrosion design measures shall be taken.

Appendix 3 -1 The Report of Water Quality Analysis

Project name:	GWADAR 300MW IMPORTED COAL POWER PLANT,PAKISTAN	Management Number: FHDI2014-2-21-30-A	
Delegation Number:SH201704-1-BJST		Report Number: FHDI-SH-2017-BJST-1	

Lab number: S1	Field number:S1(East of the site)		Sampling Depth: \		Report Date: 2017/4/19	
Analysis items:	unit	Content	Analysis items:		Content (mg/L)	Content(mg/kg)
PH	8.25		Cation	$K^+ + Na^+$	\	
Total alkalinity	mg/L	\				
Total hardness	mg/L	\		NH_4^+	\	
Temporary hardness	mg/L	\				
Permanent hardness	mg/L	\		Ca^{2+}	614.87	
Negative hardness	mg/L	\		Mg^{2+}	1349.74	
Free carbon dioxide	mg/L	0.00		In total	\	
Aggressive carbon dioxide	mg/L	0.00	Anion	Cl^-	18101.70	
Total mineralization	mg/L	\		SO_4^{2-}	2845.58	
Total acidity	mg/L	\		NO_3^-	\	
Acidity of strong acid	mg/L	\		HCO_3^-	106.11	
Blank below				CO_3^{2-}	19.78	
				OH^-	\	
				In total	\	
			In total		\	

Notes:

1. The report was carried out in accordance with DL/T5152-2001
2. Please contact us if you have any query on the report.
3. The report is only responsible for provided samples, and the tested samples only be kept for 7 days.
4. The report should not be copied without our permission.(Except full copy)

Appendix 3 -2 The Report of Water Quality Analysis

Project name: GWADAR 300MW IMPORTED COAL POWER PLANT,PAKISTAN | Management Number: FHDI2014-2-21-30-A

Delegation Number SH201704-1-BJST | Report Number: FHDI-SH-2017-BJST-1

Lab number: S1	Field number:S1(West of the site)		Sampling Depth:		Report Date: 2017/4/19	
Analysis items:	unit	Content	Analysis items:		Content (mg L)	Content(mg kg)
PH	8.26		Cation	$K^{+}+Na^{+}$		
Total alkalinity	mg L					
Total hardness	mg L			NH_4^{+}		
Temporary hardness	mg L					
Permanent hardness	mg L			Ca^{2+}	551.28	
Negative hardness	mg L			Mg^{2+}	1504.00	
Free carbon dioxide	mg L	0.00		Fe total		
Aggressive carbon dioxide	mg L	0.00	Anion	Cl^{-}	18824.88	
Total mineralization	mg L			SO_4^{2-}	5201.59	
Total acidity	mg L			NO_3^{-}		
Acidity of strong acid	mg L			HCO_3^{-}	140.83	
Blank below				CO_3^{2-}	14.10	
				OH^{-}		
				In total		
			In total			

Notes:

1. The report was carried out in accordance with DL/T5152-2001
2. Please contact us if you have any query on the report.
3. The report is only responsible for provided samples, and the tested samples only be kept for 7 days.
4. The report should not be copied without our permission (Except full copy)

8.6 Bathymetric Survey

8.6.1 Scope of the Survey

The bathymetric study of 250m from seacoast is finished. According to the data, the water depth is about 3m from the land at a distance of 250m. The larger bathymetric study is still going on by professional research institute engaged by the Sponsors.

8.6.2 Key Findings of the Survey

According to the finished survey data, the water depth is about 3m at a distance of 250m from the coast. According to the situation of the sea area near site, it is assumed that water depth of 8 meters under the lowest tide level shall be reached at about 1.3km away from the shore. During the bidding phase, the Contractor shall develop a reasonable water intake and discharge scheme depending on his engineering experience and findings of the studies under way.

8.7 Logistics and Transportation Study

The required equipment and materials shall be shipped to the Site by a combination of bulk transportation, container transportation and specialized ships in a land- sea-land-Site sequence.

8.7.1 Scope of Goods Shipment

The three types of main equipment, auxiliary equipment and auxiliary equipment materials.

8.7.2 Shipment Plan

To be determined according to detailed goods and equipment delivery plan, all the goods and equipment shall be shipped to Gwadar Port and unloaded there.

8.7.3 Ocean Shipping Option

Bulk transportation scope includes auxiliary equipment materials associated with the three types of main equipment and auxiliary equipment which are suitable for bulk transportation. In addition, equipment materials will also be sent to the Site.

For bulk transportation, one port in Shanghai and one port in Guangzhou will be designate. The transportation service provider shall arrange bulk carrier to transport the goods to the Site. Reasonable schedule for goods shipping according to the production plan of the equipment and material suppliers to minimize time and cost for goods stored in the port will be made. Reasonable sail schedule and deliver the goods required by the Project to the Site by adopting a combination of "chartered ship" and "periodic liner" will be developed.

8.7.4 Inland Transportation Options at Gwadar

Special transportation scheme will be developed for over-sized and over-weight equipment. The transportation service provider shall investigate the transportation line before equipment shipping and submit accurate transportation scheme to the procurement manager/transportation management engineer according to weight, dimension, goods features, i.e., hazardous goods, and time limit of the transportation goods. The scheme includes preparation work before transportation, transportation time, transportation means, transportation line, personnel arrangement etc.

8.7.5 Conclusions

Key management points for container gate-in, container loading inspection and transportation of the equipment and materials in the project are as follows:

(1) Develop reasonable plans, and make timely adjustment according to actual situation;

(2) Ensure smooth information transfer, such as timely sending of shipping order, timely confirmation of picking up notice, timely confirmation of equipment and material collection and loading feed-back by the transportation service provider;

(3) Teamwork and unobstructed communication, such as arrangement of connection of picking up and loading between transportation subcontractor and equipment supplier;

(4) Make quick response and develop emergency plans, such as sudden transportation accident and severe weather condition etc.

8.7.6 Recommendations

(1) Develop transportation management plans, including equipment and material transportation plan and sail scheduling etc.

(2) Develop detailed transportation scheme for over-sized and over-weight equipment.

(3) Truck unloading and ship loading, storage in the port area and loading inspection management.

9. Environmental Protection and Water & Soil Conservation

9.1 Environmental Protection Standards and Basis

The applicable Pakistani standards to be based in environmental protection design are as follows:

- National Environmental Quality Standards of Pakistan (NEQS)
- IFC Standards
- Ambient Air Quality Standards published by Government of Pakistan
- PEPA
- BEPA

9.1.1 Release Standards of Industrial Wastewater

The release of the industrial wastewater of this project shall conform to the following parameters:

Table 13.1 – Industrial Wastewater Parameters

Parameter	Limits for Discharging into Sea
Temperature Rise	≤3°C
pH value	6-9
Biochemical Oxygen Demand 5 at 20°C[1]	80**
Chemical Oxygen Demand[1]	400
Total Suspended Solids	200
Total Dissolved Solids	3,500
Grease and Oil	10
Phenolic Compounds (as phenol)	0.3
Chloride (as Cl^-)	SC***
Fluoride (as F^-)	10
Cyanide (as CN)	1.0
An-Ionic Detergents (as MBAS)[2]	20
Sulphate (SO_4^{2-})	SC***
Sulphide (S^{2-})	1.0
Ammonia (NH_3)	40
Pesticides[3]	0.15
Cadmium[4]	0.1
Chromium (trivalent and hexavalent)[4]	1.0
Copper[4]	1.0
Lead[4]	0.5
Mercury[4]	0.01
Selenium[4]	0.5
Nickel[4]	1.0
Silver[4]	1.0
Total Toxic Metals	2.0
Zinc	5.0
Arsenic[4]	1.0
Barium[4]	1.5

Iron	8.0
Manganese	1.5
Boron[4]	6.0
Chlorine	1.0

1. *Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Federal Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic metres of water for dilution of this effluent.*
2. *Modified Benzene Alkyl Sulphate; assuming surfactant as biodegradable.*
3. *Pesticides include herbicides, fungicides, and insecticides.*
4. *Subject to total toxic metals discharge should not exceed 2 mg/L.*
5. *Applicable only when and where sewage treatment is operational and BOD=80 mg/L is achieved by the sewage treatment system.*
6. *Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.*

** The effluent should not result in temperature increase of more than 3°C at the edge of the zone where initial missing and dilution take place in the receiving body. In case zone is not defined, use 100 meters from the point of discharge.*

*** The value for industry is 200 mg/L*

**** Discharge concentration at or below sea concentration (SC).*

9.1.2 Emission Standard of Waste Gas

Emissions standards shall be in line with national and international standards. The specific emission requirements of the waste gas for the Project are shown below:

Table 13.2 – Emission Requirments for Waste Gas

Item	Design Stack Limit	WBS limits	EU limits
SO_2	≤100mg/Nm^3	900~1500 mg/Nm^3	150 mg/Nm^3
NO_x	≤100mg/Nm^3	510 mg/Nm^3	150 mg/Nm^3
Particle (dust)	≤30mg/Nm^3	50 mg/Nm^3	10 mg/Nm^3

9.1.3 Release Standards of Recirculating Water

The release requirements for the recirculating seawater of this project are shown in the following table:

pH	-	≥6.5
Dissolved Oxygen	Mg/L	>5

9.1.4 Noise

The noise at plant boundary will follow the applicable noise standards of Pakistani (NEQS) and World Bank Environmental Guidelines (WBEG) as shown in the following table. In accordance with the noise standards of Pakistan and World Bank, common noise control measures (such as sound insulation, silencing, vibration damping and the like) will be taken for equipment noise.

Table 13.3 – Noise Pollution Parameters

Parameter	Pakistan		World Bank Standard	
	Day time	Night	Day time	Night
Industrial and Commercial	75	65	70	70

9.2 Prevention and Control Measures for Pollutant

9.2.1 Prevention and Control Measures for Flue Gas Pollutant

The atmospheric pollutants caused by coal-fired power plant mainly include SO_2 and NO_X. As for soot and dust, the dilution, diffusion and purification capabilities of atmosphere shall be utilized as practical as possible and proper prevention and control measures shall be taken as well to minimize pollution impact. The Project intends to take the following measures in the aspect of the prevention and control of exhausts:

1. Prevention and control measures for soot and dust

High-efficiency electrostatic precipitator will be adopted in this project after analysis; meanwhile, after soot and dust are further removed and scrubbed in desulfurization unit, the requirement that emission capacity does not exceed 30mg/Nm^3 can be met.

2. Prevention and control measures for SO_2

Since this project is on seaside, and the analysis with available seawater parameters reveals that seawater desulfurization is applicable, it is recommended to adopt seawater desulfurization, considering economic efficiency and maintenance performance. The final determination of desulfurization process shall be based on environmental impact assessment. The emission of SO_2 in flue gas can meet the requirement that emission concentration shall be $\leq$100mg/Nm^3 can be met after desulfurization.

3. Prevention and control measures for NO_x

The Project intends to adopt low-nitrogen combustion technology and to construct SCR unit synchronously. The denitration proposal shall use a reducing agent, generated through ammonia-producing process from liquid ammonia. The reducing agent NH_3 will be transferred to the ammonia/air mixer in SCR area; after ammonia is mixed with dilution air and is diluted to a safety concentration (below 5% volume concentration), the mixture is sprayed into the flue gas duct at the inlet of SCR reactor via ammonia injection grid.

4. Emission with high stack

Stack height shall be chosen rationally to make the best of the diffusion and self-cleaning capacity of atmosphere, thus minimizing the ground concentration of pollutant and obtaining maximal economic with least environmental load. It is tentatively considered to use a 180m-high steel sleeve stack to emit flue gas in this project; the final height of stack shall be based on the official reply of environmental protection impact assessment.

5. Provision of continuous monitoring system of flue gas

This project will be provided with automatically continuous monitoring system of flue gas. The items to be monitored include soot and dust, CO, SO2 and NOx, as well as applicable flue gas parameters such as oxygen content, flue gas rate, flow, flue gas temperature and the like.

6. Analysis for the impact of atmospheric pollution

The atmospheric pollutant produced in coal-fired power plant is mainly the coal-fired flue gas emitted during production, with main pollution factors being soot and dust, SO2 and NOx.

Preliminary analysis reveals that, the emission concentration of various atmospheric pollutants can satisfactorily meet the local environmental emission requirements of Pakistan after flue gas is treated with electric precipitator and seawater desulfurization and other such platforms built into the complex.

9.2.2 Sewage Treatment Measures

The sewage produced in coal-fired power plant proposal mainly includes acid and alkali wastewater, oily sewage, coal sewage, domestic sewage, etc.

A wastewater and sewage treatment station will be provided for the power plant to treat various types of industrial wastewater and domestic sewage and auxiliary facilities respectively; the sewage will not be discharged until applicable standards are completely met.

The centralized treatment station of industrial wastewater, oily wastewater treatment station and domestic sewage treatment station are provided inside the wastewater and sewage treatment station. The coal-containing wastewater treatment station will be arranged near the coal yard together with the rainwater sedimentation tank of the coal yard.

Under normal condition, the industrial wastewater, domestic sewage, coal-containing sewage and oily sewage of this project will be preferentially reclaimed after treatment is performed and local wastewater release standards are met; the wastewater and sewage that cannot be reclaimed will be discharged into sea; a set of on-line monitoring device will be provided for water quality and capacity at the discharge port of industrial wastewater.

1. Domestic sewage

Domestic sewage mainly comes from main the drainage of the toilets of power house, and the auxiliary buildings such as production buildings and administration building as well as the drainage of dining hall. Faecal sewage is collected in the collecting pipe of the domestic sewage of plant area via septic tank. The drainage from dining hall is discharged into the collecting pipe of the domestic sewage after oil is isolation; the remaining domestic sewage is directly discharged into the collecting pipe of the domestic sewage.

Most of the drainage in domestic sewage pipeline flows to the domestic sewage treatment station by gravity, and a part of the drainage from auxiliary buildings needs to be transferred to domestic sewage treatment station with pressure pipe after being collected in pipe wells and pressurized.

Biological aeration filter tank will be adopted in the domestic sewage treatment station. Effluent is reused for greening and road watering after being disinfected with chlorine dioxide.

2. Industrial wastewater

The industrial wastewater treatment system is mainly used to treat industrial wastewater such as the drainage of flushing water of coal yard and coal-handling system, the pickling wastewater of boiler, the acid and alkali wastewater from chemistry workshop, etc., and the treated effluent is reused as the mixing water of the agitator of ash silo, the spray water of coal yard, the flushing water of trestle, the floor flushing water of ash silo and dust precipitator, etc. The process flow such as coagulation, sedimentation, filtering and the like will be used in the system.

3. Oily wastewater

The Oily wastewater treatment station is mainly used to treat the oily sewage produced in the water removal of oil tank in tank farm, and the oily sewage produced in the floor flushing of oil pump house and steam turbine building. The treatment process "isolating oil by means of sedimentation + two-level gas floating + filtering" will be adopted; the treated water is discharged into industrial wastewater storage tank.

4. Coal-containing wastewater

The coal of power plant is transferred to the main power building via coal-handling trestle. Therefore, with respect to the coal-containing wastewater of the plant area, the cleaning water from coal-handling system is only considered. The cleaning water from coal-handling system is reused for the coal-handling system after being clarified and settled. The process for automatically adding coagulant and coagulant aid will be adopted in this treatment system; the treated effluent is used for coal-handling system.

9.2.3 Treatment of Ash and Slag

Ash-handling system

The design principle of slag and ash separate handling will be adopted. The ash and slag-handling system consists of ash-handling system, slag-handling system and the like. The ash and slag-handling mode of the system is that, dry-ash positive-pressure dense-phase pneumatic transfer system is used for ash-handling system; pneumatic slag-handling device is used for handling boiler slag. Ash and slag are transported to ash yard for storage or comprehensive utilization in future after being wetted. Dry ash is transferred to the ash silo near the ash yard via ash-handling pipe, and is transported to ash yard for storage or comprehensive utilization in future after being wetted.

Ash yard

The ash and slag of the power plant are transported to ash yard for disposal/storage with trucks. The dry ash of the power plant is transported with trucks to ash yard for being stacked and compacted in layers after being wetted. In order to prevent ash and slag to bring about secondary pollution for surrounding environment, the following measures shall be taken: i) ash dyke shall be designed as per anti-seepage requirements to prevent the ash water of the ash yard from seepage. ii) in order to prevent the secondary pollution due to flying ash, anti-dust spray water system shall be provided, and the ash and slag delivered to the ash yard shall be ground in a timely manner. iii) the ash yard shall be covered with soil for making land and for greening after becoming full.

Comprehensive utilization of ash and slag

Based on the existing circumstance of the legal address of the Project, comprehensive utilization for ash and slag is not considered now. The current design for the ash and slag-handling system creates condition for comprehensive disposal/storage.

9.2.4 Prevention and Control of Noise

The noise of the power plant comes from the vibration and friction of various types of object (including solid, liquid and gaseous objects) during production, and is mainly concentrated in the main power building and auxiliary production workshops. The equipment noise such as turbogenerator unit and the like as well as steam exhaust noise are the main noise sources of the power plant; other items of auxiliary equipment such as fan, various types of pump body, high-pressure pipe and the like are also the strong noise sources of the power plant.

The efficient path for the noise control of the power plant is to be accomplished in three aspects, i.e., decrease of the nose of sound source, control of spread path and implementation of personal protection. With respect to the decrease of the nose of sound source, focus on decreasing equipment noise, controlling spread path, and isolating production personnel on duty from noise.

9.2.5 Greening of Plant Area

Greening is one of important measures of environmental protection and beautification. Good greening not only can absorb the waste gases, noise and dust and reduce the adverse impact on environment by means of plants, but also can adjust the microclimate of plant area to provide a quiet, and hygienic production and living environment, to protect the physical and mental health of the personnel thus improving working efficiency.

9.2.6 Environmental Management and Monitoring

Environmental monitoring is the constituent part of the environmental protection work of power plant. For this reason, environmental monitoring station will be set up, and several full-time environmental management personnel will be designated to be responsible for the plant-wide environmental protection affairs, the management of pollution emission, the collection and filing of monitoring data, etc.

9.3 Environmental and Social Impact Assessment Study

The EIA study finds that the impacts of the project activities at the pre-construction, construction and operation stages have been adequately addressed and mitigation measures duly proposed wherever needed. Adoption of mitigation measures will ensure reduction of impact on the micro and macroenvironment as well as socio-economic conditions to acceptable levels and discharge of emissions to comply with the NEQS. The development of this project will be compatible with the requirements of the Balochistan Environmental Protection Act 2012 as well as other regulatory requirements of Government of Pakistan. The issue of safety has been duly incorporated in the design and operations phases of the project.

On the basis of the findings of the EIA Study, it is possible to conclude that proposed 2 x 150 MW CPP Project will thus respond to all aspects of sustainability: Economic, social and environmental and will thus be a sustainably viable project.

A detailed ESIA is attached as Annexure – 25.

10. Site Security

In view of the peculiar situation of the Site and the general conditions of the surrounding are, a hard look at the security threat, perception and preventive measures in terms of developing protocols, investment in procedures and equipment, was required parallel to the Project development process. For this purpose, The Belt and Road, B & R, (SMC-Pvt.) Ltd, a security consultant, was engage for security risk assessment and development of the security plan.

10.1 Security Structure

Following are the salient features of the assessment and the proposed plan.

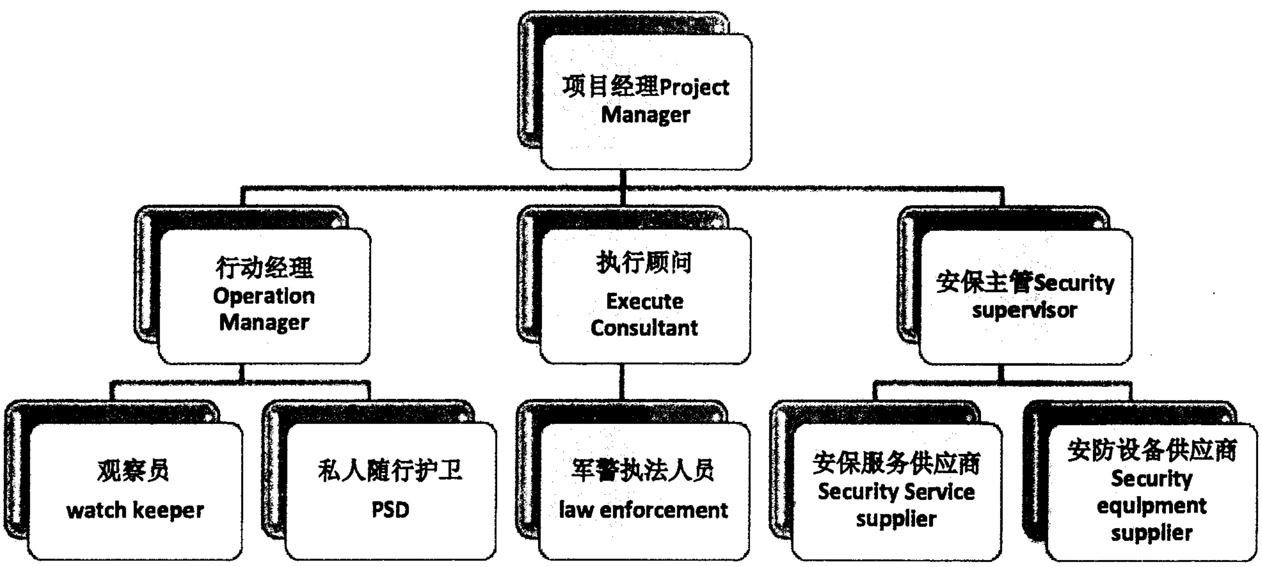
Setting up of a Field Tactical Action Centre (TOC), all of its regulatory projects related to safety projects.

Dynamic Security: Private Security Guard (PSD) Team - Personnel Transfer - Personnel Travel - Vehicle Tracking Management, QRF Rapid Response Force dispatch.

Campsite static security - 24/7 protection and security of the camp around the company's assets and personnel at Site, UAVs, operation, CCTV 24/7 monitoring, communication centre, coordination centre.

Staffing framework is as follows:

Figure 13.1 – Functional Organogram

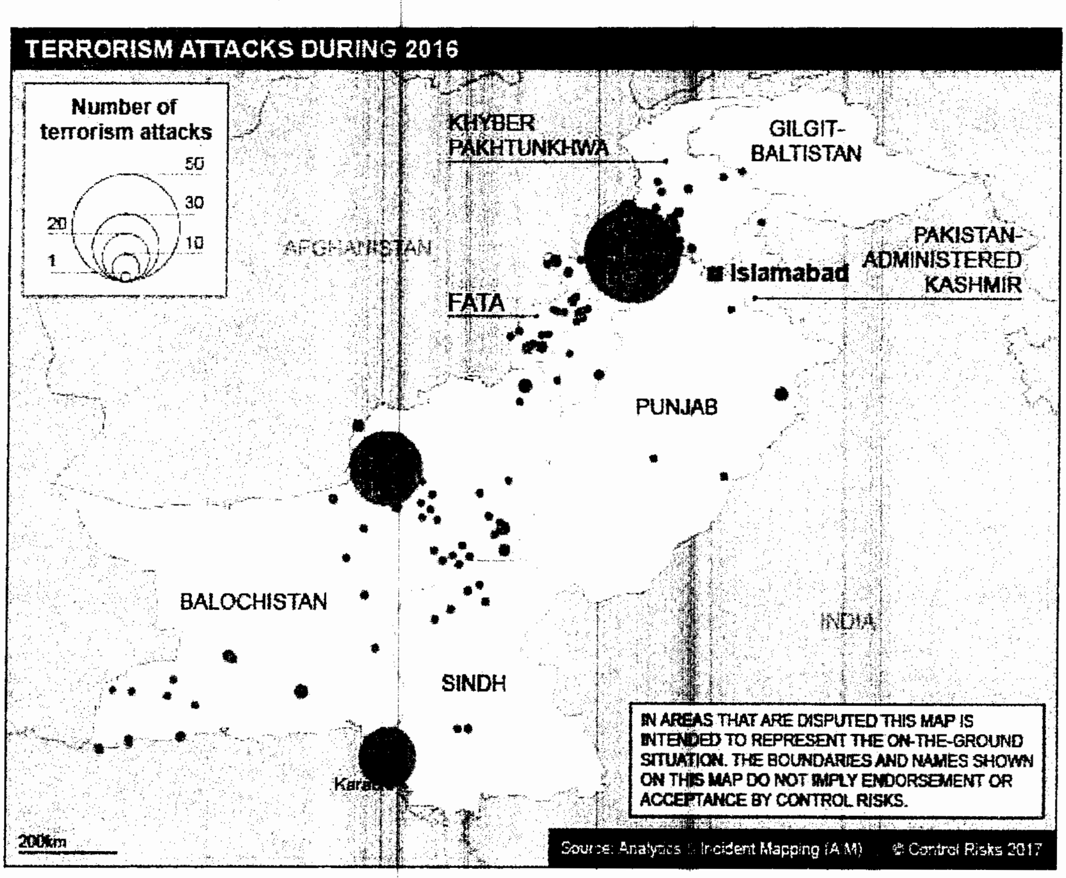


10.2 Security Risk Assessment (SRA)

10.2.1 Introduction

Recent Security Analysis in Pakistan

Figure 13.2 – Security Risk Analysis



The overall level of risk was high during first half of 2017. Crime and terrorism escalated as Balochistan and Khyber Pakhtunkhwa (KPK) remained most susceptible to sporadic acts of terrorism. The tactic of carrying out targeted attacks and Improvised Explosive Devices (IEDs) attacks against both security personnel and civilians alike continued to be used by terrorists. Moreover, the frequent occurrences of armed conflicts between security forces and miscreants also added to the level of risk.

Following the target killing of a high-profile lawyer and the subsequent suicide attack on a hospital in Quetta, combing operations have been intensified all over the country. During the operation Khyber-III launched in Khyber Agency to clear Pakistan Afghanistan border areas of the agency of terrorists, security forces resorted to intensive combing operations followed by air strikes over the Rajgal and adjacent areas. Now Khyber-IV is in progress.

On the eastern border, tensions with India have been simmering with occasional cross border firing usually along the Line of Control and the Working Boundary in the Kashmir area. Statement of Indian Prime Minister (PM) over Balochistan as well as well as the sedition laced remarks issued by the leader of Muttahida Qaumi Movement (MQM) Altaf

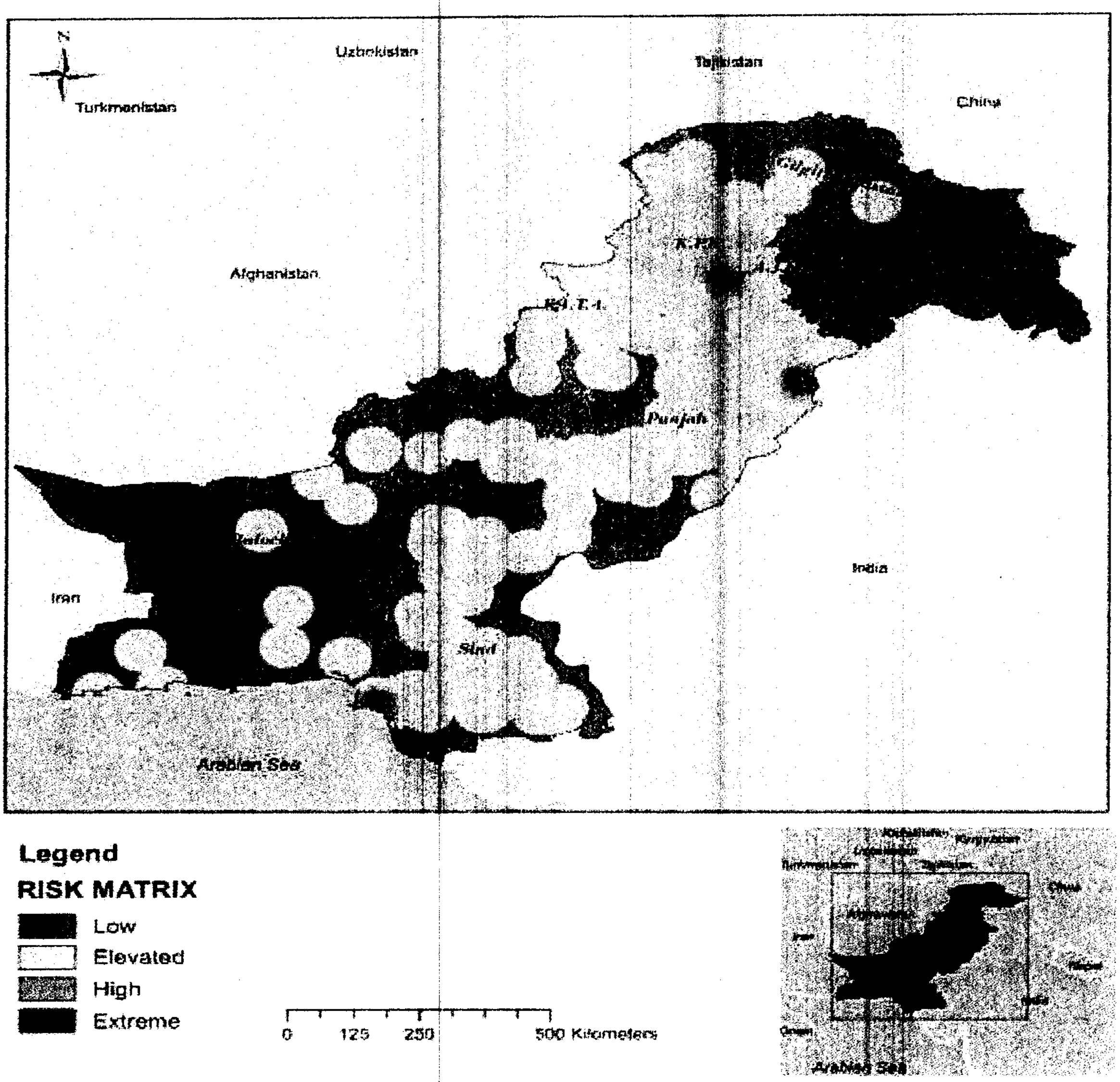
Hussain led to widespread violent protests and demonstrations in the country. Though one may also take note of the drop-in terror-related incidents across all parts of Pakistan. But the fight against terror will take many years of relentless effort, flexible security solutions, targeted operations and a general improvement in the geostrategic processes around Pakistan. Additionally, the risk emanating from robberies, vehicle lifting, accidents, murders, diphtheria and food borne illnesses also represent a daily concern and the risk of periodic surges and spikes.

Risk Comparison

Table 14.1 – Risk Comparison

Risk	**Jan**	**Feb**	**March**	**April**	**May**	**June**
Armed Conflict	342	468	755	657	410	470
Civil Unrest	117	151	92	136	170	180
Crime	478	513	658	754	886	994
General Risk	281	355	308	498	555	556
Political Instability	7	16	17	23	62	25
Terrorism	62	49	51	39	57	59
Total	**1287**	**1552**	**1881**	**2133**	**2140**	**2284**

Figure 13.3 - Pakistan Overall Risk Map



Outlook

Terrorism is expected to continue to remain the chief threat and would continue to warrant relentless counter-terrorism actions including extensive combing operations, being conducted nationwide, forcing some them to resort to revenge attacks which are likely to appear in the shape of targeted ambushes, suicide and hit and run attacks on high profile victims or high impact attacks on soft targets. General risks are also going to be prevalent as even at best these risks under the best of circumstances take years on end to subside and eventual elimination. Moreover, risk emanating from crime is also expected to remain high.

10.2.2 Scope and Methodology of SRA

The B&R conflict/security database and archives are the basic sources relied upon for this assessment. The archives and the database are the outcome of a meticulous monitoring process on every relevant incident in the country on a daily basis. A regular follow up is conducted in liaison with B&R correspondents in the regions in order to keep track of daily developments on such incidents. B&R compiles data from sources including newspapers, magazines, journals, field sources and screening of official record. More than 30 English and Urdu dailies, magazines, and journals, and various television news channels are monitored to update the database and archives. Regional daily newspapers and weeklies from Peshawar, Quetta, Gilgit and Karachi are also monitored for details of incidents reported in the local media. Correspondents in provincial capitals are the primary source for B&R to verify the media reports.

In case of a major incident, B&R teams consult the local administration and journalists for further details. In cases where B&R finds it difficult to verify facts of a particular incident, it gives preference to the official statements in that regard. B&R security reports utilize eight major variables with their respective set of sub variables for analysis of the security situation in Pakistan. The security landscape is mapped through a combination of quantitative and qualitative approaches. Quantitative methods are used, based on B&R Conflict and Security Database, to measure the scale and level of violence. Meanwhile, the qualitative approach dilates upon changes and developments on the militants' front, state responses to these developments and projections of future scenarios. The following eight major variables with their sub-sets of variables are used in the B&R Risk Assessments:

(1) Attacks: This major variable has a sub-set of five sub-variables i.e.

(i) terrorist attacks including militant attacks, nationalist insurgent attacks and sectarian-related attacks;

(ii) incidents of ethno-political violence;

(iii) cross-border attacks;

(iv) drone attacks; and

(v) operational attacks by security forces against militants.

Since Pakistan's security landscape is very complicated with a diverse array of insecurity indicators in different parts of the country, the type of violence in one geographical unit is often different in its nature and dynamics from security landscape in other parts of the country. For this purpose, the mentioned sub-set of variables is carefully monitored and analysed in the security report with a view to suggest specific counter-strategy for each type of attack in these areas.

(2) Clash: Another variable used is of clashes which include four sub-variables, i.e.,

(i) inter-tribal;

(ii) sectarian;

(iii) clashes between security forces and militants; and

(iv) militants' infightings.

The number of such clashes and their geographic location is taken as an indicator of parallel trends unfolding simultaneously with major trends and patterns of security in different areas of the country.

(3) State Reponses: It has two sub-variables:

(i) security measures, and

(ii) political and administrative responses.

The first considers the security forces' operational attacks and clashes with militants, search and hunt operations and terrorists' arrests, etc. The second variable entails the government's political and administrative measures to maintain law and order and reduce insecurity and violence.

(4) Casualties: Casualties include both the number of people killed and injured. Casualties among civilians, militants and security forces are treated as another indicator to measure the levels and trends of security in the country.

(5) Attack Tactics: This head takes a comprehensive account of various tactics used by different actors including suicide attacks, missile attacks, hand grenade attacks, kidnappings, rocket attacks, beheadings, landmine blasts, firing, sabotage, target killings, and bomb and improvised explosive devices blasts.

(6) Development on Militants' Front: This variable analyses statements, activities, internal divisions and other activities of militants to determine their strength and the dynamics of their strategies.

(7) Opportunities and Challenges include political measures and military responses to different security issues along with highlighting constraints and challenges encountered by the state.

(8) Claim of Responsibility: It provides insight into militants' targets, tactics, areas of operation, and agendas.

10.2.3 Survey and Project Constraints

Project area, about 330 acres, is located about 40 kilometres northeast of Gwadar port, north N10 national highway, at south washed by the Arabian Sea. Balochistan borders Iran in the west, Afghanistan in the northwest, Khyber Pakhtunkhwa province in the northeast, Punjab province in the east, Sindh province in the southeast, and the Arabian Sea in the south. Balochistan is the largest province of Pakistan but in terms of population it is the smallest. The majority of the people are Baloch, but the second largest group are Pashtun (40%). The provincial capital Quetta is also the home of a large part of the Hazara community in Pakistan.

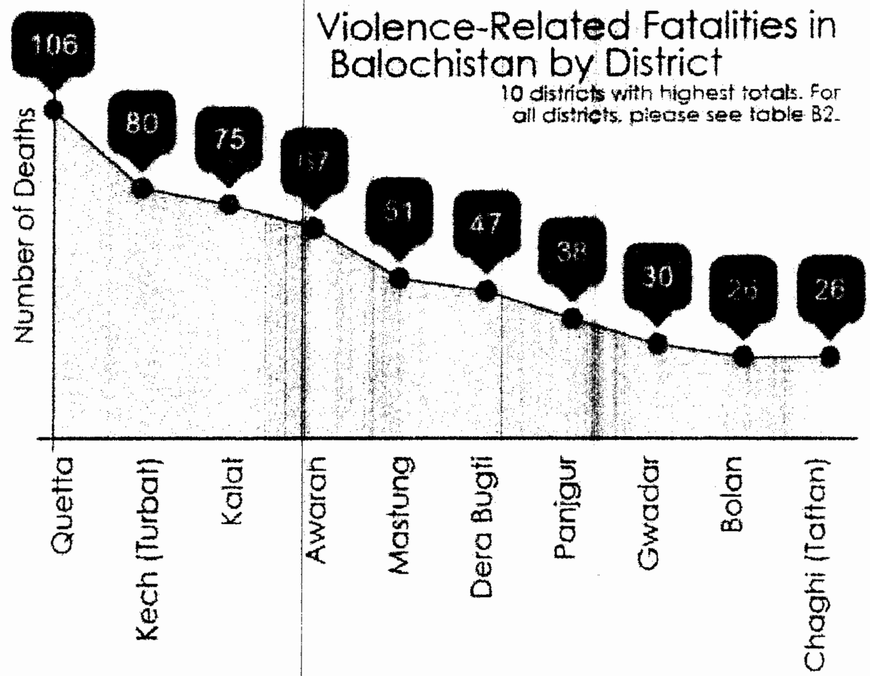
In 2006, the violent death of tribal head Nawab Akbar Bugti sparked unrest in the province. Since then, the two biggest militant groups, the Baloch Liberation Army (BLA) and the Baloch Liberation Front (BLF), have staged numbers of attacks on government targets and on Punjabi settlers. The authorities have reacted strongly. The fighting in Balochistan is usually referred to as 'a low-level insurgency'.

Apart from a nationalist uprising, Balochistan is also plagued by sectarian violence. The local Shia community, mostly Hazara, has increasingly become the victim of violent attacks. It is generally assumed that LeJ and al-Qaeda affiliates are responsible for most of the attacks against the Hazara community.

Another factor contributing to the conflict in Balochistan in recent years is the international involvement in Pakistan's efforts to build the Gwadar Port in collaboration with China. To protect the project, Pakistan intends to increase its military presence in the region. Pakistan accused India and other countries of interfering and supporting the Baloch separatists.

Similar to 2015, PIPS states that Quetta (48 attacks) was most affected by terrorist attacks, followed by Dera Bugti (29 attacks) and Kech (20 attacks). According to CRSS, most fatalities occurred in Quetta, Kech, Kalat and Awaran (see Figure 8). CRSS mentions that the number of fatalities in Quetta is declining in recent years, but that there is an increase of fatalities in districts such as Kech, Kalat, Awaran, Mastung and Panjgur.

Figure 13.4 – District-wise Fatalities: Balochistan



The Center for Research and Security Studies, Pakistan Annual Security Report

In the first three months of 2017, 164 fatalities were observed by SATP. This includes 32 civilians, 42 security personnel and 90 militants. Compared to the same period in 2016, this is a slight increase in fatalities (130 in 2016).

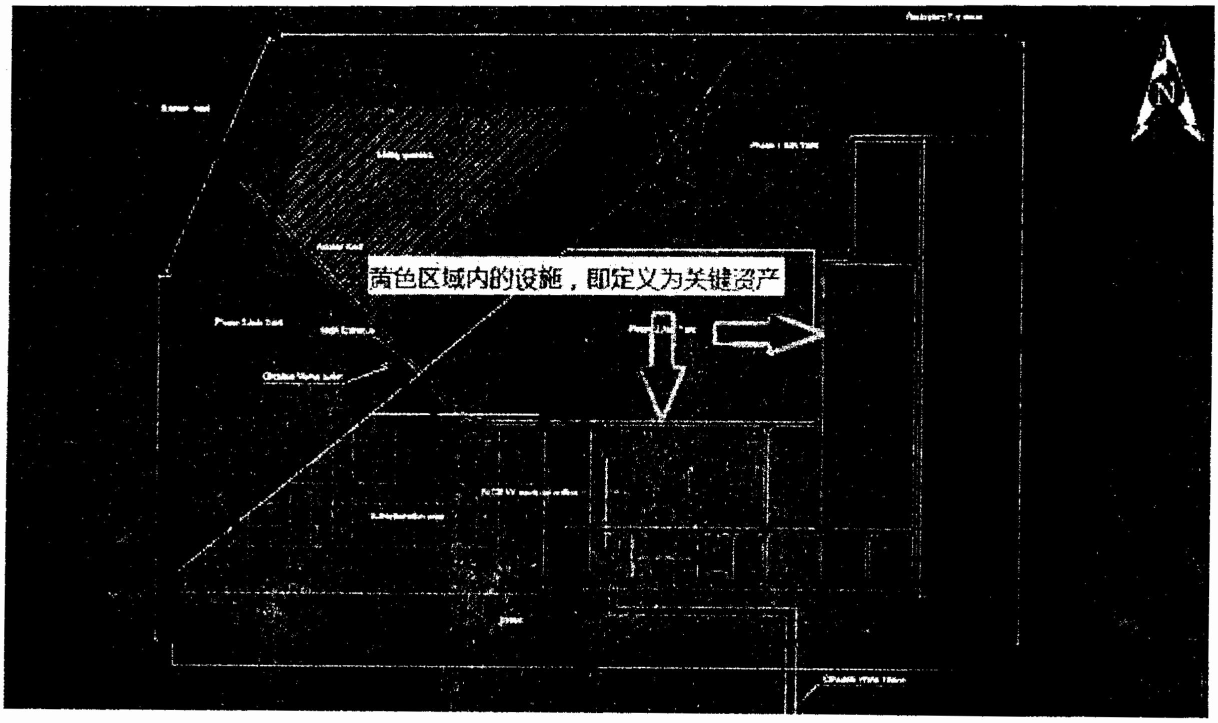
In 2006, when President General Pervez Musharraf launched a military operation in the Marri and Bugti tribal areas, it caused a wave of about 100,000 IDPs who fled to neighbouring districts. By 2016, the precise number of Baloch IDPs was unclear. A huge number of Baloch IDPs fled to Afghanistan but are still being targeted by the ISI.

As of February 2017, an estimated 250,000 people are displaced by violence from Balochistan.

10.2.4 Critical Assets

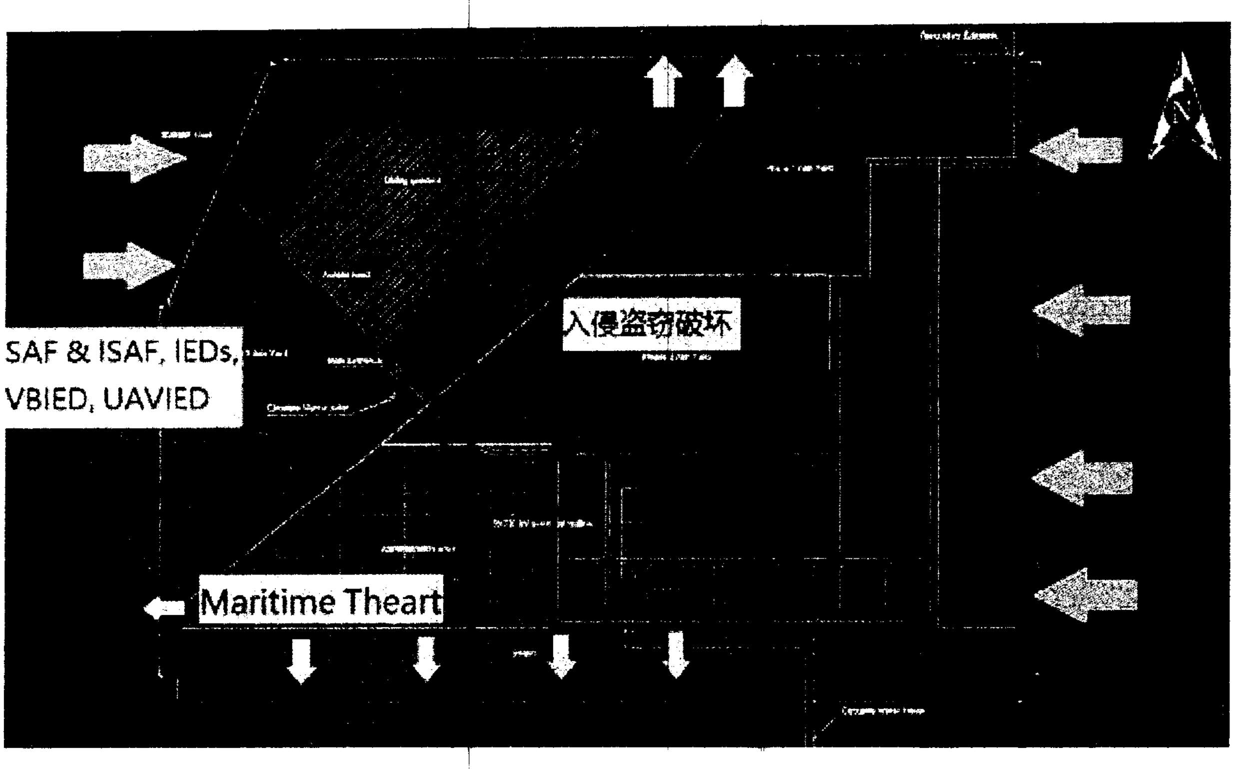
Key assets are defined as - systems and equipment that, if subjected to any damage that will affect the reliability or operability of large capacity power systems, are referred to as critical equipment

Figure 13.5 – Security Layout



10.2.5 Threat Assessment

Figure 13.6 – Threat Assessment



The following alert states table is provided as an explanation of the varying degrees of criticality/threat levels and associated actions that will be undertaken in the event of the occurrences of any of these various threat scenarios.

Criticality/Threat Level	**Situation**	**Action**
Extreme (B&R Emergency Evacuation Procedures Level BLACK)	▪ Declared when an attack by Anti-Pakistani Forces (APF) has occurred or credible intelligence indicates that an attack is imminent against project. ▪ Iraqi government is close to losing control and Iraqi Security Forces (SF) are no longer in control. ▪ General breakdown in law and order. ▪ Security of life support facilities, work sites or other facilities are likely to be compromised or overwhelmed. ▪ LN security personnel/SF dessert posts ▪ Outbreak of civil;secular war appears imminent.	▪ Emergency Management Team (EMT) assembled as required by B&R Emergency Evacuation Procedures and assumes control ▪ Constantly revaluate security situation/posture ▪ Site lockdown ▪ Secure and account for all clients Confirm evacuation location and movement plan with EMT ▪ Prepare sites for evacuation (if applicable) Shred/Burn/destroy commercially sensitive documents and electronic memory devices (portable/hard drives etc) ▪ Secure or destroy non-essential

High (B&R Emergency Evacuation Procedures Level BLACK)	▪ Credible threat exists, declared when there is a high risk of attack by APF and civil unrest. ▪ Civil unrest increasing and law and order breaking down. ▪ Regular indirect fire attacks on company facilities. ▪ Continuing attacks against project assets, critical infrastructure and facilities such as logistics convoys or critical infrastructures effecting ability to provide life support or continuing operations.	▪ EMT assembled as required by B&R Emergency Evacuation Procedures and assumes control ▪ Constantly revaluate security situation/posture. ▪ Site lockdown. ▪ Secure and account for all clients. Increase frequency of threat assessment updates. ▪ Confirm evacuation location and movement plan with EMT. ▪ Evacuation resources to be identified andprepared and confirm emergency stocks. All movement to and from affected
Significant (B&R Emergency Evacuation Procedures Level RED)	▪ Significant risk of attack by APF or civil unrest. ▪ There is a general risk of APF attacks against project assets (personnel and material). ▪ Frequent and effective attacks against SF. ▪ Potential for civil unrest.	▪ EMT assembled as required by B&R Emergency Evacuation Procedures and assumes control ▪ Constantly re-evaluate security situation/posture ▪ Daily meeting of key stakeholders. Review security measures in relation to escalation of criticality/threat level ▪ Review evacuation management
Moderate (B&R Emergency Evacuation Procedures Level AMBER)	▪ Declared when there is a moderate risk of APF attacks against project assets (personnel and material). ▪ Infrequent but effective attacks against SF. ▪ No civil unrest. ▪ Law and order maintained by SF	▪ EMT liaises with national SF elements. ▪ EMT monitoring. ▪ All personnel to be accounted for and documented muster conducted. ▪ Continue to monitor security
Low (B&R Emergency Evacuation Procedures Level AMBER)	▪ Declared when there is a low risk of APF attacks against project assets or critical infrastructures. ▪ No recent attacks against SF. ▪ No civil unrest. ▪ Law and order maintained by SF	▪ All personnel to be accounted for and documented muster conducted. ▪ Continue to monitor security situation and escalate if required.

10.3 Vulnerability Assessment

Vulnerability assessment among Site security also covers mobile operations of CCCC's personnel traveling out of premises.

Identified Threat	Untreated Vulnerability Rating	Mitigating Strategies	Treated Vulnerability Rating
Direct small arms fire (SAF)	Elevated	▪ Robust and detailed mission planning ▪ Use of properly maintained B6 armoured vehicles, Use of appropriate PPE ▪ Experience and qualifications of security personnel Training provided to security personnel ▪ Adherence to tested standard operating procedures and tactics Information and	Low
Indirect SAF	High	▪ Robust and detailed mission planning ▪ Use of properly maintained B6 armoured vehicles, Use of appropriate PPE ▪ Experience and qualifications of security personnel Training provided to security personnel ▪ Adherence to tested standard operating	Low
Direct exposure to improvised explosive devices (IEDs). Include	Elevated	▪ Robust and detailed mission planning ▪ Use of properly maintained B6 armoured vehicles, Use of appropriate PPE ▪ Experience and qualifications of security personnel Training provided to security personnel ▪ Adherence to tested standard operating	Low
Indirect ex posure to improvised explosive devices (IEDs).	High	▪ Robust and detailed mission planning ▪ Use of properly maintained B6 armoured vehicles Use of appropriate PPE ▪ Experience and qualifications of security personnel Training provided to security personnel ▪ Adherence to tested standard operating	Low
Kidnap and ransom	Medium	▪ Robust and detailed mission planning ▪ Use of properly maintained B6 armoured vehicles Use of appropriate PPE ▪ Experience and qualifications of security personnel Training provided to security personnel ▪ Adherence to tested standard operating procedures and tactics Information and intelligence received from credible sources	Low
Detention by local security forces	Medium	▪ Meet and greet provided at point of arrival into Iraq, ▪ Team leader ensures all personnel B&R/CCCC) possess required documentation prior to mission launch, ▪ Each team has at least one member with Punjabi/Pashto/Balochi/Chinese/English language abilities, Properly licensed private security company, compliance with all relevant laws and directives,	Low

Road Traffic Accidents	Medium	▪ Experience and qualifications of security personnel. Training provided to security personnel relating to driving mission specific vehicles, ▪ Adherence to CCCC specified compliance with all ees Training provided tions to night driving, ▪ B&R driver meets all applicable standards including CCCC's Health Safety and Environment (HSE) standards	Low

10.4 Security System Concept Design

10.4.1 Scope of Security Systems Concept

The Concept of Security system is combining of physical security with help of electronic security equipment. Perimeter will be monitored by tower guards in watch towers and patrol guards, together with CCTV and intruder detection system. Entry control points will be permanently operated by security personnel accompanied by K-9 dogs and equipped with modern scanning and screening equipment, such as metal detectors, x-ray machines etc. B&R will draw on all its experiences and practices developed in different hostile environments while developing and operating the security regime at the Site.

Security personnel performing security tasks will be local nationals who have been properly vetted by B&R and who have the necessary qualifications and experience to perform entry control point duties, guard tower operations, static and roving patrols and will be overseen by onsite expatriate managers.

Guards will be assigned in two, twelve-hour shifts per day along with an expat Guard Force Supervisor (GFS) performing one shift per day overlapping the security shifts, and supervision provided each day through shift leaders. The number of security personnel assigned to this task is based on the current general risk/threat profile for Pakistan, and the physical size of the Sponsors' camp. The solution is scalable and can be increased or decreased dependent on the requirements.

While on duty, security personnel will be equipped with PPE and other security equipment such as two-way radios, flash lights, under vehicle viewing mirror, etc. Security personnel will be properly qualified and trained in relation to the security equipment.

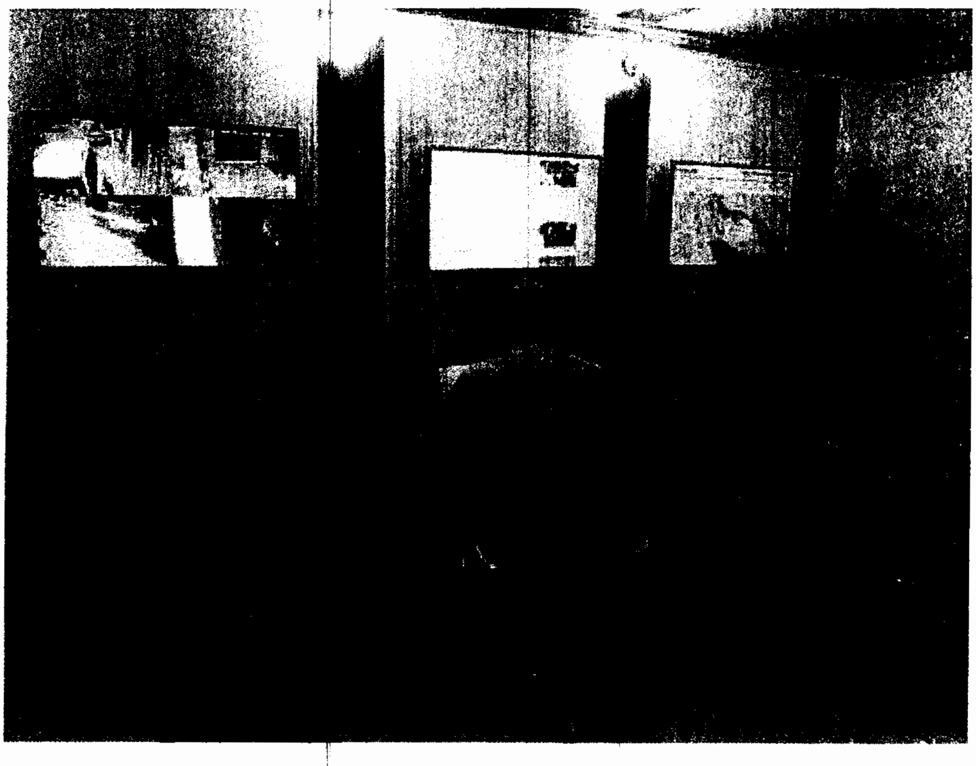
Scope of Security Systems will cover:

- **Physical Security**
    - Tower Guards;
    - ECP Guards;
    - ECP K-9 teams;
    - Patrol Guards;
- **Electronic Equipment means:**
    - CCTV Surveillance system;
    - UAV monitoring (optional);
    - Intruder Detection System;
    - Explosive Detection equipment;
    - More details in part 5.

10.5 Security Systems

10.5.1 Command and Control

B&R will maintain a centralized monitoring and command location at the Sponsors' Main Camp staffed by the on-site operations room security personnel on a 24/7 basis. The control centre will serve as the communication dispatch centre for the site static security operations. The Control Centre will also maintain communications with B&R's Headquarter for the close monitoring and tracking of the Sponsors' mobile security operations. The Command Centre will maintain audio contact with the static security team, as well as monitor through the personnel tracking system.



10.5.2 Surveillance Systems

Surveillance system to be established for video monitoring of the Site. Monitoring will be conducted on 24/7 basis from control room by trained and duly vetted security personnel. Exact scheme of camera placing is to be developed in accordance with the building schemes taking into account location of premises, landscape and weather conditions.

10.5.2.1 CCTV System

Design Concept:

- The entire IP surveillance system is designed to control and monitor the different Site area. All the corridors will have IP Fixed dome camera to monitor the connecting corridors.
- Three types of cameras will be installed to monitor the movement of the people as follows:
  - IP fixed dome camera indoor type;
  - IP fixed box camera outdoor type;
  - IP fixed dome camera will be installed at the entrances and connecting

corridors of the main buildings like offices, laboratories, server rooms, living areas, etc.

- IP fixed box camera will be mounted on the pole at all boom-barrier and main gate to monitor the vehicles and pedestrians passing by.
- All cameras will be true IP camera.
- All outdoor cameras will be in IP-66 housing.
- All outdoor items for cameras like JBs, power supply, media convertor etc. will be in water poof and dust proof housing.
- LAN network being laid by third party would be utilized to extend the IP CCTV connectivity to central server.
- All CCTV cameras will have connectivity to non- PoE port of networking switches on LAN.
- UPS Power supply for each camera.
- Tentative locations of cameras shall be determined during the Site visit after finalization of the Project construction plan.

Work to be done:

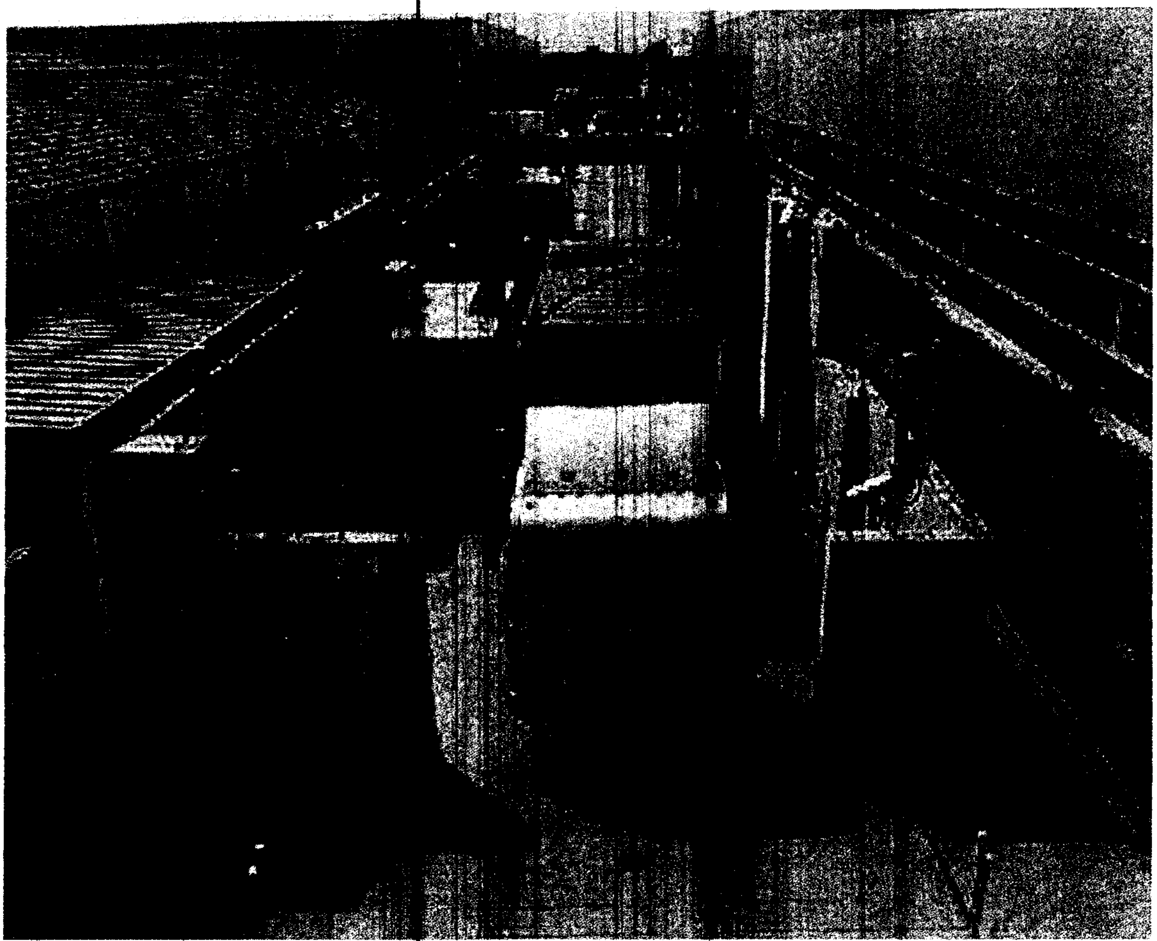
- Supply, installation, testing and commissioning high quality fast-acting IP CCTV surveillance system along with power supply, power distribution and required accessories in the different blocks of CCCC Premises.
- The CCTV surveillance system will consist of IP Fixed dome cameras (indoor type), fixed box cameras (outdoor type), software, server, power supply and cables.
- Video management software, including recording, will offer both video stream management and video stream storage management. Recording frame rate and resolution in respect of individual channel will be programmable.
- The system is presently designed for 32 cameras whereas not limited to the same and scalable up to unlimited cameras if required in the future.
- Cat 6cable/fibre cable connectivity with all required hardware up to networking switches of LAN, locations of networking switches.
- 230 volts AC Power supply distribution from UPS to each location of cameras along with DBs, JBs, cabling work etc. with required accessories.
- Power supply unit as required for cameras.

10.5.2.2 Vehicle detection system

In order to prevent and control the possible risk of VBIED or IED, for the daily multi-vehicle round-trip of large-scale coal truck, vehicle scanning technology will be adopted to improve the speed of plant traffic and effective prevention and control of explosives risk.

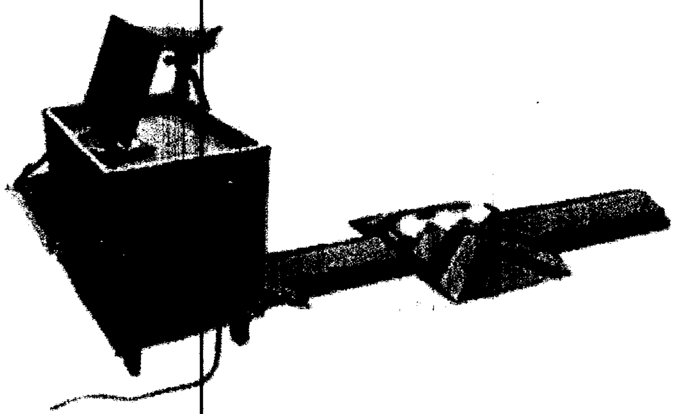
(1) Vehicle inspection system

Large transport vehicle quick check system can be done without stopping due to high pass rate fast X-ray inspection system. At the same time through the optional drag device can be applied on cars, sport utility vehicles, pickups, micro-buses and other small and medium-sized vehicles, with a high pass rate, check the channel, the image quality and other characteristics.



(2) Vehicle floor inspection system

The vehicle safety inspection scanning system mainly for the car, can quickly and accurately check out hidden in the car at the end of the explosives, weapons, suspicious items, compared to the traditional hand-held mirror human detection more quickly and accurately, greatly improving the access through the rate, while preventing Dangerous vehicles to enter, take preventive measures.



10.5.2.3 Remote monitoring by the means of Unmanned Aerial Vehicle (UAV)

(1) UAV use purpose

Equipped with high-definition digital cameras and cameras and GPS positioning system UAV, can be positioned along the power plant independent cruise, real-time transmission of shooting images, monitoring personnel can be synchronized on the computer to watch and control.

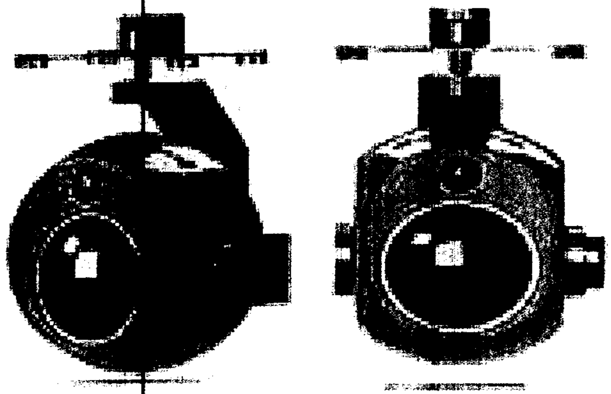
- As an air patrol, early warning time
- all-weather patrol, equipped with FLIR (thermal imaging system) so that lawless elements without any escape
- real-time transmission to increase the warning field, and video archive
- with security monitoring radar, complementary zone
- When the electronic fence detection alarm can be dispatched first, in advance for the patrol to find out the situation
- multiple groups of unmanned aerial vehicles can be composed of multiple sub-regional patrol, ready to provide information
- can monitor the weaknesses for long periods of standby
- Instant transmission to the TOC to provide PM first line of information to help release the correct response

UAV will be controlled by the OM in the TOC and the other will be the Chinese security officer. The routine patrol will be controlled by the OM, set up patrol routes and patrol points.

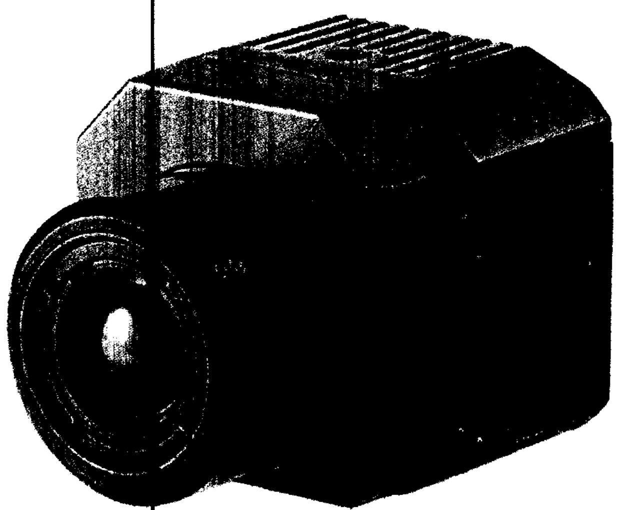
It may be noted that the adoption of UAV at a systematic level for a long period of time over a space beyond the Site itself, i.e., when it will be used to track the movement of coal trucks etc., may need clearance / NOC from defence authorities as such a usage for this type of technology over an extended area for an extended time is unheard of.

UAV vehicle monitoring of coal handling fleet

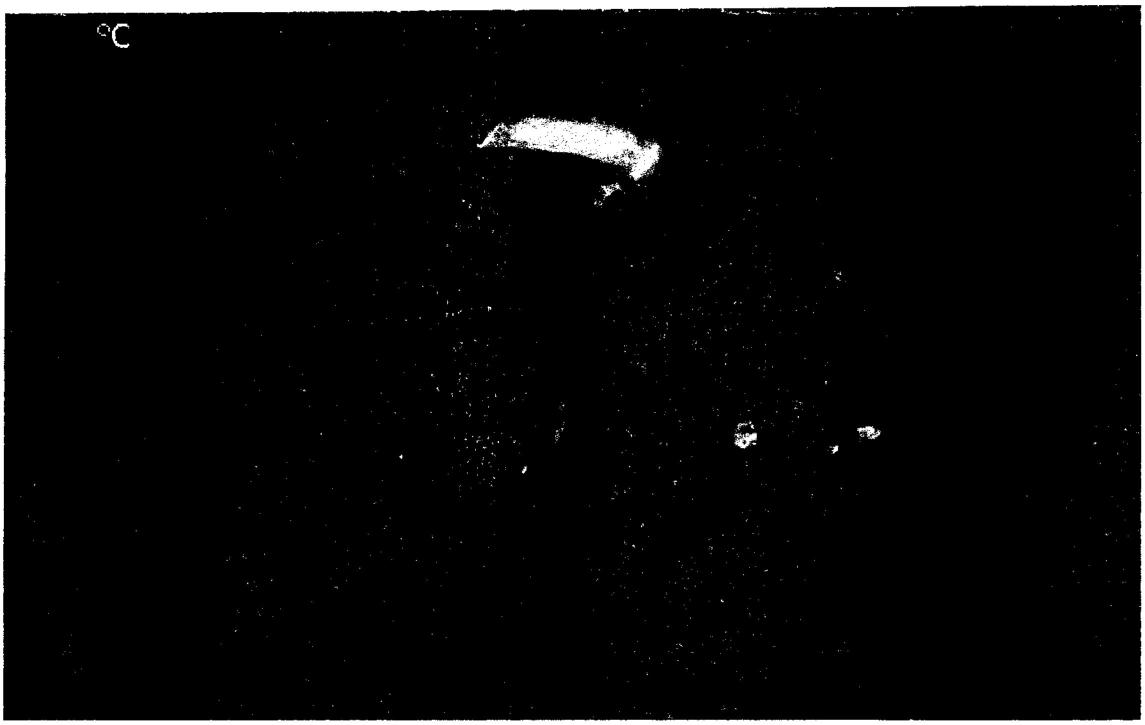
B&R choose to be able to stay for a long time, carrying heavy-duty photoelectric system and vehicle transport radar module, IFF enemy identification system of unmanned aerial vehicles, 10 km away from the power plant before the first detection and identification of vehicles, confirmed that they belong to coal vehicles, Traffic, supplemented by the OBD records and GPS systems on each vehicle of the fleet, to identify anomalies of the vehicle to inform the remote checkpoints to be intercepted, and to block all possible hazards outside the power plant.



UAV photoelectric cabin, double light



FLIR lens



FLIR Imaging

10.5.3 Automatic Access Control and ID Management

ID management

The ID card is an electronic identification card containing the chip, which allow personnel to pass through the access control device according to the different permissions of the defined regional activities.

Employee card

Identity card issued to personnel to perform their duties.

- All employee cards will contain information representing name, department, employee number, permission sign and photo.
- The ID card must be worn above the waist and can be observed at any time.
- When working in other non-authoritative areas, the employee must request his supervisor for requesting access to the area with indicating of a certain date and time, PM will be given for temporary according to the assessment of the staff ID card.
- ID card content is unique for each employee, the ID card cannot be used for access control, electronic verification must be in accordance with the person.
- Any employee who has lost the ID card should immediately contact his department head to report to the Human Resources Department.

Contractor's card

Issued to the material supplier, service supplier representatives or professional consultants, related to the category and the business field.

- The contractor's card is required to submit the name, supplier name, number or any other link to the responsible department.
- The Contractor shall wear a compliant supplier card in a visible position during staying at the facility.
- Departmental staff or department heads related to the contractor is the person in charge of the contractor.
- The person in charge will be accompanied by the contractor entering the camp area at all time.
- At the request of the responsible person, the contractor will remain in the work area for more than one day
- Temporary personnel will be issued IDs through the contractor with a photo and the use of the temporary authority ID card.
- The contractor's card must be returned to the person in charge or to the security manager at the end.

Visitor Card

Distributed to groups, individuals, or family members who have a reasonable need for a site visit.

- All visitors are required to have designated staff or designated docking department head as the person in charge.
- Visitors shall be required to inform the security department at least one day in advance of the visit and name, reason, activity area, visit time, shall be shared with the person in charge.
- After entering the relevant area, visitors should wear ID cards accordingly.
- The person in charge shall accompany the visitor to enter the camp until they leave.
- Employee family members who apply for a visitor card need to register employee information and have no access to work area.
- The visitor card must be returned to the person in charge or to the security manager at the end.

Automatic access control system

This system is powered by an electronic card reader through the custom ID card, various colours for various levels, for access control, sensor scan, while on the computer side the access information is aggregated into the TOC server centre. In the office area and the key areas of the plant or areas with confidential needs domain settings password or fingerprint detection system is added to create a hierarchical system to ration access.

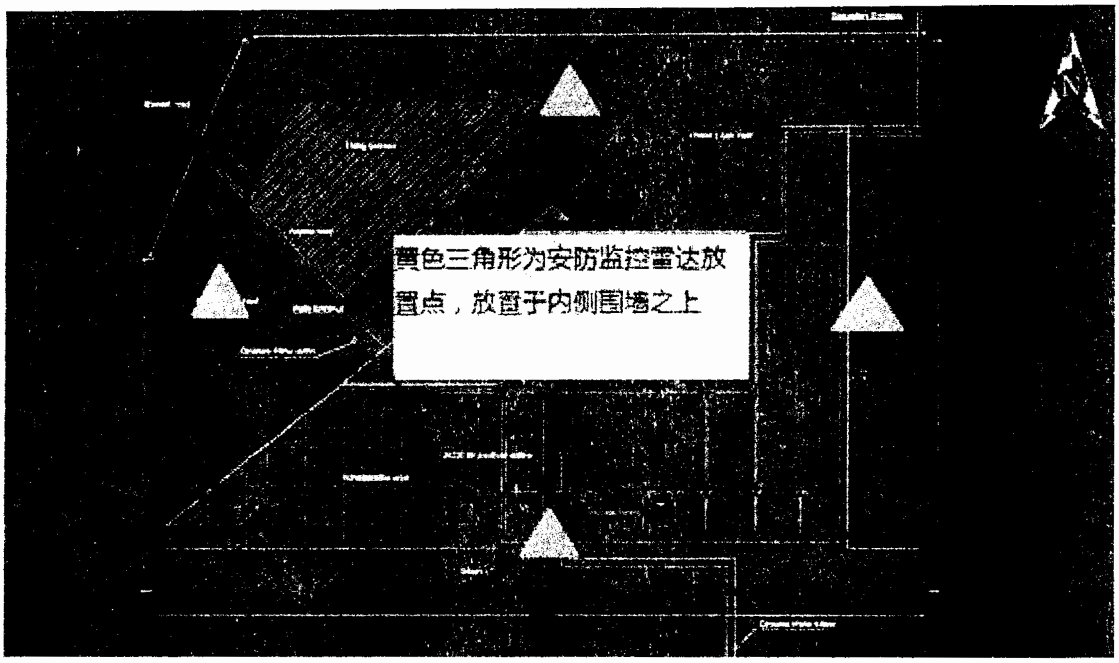
A license plate recognition system and pedestrian access registration system, with ID card entry line scan will be provided.

10.5.4 Intruder Detection System

It has been assumed that the perimeters in the main will consist of a perimeter wall 8ft high with a concertina coil overhang of 1 and ½ ft.

The total CCTV/PIDS solution will be connected to a Main Control Room within the CCCC facility.

Figure 13.7 – Detection System



Secondary Detection System

The Active Infra-Red Beam Detection System is a series to transmit and receive multi beam sets enclosed in a 2m external freestanding beam tower. Each tower is to be located in parallel to each Radio Frequency Intruder Alarm Detection zone and is to be interfaced with the Primary detection zone to provide a secondary verification detection zone.

10.5.5 Pedestrian Screening

Similar to vehicles entering and leaving the Site, pedestrians will also be subject to random searches while entering or exiting the facility primarily as a security and loss prevention measure.

10.5.6 Maritime Security Measures

The objective of waterfront security system is to secure the waterfront from unauthorized access and to detect and neutralize threats while minimizing impacts to port operations and the environment. Design considerations are:

- Security
- Port Operations
- Safety
- Appearance
- Environmental impact

Security:

Installations should focus first on threats at the first line of defence – the installation perimeter. Consideration of the waterfront is extremely important to defence-in-depth and effective risk mitigation.

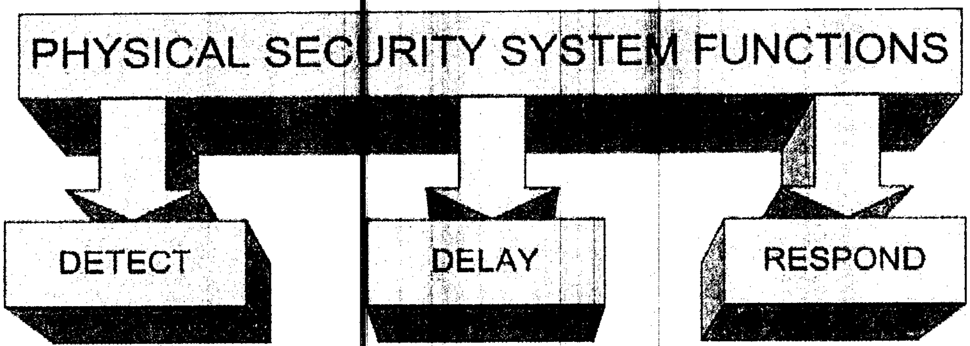
The first priority of a waterside security system is to maintain perimeter security.

Physical Security System.

The figure below shows the functions of a physical security system. The table below that depicts the physical security protection measures of a waterfront security system.

Figure 13.8 – Physical Security System Functions

Diagram of Physical Security System Functions



- Intrusion Detection/Alarm Communication/Alarm Assessment/Access Control
  - Electronic Security System (ESS)
  - Electronic Harbor Security System (EHSS)
  - Security Forces
  - DoD Personnel
  - Military Working Dogs
  - Security Lighting

- Obstacles
  - Security Patrols
  - Barriers
    - Fences
    - Walls
    - Gates
    - Locks
  - Distances
  - Procedures

- Communicate Threat
- Deploy response capability
- Time to engage threat
- Threat neutralized by response capability

Table 14.2 - Waterfront Security Elements

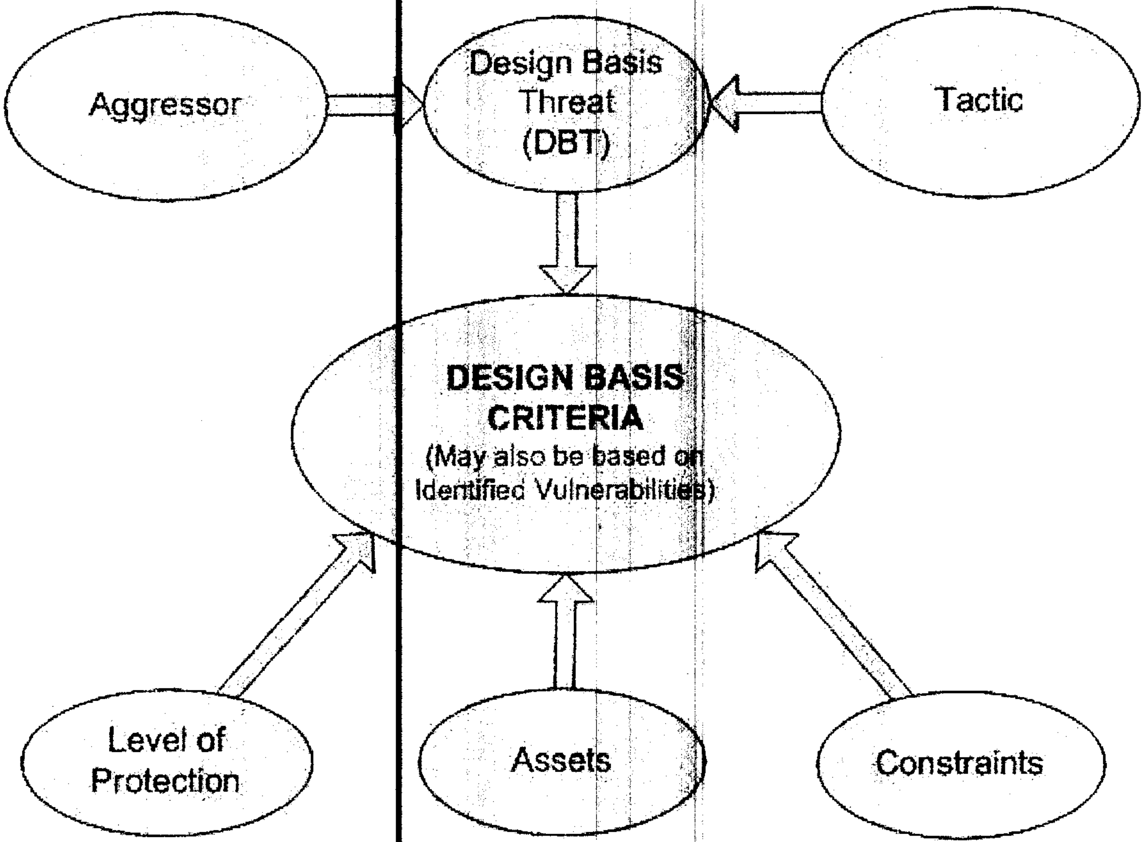
Waterside	Landside	
Water	**Piers/ Wharfs**	**Land**

Channel
Markers Buoy
Line Barriers
Signage Patrol Boats
Electronic Harbour
Security System (EHSS)
• Surface detection/assessment o Cameras
  o Thermal Imagers
  o Radar
  o Video Analytics
• Subsurface detection/assessment
• Sonar
	Guard Towers
	Security Lighting
	Access Control
	Point
	• Vehicle
	• Pedestrian Giant Voice
		Fences
		Access Control Point
		• Vehicle
		• Pedestrian Security
		Lighting
		Electronic Security
		System (ESS)
		• Camera
		• Intrusion Detection
		• Access
		Control Giant
		Voice

Establish Liaison with the Local or Assigned Security Personnel

The most important component of the security services management process is close liaison with the local administration and the security administration. B & R and the Project management shall develop protocols and SOPs for clarity and effective implementation of the security strategy.

Figure 13.9 –Project Security Process



11. Project Operations and Maintenance

11.1 O&M Philosophies and Considerations

The 30-year operating period of the power station shall include two stages, wherein the first stage shall be EPC stage (including two years of operation warranty period), and the second stage is the long-cycle operating stage, namely the power station shall be operated 28 years continuously upon expiration of the operation warranty period. In the first stage, the plant shall be operated by the O&M Operator or the Owner and the EPC contractor shall be liable under the warranty period or extended warranty period liabilities.

(1) Management contents of the first stage

The service cycles of the operating units shall last from starting of production preparation period until the 2-year operation warranty period ends. This period shall be longer than two years.

In the first stage, the Owner, the EPC party and the operating units shall have respective responsibilities as follows:

Responsibilities of the Owner: take charge of buying the fuel and controlling the production expenses while formulating the annual power quantity plan, acquiring the feed-in tariffs and selling the electricity.

Responsibilities of EPC Contractor, EPCC: responsible for designing, purchasing, construction and installation of the project before RTR; take charge of eliminating the defects due to design, equipment, installation and construction reasons during 2-year operation warranty period after RTR, and unified management of operating units. This is true if the EPCC is the O & M Contractor. Even if the EPCC is not the O & M Contractor, the liabilities under warranty and extended warranty shall continue to be EPCC liabilities.

Responsibilities of EPCC / O & M Operator: Take charge of operating the units safely, stably and economically, improve the health and reliability levels of the equipment of the power station in order to ensure the equipment are in the good state; implement professional training for the operating personnel and equipment maintenance personnel in league with the EPCC; submit the defects of the system and the equipment to the Owner and EPC party timely, wherein the EPC party shall be responsible for eliminating these defects; offer the technical monitoring reports of the equipment to the Owner timely in order to help the Owner to control the health condition of the equipment and make the equipment achieve the great health level after the operation warranty period.

(2) Management contents of the second stage

The second stage is the long-term operating stage, namely the power station shall be operated for 28 years continuously after the operation warranty period.

This scheme calculates the expenses on the basis of firm fixed-price.

In the second stage, the Owner and the O&M Operator shall have respective responsibilities as follows:

Responsibilities of the Owner: take charge of buying the fuel and controlling the production expenses while formulating the annual power quantity plan, acquiring the feed-in tariffs and selling the electricity.

Responsibilities of the Operator: take charge of managing the power generation operation and production equipment of the power station; implement professional training for the local personnel, increase the proportion of local employees of the power station gradually and reduce the labour cost year by year; and offer the technical monitoring reports of the equipment to the Owner timely in order to help the Owner to control the health condition of the equipment.

In short, the relationship between the O&M Operator and the Owner shall be typical of such relationships as exhibited in case of other IPPs where the IPP is under a long-term O&M contract with a third party

11.2 O&M Agreement

The Owner may consider for its O&M Contractor, some leading Chinese operators, with solid reputation and experience for similar projects. The O & M agreement is expected to be generally along the lines as practised in many such projects in Pakistan and abroad.

11.3 Scope of Services

The operating contents of the production preparation period shall include formulation of operating documents, such as operating rules, operating system diagram and operating standard operation ticket, formulation of operation management system, training of operating personnel, preparations of operating tools, qualification acquisition of operating personnel, etc.

Maintenance service contents of commissioning period

1) Participate in commissioning of the equipment and write down the test run records of equipment for each unit from the single commissioning.

2) Do a good job in supervision of health condition of equipment during test run of subpart, overall start-up and reliability test run of each system; and supervise and check the installation condition of equipment after getting approval from the Owner.

3) Guide the local maintenance personnel to complete equipment defect elimination and maintenance of the routine equipment during quality inspection period.

4) Before test run of subpart and reliability test run, participate in reviewing of the commissioning program or operating instruction offered by the commissioning unit.

5) Participate in review the performance test scheme of the unit and assist the testing unit to complete the performance test.

6) Write down the test records and inspection records during the whole process including single test run, test running of subpart and overall start-up.

7) Participate in design review in accordance with requirements of the Owner, offer the technical support and assist to implement acceptance inspection and sign the certificate for the test run equipment.

8) Write down the detailed records timely in allusion to the problems on aspects including design of the project, equipment installation and system commissioning and the equipment defects, and report these conditions in time.

9) The guiding personnel shall do a good job in relevant safety and technical measures and failure prediction before the equipment problems are solved in order to prevent the situation from escalation.

10) Check I/O list of the control system, fixed values of thermal control and electric protection, and fixed value of interlocking, and put forward the suggestions.

11) Assist to complete suspension and checking of all placards of equipment and valves and all kinds of warning boards, and set up the equipment account.

12) After getting approval of the Owner, participate in investigation and analysis in allusion to equipment damage, manual incidents or interrupt accidents occurred during running before completion of performance test of the unit; and put forward the countermeasures.

Maintenance contents of 2-year operation warranty period

1) Be responsible for guiding operation and maintenance, such as normal running operation, monitoring, patrolling inspection, repairing, recording, maintenance and accident handling of the equipment within the scope of work of the Owner.

2) Arrange the operating mode of the unit reasonably in accordance with the power generation plan, or the Owner's instruction, the technical condition, fuel supply and other conditions of the generating equipment during the operating period.

3) Do a good job in counting, collecting and keeping the operating records and operational performance documents of the generating equipment, and report the operating information and statistical information of the generating facilities in accordance with the requirements of the Owner. Do a good job in safe and economic operation analysis of the unit, schedule the unit reasonably, optimize and adjust it to improve the economic operation level of the unit

4) Implement necessary training on production knowledge for the operating and maintenance personnel of the Owner.

5) Convene the regular operation meeting every week periodically, wherein the Owner representative shall participate in the meeting. Implement regular meeting with the Owner party after internal regular meeting every week, offer and analyse the running condition of the equipment system and main technical and economic indexes while formulating the scheme and measures of improving the safe and economic operation level and urging the operating personnel to implement.

6) The person in charge of operation shall be responsible for operation guidance, and the situation at post and mental condition of the operating personnel shall be checked randomly; and the professional engineer shall be responsible for revision of the operating specifications and relevant rules and regulations, post technology training, and formulation of major operations, such as test run, start-up and shutdown of the unit, organization measures of the test safety technology and accident emergency plan.

7) The shift supervisor shall be responsible for organizing and leading all operating personnel to complete the instruction, command and work plan of the Owner. The shift

supervisor shall implement production scheduling (including emergency stop for rush repairs of the main and auxiliary equipment, and maintenance arrangement) in accordance with the scheduling command and load curve. The shift supervisor shall also ensure safe and economic operation of the unit and coordinate the jobs among all specialties.

8) The chief person on duty shall accept scheduling of the shift supervisor and take charge of safe and economic operation of the equipment and system. The chief person on duty shall implement various rules and regulations seriously and arrange the personnel at post to adjust, operate and patrol normally, report the problems found in timely and take the measures quickly to handle. The chief person on duty shall also ensure to report any problems found to the Project Department first.

9) The person on duty shall accept the command and guidance of chief person on duty on operation; and the person on duty shall also complete operation, periodic switching test and inspection, report the abnormal condition found in time and assist the chief person on duty to take measures quickly to handle the abnormal condition.

10) Set up the effective mechanism, implement various labour contests, such as operation optimization, and try to reduce consumption and maintain advantages of the operating indexes of the unit.

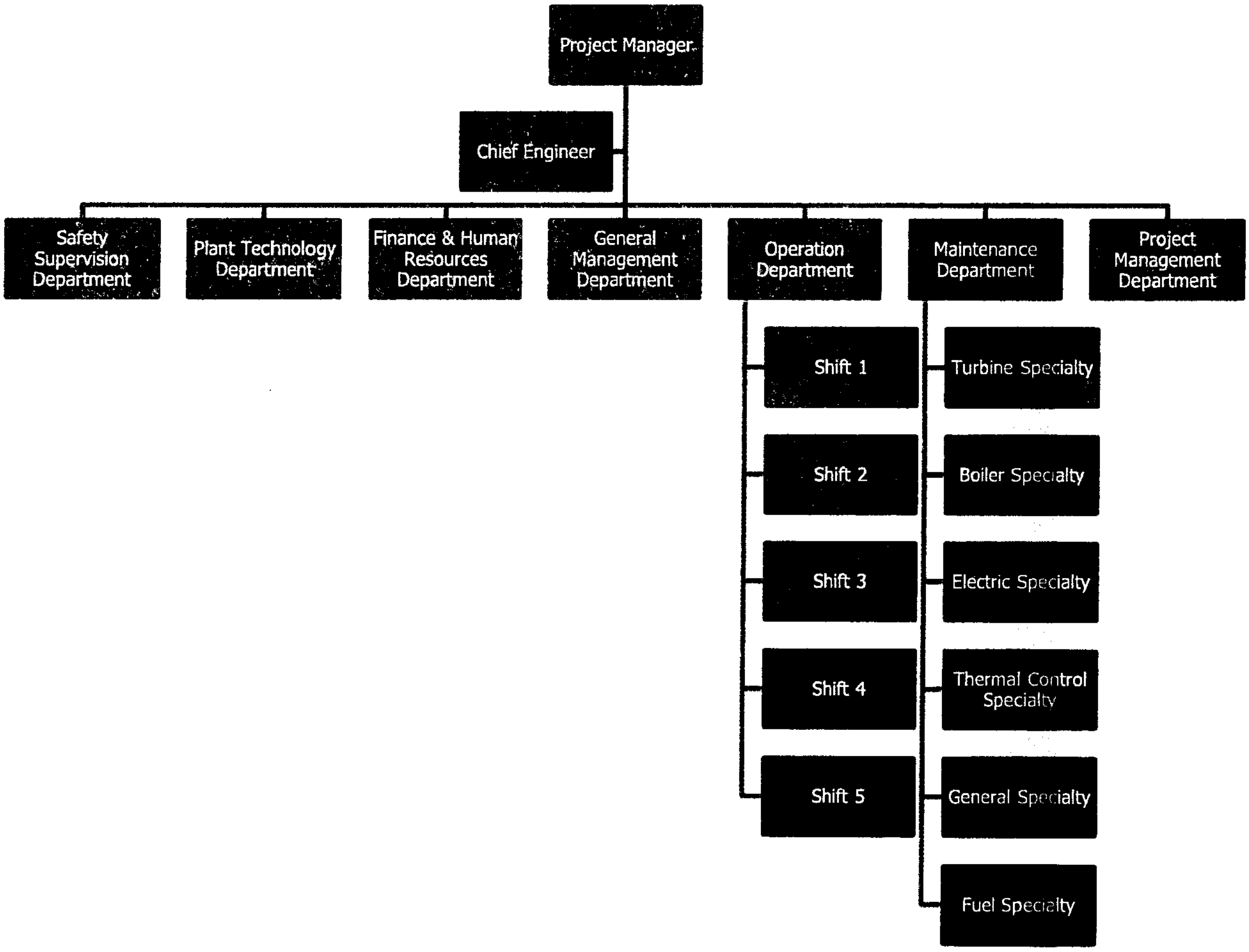
11) Hold the operation analysis periodically and prepare the failure plan effectively in allusion to the seasonal characteristics and equipment condition; and implement anti-accident and fire-fighting drill to improve the handling ability of the operating personnel when meeting accident.

Operating organization and contents of the second stage

Compared with the 2-year operation warranty period of the first stage, the organization, personnel allocation, department responsibilities, and responsibilities of posts on site of the operating organization and contents of the second stage are identical. And the localization proportion of production personnel shall be improved to 10% every year from 5%. Moreover, the detailed content of overhauling management and personnel training shall be explained in the part below.

11.4 Operator O&M Methodology

11.4.1 Organization Chart



The Project management in all the phases, development through commercial operations shall be governed by best practices as applicable in Pakistan.

12. Project Participants

12.1 Sponsors

China Communications Construction Company Limited ("CCCC" or "Main Sponsor")

CCCC is listed on the Shanghai and Hong Kong stock exchanges (Ticker symbols: 601800, 1800, respectively). As a world leading extra-large infrastructure comprehensive service provider, CCCC is involved in traffic infrastructure, equipment manufacturer, real estate, comprehensive urban development, etc. Its aim is to provide clients with complete solutions and integrated services for investment and financing, consultancy and planning, design and construction, as well as management and operation. At present, CCCC is the largest harbour design and construction company, highway and bridge design and construction, dredging, container crane manufacturer, and the largest offshore oil drilling platform design company in the world. Moreover, it is the largest international project contractor, the largest design company, the largest express highway investor, and possesses the largest dredging fleet in China. In 2016, CCCC was ranked 110th by Fortune 500 and ranked third (3rd) in Top 250 International Contractors by Engineering News-Record ("ENR"), a leading magazine for the construction industry. CCCC, being the Main Sponsor will hold 74.5% of the total shareholding.

Tianjin Energy Investment Group ("Tianjin" or "Co-Sponsor")

Tianjin, a state-owned corporation, was founded in May 2013 and has registered capital of RMB 10 Billion. As a main entity based in Tianjin, it is involved in the construction, operation, and management of energy projects. Accumulated installed capacity of invested and constructed units is 12,558MW, which more than 90% of total adjustable installed capacity of Tianjin. They have constructed the largest fuel gas heat power plant in China, Tianjin Chengnan Fuel Gas Heat Power Plant. Projects in association with large power generation enterprises of China, namely Huaneng Group, Datang Group, SDIC Power Group, China Guodian Corp., China Huadian Corp., and Guohua Power Group, include Beijiang Power Plant, Yangliuqing Heat Power Plant, Dongbeijiao Heat Power Plant, Beitang Heat Power Plant, Junliangcheng Heat Power Plant, Dagang Power Plant, and Panshan Power Plant.

12.2 Power Purchaser

CPPA-G, a company created by Government of Pakistan, is a non-profit independent company established under the Companies Ordinance, 1984 and solely responsible for implementing and administering the "Single Buyer Plus" market mechanism (ultimately leading to competitive market operations). CPPA-G purchases power on behalf of Distribution Companies ("DISCOS") from IPPs. The Project shall be entering into negotiations with CPPA-G for the sale of energy to the national grid and shall enter into a PPA in this regard.

12.3 EPC Contractor

EPC contractor will be later determined through bidding conducted under NEPRA guidelines.

12.4 O&M Contractor

O&M contractor will be later determined through bidding.

12.5 Coal Supplier

Renowned coal suppliers such as Anglo - American resources, Glencore, Surveyor Carbon Consulting Indonesia, CCIC Singapore PTE LTD etc. shall be considered and invited for coal procurements discussions.

13. Personnel & Labour Security

13.1 Personnel Requirement

13.1.1 Development Phase

During the development phase personnel will mainly come from the Sponsors.

13.1.2 Construction Phase

Besides main engineers and technician, most of the labour resource will be procured from local markets during construction phase. During construction and installation peak period, it is estimated 800~900 people will be required on site.

13.1.3 Operations Phase

The Project shall generally follow the "Notice on Issuing the Labour Requirement Standard of Thermal Power Plant (trial)" by State Grid Corporation of China. The general organizational framework and staffing principles for the project are as follows, subject of course to the actual situation on the ground:

Table 15.1 – Operations Phase Personnel

Item	Persons	Description
1. Production Personnel	293	Includes maintenance personnel
a. Operation personnel of units	102	Includes 10% back-up operation personnel
i. Operation personnel of steam turbine, boiler and generator (central control room)	55	Recirculating water equipment is concurrently managed by the operation personnel of central control room and air compressor
ii. Operation personnel of ash-handling and dust removal	11	Two units share a control room
iii. Operation personnel of desulfurization and denitration	17	
iv. Chemistry operation personnel	19	Control room in which on-line monitoring system is available
1) Chemistry operation personnel	11	
2) Analysis personnel	8	
b. Maintenance of Units	114	
i. Thermotechnical	52	Include 4 persons of FGD system
ii. Electrical	30	
iii. I&C	32	
c. Fuel System	63	Includes 10% back-up operation personnel
i. Fuel Operation Personnel	24	
ii. Fuel Maintenance Personnel	24	
iii. Fuel Management Personnel	15	Land transportation and manual sampling of coal
d. Others	14	

i. Warehouse	6	
ii. Vehicle	8	
2. Management Personnel	30	Includes admin, production, business, logistics and management personnel
3. CCP and Mass Work Personnel	7	
4. Service Personnel	20	Includes cleanness-keeping personnel and the service personnel of dining hall and dormitory
Total Personnel	350	
Associated Security Personnel	200	Security personnel are allocated according to the Owner's opinion and responsible for the security guard during construction and Operation
Personnel quota index of the Project	1.83 person/MW	Associated security personnel 0.67 person/MW

13.2 Basis for preparation

13.2.1 Applicable China national standards, regulations and codes

1. Code for the Fire Protection in Architectural Design (GB50016-2014);
2. Code for Seismic Design of Buildings (GB50011-2010);
3. Code for the Design of Lightning Protection of Buildings (GB50057-2010);
4. Code for the Design of Compressed Air Station (GB50029-2014);
5. Code for the Design of Electric Installations in Explosion and Fire Hazard Atmospheres (GB50058-2014);
6. Code for the Design of Petroleum Depots (GB50074-2014);
7. Code for the Design of Automatic Sprinkler System (GB50084-2005);
8. Code for the Design of Automatic Fire Alarm System (GB50116-2013);
9. Code for the Design of Fire Extinguisher Disposition in Buildings (GB50140-2005);
10. Code for the Design of Foam Fire Extinguishing System (GB50151-2010);
11. Code for the Design of Hydrogen Station (GB50177-2005);
12. Code for the Design of CO2 Fire Extinguishing System (GB50193-2010);
13. Specification for Water Spray Fire Extinguishing System (GB50219-2014);
14. Code for the Fire Protection in the Design of Thermal Power Plant and Substation (GB50229-2006);
15. Code for the Design of Cables of Electric Works (GB50217-2007);
16. Safety Colour (GB2893-2008);
17. Guideline for Safety Marking and its Application (GB2894-2008);
18. Safety Requirements for Fixed Steel Ladder and Platform, Part 1: Steel Ladder (GB4053.1-2009);
19. Safety Requirements for Fixed Steel Ladder and Platform, Part 2: Inclined Steel Ladder (GB4053.2-2009);
20. Safety Requirements for Fixed Steel Ladder and Platform, Part 3: Industrial Protective Guardrails and Steel Platform (GB4053.3-2009);
21. Safety Procedure for in-factory Railway and Road Transportation of Industrial Enterprise (GB4387-2008);
22. General Rule for the Design of the Safety and Health of Productive Equipment (GB5083-1999);

23. Code for the Design of the Grounding of AC Electrical Installations (GB50065-2011).

13.2.2 Applicable industrial procedures, codes and regulations

1. Supervision Procedure for the Boiler and Pressure Vessel of Electric Power Industry (DL612-1996);
2. Overvoltage Protection and Insulation Coordination of AC Electrical Installations (DL/T 620-1997);
3. Specification for the Grounding and Resistance Decrease of Electric Power Engineering (DL/T 1678-2016);
4. Code for the Design of Large & Medium-sized Thermal Power Plants (GB 50660-2011)
5. Technical Regulation for the Design of the Civil Structure of Thermal Power Plant (DL5022-2012);
6. Typical Fire Protection Procedure of Electric Power Equipment (DL5027-93);
7. Technical Procedure for the Design of General Arrangement and Transportation of Thermal Power Plant (DL/T5032-2005);
8. Procedure for the Design of the Occupational Safety of Thermal Power Plant (DL5053-2012);
9. Procedure for the Design of the Occupational Health of Thermal Power Plant (DL5454-2012);
10. Code for the Design of the Steam & Water Piping of Thermal Power Plant (DL/T5054-2016);
11. Code for the Design of the Chemistry of Thermal Power Plant (DL/T5068-2014);
12. Procedure for the Design of Building of Thermal Power Plant (DL5094-2012);
13. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 1: Coal-handling System (DL/T5187.1-2016);
14. Code for the Design of Hydrotechnics of Thermal Power Plant (DL/T5339-2006);
15. Technical Regulation for the Design of the Lighting of Power Plant and Substation(DL/T5390-2014);
16. Technical Procedure for the Design of High-voltage Distribution Device (DL/T5352-2006);
17. Specification for the Monitoring of the Working Environment of Electric Power Industry (DL/T 799.1~799.7-2002).

13.3 Process and locations where safety measures shall be taken

1. Explosion protection of boiler and pressure vessel;
2. Fire protection of various types of building (structure) and oil system;
3. Safety-related accident of electrical equipment;
4. Various types of injury accident resulted from rotating machinery;
5. Safety facilities of platform, staircase and lifting openings/holes;
6. Emergency lighting measures

13.4 Fire protection and explosion protection

13.4.1 Fire protection design principle and measures for buildings (structures)

Fire protection design principle for buildings (structures)

The minimum distance among the main buildings (structures) of this project meets the minimum distance requirements of various buildings (structures) of power plant as specified in Code for the Fire Protection in Architectural Design(GB50016-2014) and Code for the Design of Large & Medium-sized Thermal Power Plants (GB 50660-2011).

Fire hazard and minimum fire resistance rating of various buildings (structures) during production

The fire resistance rating of various buildings (structures) of this project will meet the regulations of Code for the Fire Protection in Architectural Design(GB50016-2014), Code for the Fire Protection in the Design of Thermal Power Plant and Substation (GB50229-2006) and Code for the Design of Large & Medium-sized Thermal Power Plants (GB 50660-2011) as per the fire hazard during production.

Fire-proof and explosion-proof safety measures for main power building and the arrangement of escape corridor and access

The steel staircases that lead to various stories of steam turbine building and the exits that directly lead to outside are provided on Row A of the main power building to ensure that the distance from the farthest working point to safety escape exit in the main power building does not exceed 50m. All power distribution device rooms, cable interlayers and cable shafts are provided with Class C fire doors.

In addition to meeting the requirements of existing fire protection procedure and code, the traffic design inside the main power building concurrently considers the safety and accessibility of production, operation and maintenance.

13.4.2 Plant-wide fire protection and alarm facilities

The design of fire-fighting system of the power plant follows the working guideline "prevention first and combination of prevention and fighting action", and is in accordance with the requirements of the standards, regulations and codes listed in section 9.1.

Independent firewater supply pipe network will be provided in the plant area and will be arranged as per cyclic pipe network.

Based on the requirements of "Code for the Fire Protection in the Design of Thermal Power Plant and Substation" (GB50229-2006) and different protected objects, in addition to indoor and outdoor hydrant systems in this project, foam fire-fighting system, automatic sprinkler system, water spray fire-fighting system, gas fire-fighting system, automatic fire alarm system, movable fire extinguishers and the like will be provided, and a fire vehicle will also be provided.

Emergency oil tank will be provided outside the columns of Row A of the main power building to receive the oil drained from transformer and the oil tank of steam turbine under emergency condition.

Fire protection measures for transformer

The distance between transformers meets the fire protection requirements of relevant procedures and regulations. Transformers are provided with oil conservators and oil drain facilities so that the oil in oil conservator can be drained into emergency oil tank via the oil drain tube at the bottom of the oil conservator in case of emergency oil drain.

Fire protection for cables

The fire protection of cables is designed according to the requirements of Code for the Design of Cables of Electric Works GB 50217.

Necessary fire-resisting walls shall be provided inside cable tunnels and cable trenches; cable shaft holes, the openings beneath switchboard and wall-penetration holes shall be plugged, and fire-resistant partition and automatic fire extinguishers shall be provided in the locations where cables are dense.

Explosion-proof measures for electrical facility

The ventilator and motor in storage battery room shall be of explosion-proof type.

13.4.3 Technical safety measures for pressure vessel and explosive devices

Explosion-proof measures for boiler

Boiler will be provided with furnace safety supervisory system (FSSS). Furnace will be available with soot-blowing function. In order to prevent the existence of combustible substance inside furnace during furnace shutdown, furnace will be purged when main fuel trips and prior to the ignition of main fuel. Superheater and reheater will be provided with safety valves.

Explosion-proof measures for pressure vessel

Deaerator, blowdown flash tank, high-pressure heater and low-pressure heater will be provided with safety valves to prevent explosion.

13.4.4 Fire protection and explosion protection in oil tank farm and ammonia area

Since fuel oil tank farm is a critical fire-protection area, high enclosing wall will be provided surrounding the area to form an independent area. Fire dyke will be provided surrounding the fuel oil tank; the effective volume inside the fire dyke conforms to the requirement of "the effective volume inside fire dyke shall not be smaller than the volume of the largest oil tank in the tank bank". The distance between oil tanks and between oil tank and fire dyke meets the requirement of "the distance from vertical oil tank to the basal slope line inside fire dyke shall not be one half smaller than the height of tank shell". The distance among various buildings (structures) in the fuel oil tank meets the fire separation requirement as specified in Technical Procedure for the Design of General Arrangement and Transportation of Thermal Power Plant. In addition, firewater and foam fire-fighting systems will be provided inside the fuel oil tank farm according to fire protection code.

Ammonia is also a critical fire-protection area, isolation wall will be provided surrounding the area to form an independent area.

13.5 Prevention of electrical injury, mechanical injury and other injuries

13.5.1 Design principle and protective measures for lightning-protection grounding

The lightning-protection grounding of this project will be designed according to the relevant requirements of Overvoltage Protection and Insulation Coordination of AC Electrical

Installations DL/T620. The incoming lines/outgoing lines of 220/132kV power distribution devices will be provided with lightning rod and lightning conductor; independent lightning rod will be provided in fuel oil pump house; several lightning rods will be installed on the top of stack; lightning arresting band will be provided on high buildings such as the coal crusher house of coal-handling system, etc., to protect against direct strike lightning.

Fuel oil pump house and its piping will be provided with static electricity and lightning induction protection.

The plant-wide grounding will be in accordance with Code for the Design of the Grounding of AC Electrical Installations GB50065-2011, and grounding material will be of steel.

13.5.2 Technical measures against electrical maloperation

1. Blocking device is provided between disconnecting switch and applicable circuit breaker and between knife switches. The blocking device is consisted of mechanical, electromagnetic and electrical circuit blocks.
2. High-voltage switch cabinet will be consisted of the equipment available with "five-prevention" function.

13.5.3 Isolation and protection measures for live electrical equipment

1. The safely clear distance of all items of live electrical equipment is not smaller than the minimum value specified in relevant procedures.
2. The enclosures of live electrical equipment are ground.
3. In order to prevent overvoltage from endangering personal safety, contact potential and step potential shall be decreased as far as possible when the form and arrangement of grounding device are determined; And measures shall be taken to ensure that contact potential and step potential will not exceed the values specified in relevant procedures.

13.5.4 Measures against mechanical injury

There is a great amount of rotating equipment during the operation of power plant; it is essential to get done well with the protection of rotating machinery to protect the personal safety of operation personnel. It intends to take the following measures in the aspect of preventing mechanical injury:

1. The exposed rotating part of rotating machinery is provided with protective hood.
2. Necessary blocking device is provided for rotating machinery.
3. The crossover staircases with guardrails are provided at the crossover point of long-distance conveying machinery.
4. Protective hood and removable guardrails are provided at the shaft ends of the tail roller and all other turning rollers of belt conveyer respectively.
5. Protective hood or shield is provided in the rotating part of the equipment of coal-handling system; Removable guardrails are provided on the two sides of belt conveyer; guard fence is provided below the weight box of vertical tension device.
6. Enclosing shield is provided within the throwing range of belt iron separator.
7. Belt coal conveyer is provided with start-up predictor and the device against wrong start-up; Pull switches are provided along the line so as for brake under emergency condition.

13.5.5 Measures against fall injury

1. Guardrails or cover plates will be provided around the staircases, platforms, pits, basins, openings and holes of the power plant. The height of the guardrail around indoor platforms and openings/holes is not smaller than 1.05m; the height of the guardrail around outdoor platforms and openings/holes is not smaller than 1.10m; the height of the guardrail around the platforms and openings/holes above 20m high is not smaller than 1.20m. Anti-slip measures will be taken for staircases and platforms.
2. The parapet with clear height being above 1.20m is provided on the roof that can be stamped.
3. The access ladders on stack and the like are provided with guard rings; Resting platform is provided in the middle of access ladder.

13.6 Safety Colour and Marking

The colour-conditioning design for workplace is in favour of strengthening identification sense, concentrating attention and reducing asthenopia; and, colour-conditioning design can adjust the emotion of operation personnel to improve labour enthusiasm during operation, to improve production efficiency and to decrease the occurrence rate of accident.

In accordance with the regulations of Safety Colour GB2893-2008 and Safety Marking GB2894-2008, four kinds of safety colour, i.e., red (representing prohibit and danger), yellow (representing warning and attention), blue (representing instruction and observance) and green (representing passing and safety), will be used to transmit safety information so that personnel can promptly find or identify safety marking, and can be reminded of in time, thus preventing the occurrence of accident and hazard.

See the following table regarding the location and type of safety colour and safety marking.

Table 15.2 – Safety Colour and Marking

Marking	Safety Colour	Location	Content
Prohibit	Red	Cable Entry, the entrance of oil system room	No smoke or fire
Warning	Yellow	Fencing of electrical equipment	Warning electric shock
		Equipment enclosure or framework on which temperature-rise exceeds 65K	Warning high temperature
		Guardrails around collecting well and lifting hole	Warning drop down
		Upper end of steel ladder above 2.0 m	Warning drop down
		The entrance of mechanical maintenance room and repair shop	Warning mechanical injury
		Inclined steel ladder above 55°	Caution, stumbling
		Main traffic crossings	Warning vehicle
Instruction	Blue	Compressed air equipment house	Ear plug required
Prompt	Green	Fire-fighting facility	Hydrant
			Fire extinguisher
			Fire hose
		Evacuation exit	Escape corridor, emergency door

13.7 Other Safety Measures

The design of lighting system will be in accordance with Technical Regulation for the Design of the Lighting of Power Plant and Substation (DL/T5390-2014). The lighting system of this project is consisted of three independent subsystems, i.e., normal AC lighting system, emergency AC lighting system and DC emergency lighting system.

The AC lighting system will be of 380/220V three-phase four-wire neutral solidly grounded system; lamp voltage is 220V, and the lighting voltage for the maintenance of boiler body is 12V. As for the lighting of cable tunnel, 220V power supply with leakage protection will be adopted.

Various corresponding Units in the main power building will be provided with main AC emergency lighting switchboards respectively. The main AC emergency lighting switchboard will be supplied from the normal lighting section of corresponding Unit during normal operation, and will be automatically switched to emergency power supply in case of emergency condition.

DC emergency lighting device is only arranged in central control room and diesel generator house; emergency lighting inverter switchboard is arranged in central control building, with supplied being powered from 220V DC switchboard and emergency power supply section. DC emergency lighting device is powered from emergency power supply section during normal operation, and will be automatically switched to DC power supply after all AC power supplies disappear. DC pilot lamp is provided inside the main loop of the central control room.

13.8 Labour Security Authority and Facility

13.8.1 Working Environment Monitoring & Supervision

It is tentatively considered to set up a working environment monitoring & supervision station in this project.

13.8.2 Safety Education Office

It is tentatively considered to set up a safety education office in this project.

13.9 Security System

Based on the actual situation of the legal address and site of this project, see the special report entrusted by the Owner for details about security proposal.

13.10 Comprehensive Assessment

After the above-mentioned measures are taken, the safety work condition of the workplace of the operation personnel of the power plant can meet the requirements of relevant standards.

14. Design, Material and Process Standards, Codes

14.1 Basis for Preparation

14.1.1 Applicable China national standards, regulations and codes

1. General Rule for the Design of the Safety and Health of Production Equipment (GB5083-1999);
2. Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010);
3. Occupational Exposure Limit for the Hazardous Factors in Workplace, Part 1: Chemically Hazardous Factors (GBZ2.1-2007);
4. Occupational Exposure Limit for the Hazardous Factors in Workplace, Part 2: Physical Factors (GBZ2.2-2007);
5. Code for the Design of Noise Control in Industrial Enterprises (GB/T 50087-2013);
6. Standard for the Design of Architectural Daylighting (GB50033-2013);
7. Code for the Design of the Heating, Ventilation and Air Conditioning of Industrial Building (GB 50019-2015);
8. Code for the Design of General Plan of Industrial Enterprises (GB50187-2012);
9. Guideline for the Gas Management and Test of Sulfur hexafluoride Electrical Equipment (GB/T8905-2012);
10. Code for the Design of Compressed Air Station (GB50029-2014).

14.1.2 Industrial procedures, codes and regulations

1. Code for the Design of Large-sized Thermal Power Plant (GB 50660-2011);
2. Procedure for the Design of Occupational Safety of Thermal Power Plant (DL5053-2012);
3. Procedure for the Design of Occupational Health of Thermal Power Plant (DL5454-2012);
4. Technical Procedure for the General Arrangement and Transportation of Thermal Power Plant (DL/T5032-2005);
5. Regulation for the Architectural Design of Thermal Power Plant (DL/T5094-2012);
6. Code for the Design of the Heating, Ventilation and Air Conditioning of Power Plant (DL/T5035-2016);
7. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 1: Coal-handling System (DL/T5187.1-2016);
8. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 2: Prevention and Control of Coal Dust (DL/T5187.2-2004);
9. Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 3: Coal-handling Automation (DL/T5187.3-2012);
10. Code for the Chemistry Design of Thermal Power Plant (DL/T5068-2014);
11. Technical Regulation for Lighting Design of Power Plant and Substation (DL/T5390-2014);
12. Specification for the Monitoring of the Working Environment of Electric Power Industry (DL/T799.1~7-2010).

14.2 Process links and locations where health protection shall be provided

1. Coal-handling system (including coal-unloading device, coal crusher house, belt layer and various forwarding stations) in which dust is produced;
2. The protection measures to be taken for the locations where hazardous substance and corrosive fluid exists;

3. The heat insulation and cooling for the main power building of the power plant belonging to high-temperature workshop;
4. Prevention and control of the noise originated from the rotating machinery such as turbogenerator unit

14.3 Measures against dust, toxic substance and chemical injury

14.3.1 Dust-proof design principle and measures

Dust-proof design principle

Prevention and control of coal dust of coal-handling system, the comprehensive prevention and control of "prevention first and combination of prevention and control" will be subject to Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010), Code for the Design of Large-sized Thermal Power Plant (GB 50660-2011), Technical Procedure for the Design of the Coal-handling of Thermal Power Plant, Part 2: Prevention and Control of Coal Dust (DL/T5187.2-2004)and Code for the Design of the Heating, Ventilation and Air Conditioning of Power Plant (DL/T5035-2016).

14.3.2 Measures against toxicity and chemical injury

The corrosive fluid and hazardous gases stored and produced in the locations of power plant are mainly stored or produced inside chemical system. In order to allow the concentration of the hazardous substance of workshop to be lower than the allowable maximum concentration as specified in Occupational Exposure Limit for the Hazardous Factors in Workplace (GBZ2.2 2007) to protect the physical health of operation personnel, it intends to take the following protective measures:

1. Protective weir is provided around acid & alkali storage equipment. Safety passages, showers, flushing and draining facilities are provided in acid & alkali storage rooms, metering rooms, and acid & alkali unloading pump houses. Pumping mode is used when concentrated acid and alkali liquor are loaded and/or unloaded.
2. Acid & alkali pipe will not be arranged overhead in the indoor locations where personnel pass by; Where overhead arrangement is necessary, protection measures will be taken on flange and connections.
3. The drummed ammonia that is used for chemical dosing will be placed in chemical dosing room. Breather is provided for the mixing solution tank of ammonia liquor to prevent ammonia from being diffused into air.
4. Chemical dosing room is provided with mechanical ventilation unit.

14.3.3 Ventilation System

1. Ventilation of steam turbine house: The ventilation mode of natural air intake and mechanical exhaust will be adopted for steam turbine house.
2. Central control building: Rooms inside the central control building will be provided with mechanical ventilation systems according to actual demand and the requirement of process equipment as well as specific arrangement respectively; and applicable technical measures will be taken according to explosion protection and anticorrosion requirements.
3. All power distribution devices and MCC rooms in the entire plant are provided with mechanical ventilation units; These ventilation units are used for emergency exhaust as well as ventilation during normal operation.

4. With respect to the remaining production and auxiliary production buildings, mechanical ventilation systems are respectively provided for the rooms, in which hazardous gases and residual heat and residual moisture are produced, according to actual demand and the requirement of process equipment; And applicable technical measures will be taken according to explosion protection and anticorrosion requirements.

14.3.4 Air-conditioning system

A central control building is provided for the two units in this project. The air-conditioning system of the central control building mainly serves for process equipment rooms such as unit control room, engineer room, electronic equipment room and the like.

Local split type air conditioners will be used for local arrangement and control in the remaining control rooms of the plant and the rooms in which process system has applicable requirements for temperature and humidity.

14.4 Noise and Vibration Prevention

14.4.1 Design standard for noise control

In accordance with Code for the Design of Noise Control in Industrial Enterprises (GB/T 50087-2013), the noise limits of various types of workplace are shown in the table below.

Table 16.1 – Noise Limits (1)

Workplace	Limit [dB(a)]
Production workshop	85
Background noise level in the duty room, observation room, restroom, office, lab and design room inside workshop	70
Precision assembly line, precision machining workshop and computer room in normal operation condition	70
Background noise level in main control, central control room, communication room, telephone exchange room, fire duty room, general office, conference room, design room and lab	60
Background noise level in doctor's office, classroom, duty dormitory room	55

Note: background noise level refers to the noise level that is transmitted from outdoor to indoor.

In accordance with Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010), the noise design requirements for non-noise workplace are shown in Table 10.5.2-2/

Table 16.2 - Noise Limits (2)

Location	Limit dB(A)	Working Efficiency Limit dB(A)
Observation (duty) room of noise workshop	≤75	≤55
Office and conference room of non-noise workshop	≤60	
Main control room, precision machining room	≤70	

14.4.2 Prevention and control measures for noise

Decreasing the ambient noise of workshop is one of important measures that ensure safety operation, protect the physical and mental health of staff and improve the working environment of operation personnel. Decreasing noise shall first proceed with the radical treatment of equipment, i.e., decreasing the noise level of noise source; and then, take necessary measures in the aspect of architectural arrangement and the treatment of building construction, allowing the ambient noise value of workshop to reach the allowable national standards. The specific measures to be taken in design are as follows:

1. Manufacturers are requested to provide the equipment conforming to the noise standard of national regulations when the type of various main equipment and auxiliary equipment is chosen.
2. Control valves and relief valves shall be of low-noise valves.
3. With respect to coal crusher, high-pressure fan, attempering & depressurizing units, air compressor and the head of steam turbine on which high noise may be produced, silencing and sound-insulating measures shall be taken.
4. Silencers shall be provided on the steam exhaust pipe of boiler ignition and boiler safety valve to atmosphere.
5. Sound-insulating doors and windows shall be provided for central control room where noise-prevention requirement is high. Closet shall be provided at the entrance of central control room; to decrease the indoor reverberant sound, porous sound-absorbing mineral wool board lined with mineral wool felt shall be used for suspended ceiling.
6. The closed doors and windows of communication room, chemistry water sampling room and the like, where air conditioners are used, already have sufficient sound-insulating performance.

14.4.3 Health limits for vibration

In accordance with Hygienic Standard for the Design of Industrial Enterprise (GBZ1-2010), the health limits for local vibration strength are shown in the table below. The vertical or horizontal vibration strength of auxiliary rooms being affected with vibration shall not exceed the limits are also given in the table below.

Table 16.3 – Local Vibration Strength (1)

Daily Exposure Time (hrs)	Health Limit (m/s²)
4.0<t≤8.0	0.62
2.5<t≤4.0	1.10
1.0<t≤2.5	1.40
0.5<t≤1.0	2.40
t≤0.5	3.60

Table 16.4 - Local Vibration Strength (2)

Daily Exposure Time (hrs)	Health Limit (m/s²)	Working Efficiency Limit (m/s²)
4.0<t≤8.0	0.31	0.098
2.5<t≤4.0	0.53	0.17
1.0<t≤2.5	0.71	0.23
0.5<t≤1.0	1.12	0.37
t≤0.5	1.80	0.57

14.4.4 Vibration-proof measures

1. Manufacturers are requested to provide the equipment conforming to the vibration standard of national regulations when the type of various main equipment and auxiliary equipment is chosen.
2. Vibration-damping measures shall be taken at the connections between the ventilation duct, enclosing construction and floor slab of central control room, main control room, unit control room, electronic computer room and the like; Their air-conditioning systems shall also be provided with vibration-damping measures.
3. With respect to the design of steam/water pipe subject to vibration, vibration-damping measures shall be taken for their supports and hangers.

14.5 Personal Protection Equipment for Occupational Disease

The power plant shall provide its working personnel with personal protection equipment conforming to applicable national standards, e.g., providing anti-dust respirators for dust workers; providing protective clothes, caps, gloves and goggles for those who contact acid and/or alkali; providing noise-proof ear plugs for those who are exposed to noisy atmosphere; providing necessary gas masks for those who manually add ammonia and hydrazine or manually prepare toxic substance such as hydrochloric acid, sulfuric acid, etc.; providing shielding clothes for those who work in microwave station and switchyard, etc. All personal protection equipment chosen shall conform to the requirements of applicable national standards.

14.6 Warning Identification for the Hazard of Occupational Disease in Workplaces

Warning identification for the hazard of occupational disease shall be provided in the eye-striking positions of power plant where the hazard of occupational disease possibly occurs.

14.7 Occupational Health Management

Adhere to the working guideline of occupational disease "prevention first and combination of prevention and control" to create the working environment and condition, which conforms to occupational health standards and health requirements, for labours. Strengthen the training of staff in occupational health knowledge to fully understand the severity and preventability of the hazard of occupational disease, and to strengthen individual protection awareness.

Establish the strict management and utilization system for personal protection equipment to check the allocation, distribution and use of the protection equipment of occupational disease and personal protection equipment to ensure that staff can strictly use valid personal protection equipment of occupational disease under normal production condition.

Establish occupational health and safety work management system to ensure that enterprises can follow national regulation regarding the protection facility of occupational disease, i.e., the protection facility of occupational disease of construction project shall be designed, constructed and put into production and service in the same time as that of the main part of the project; the maintenance and management of production equipment and protection facility shall be strengthened during routine production to avoid the occurrence of "escape, overflow, dripping and leakage" so as to ensure the normal operation of health protection facility; take and make good occupational health protection measures for accident and maintenance.

Establish the management system of occupational health supervision to accomplish institutionalized management. Carry out occupational health supervision for working personnel at regular intervals; if occupational contraindication or suspected occupational patient(s) is (are) found, applicable work adjustment and alteration for this type of personnel shall be performed, and when necessary, vacation even diagnosis and treatment shall be provided to minimize the occurrence of occupational disease.

Establish the periodic monitoring and assessment system for the hazard factors of the occupational disease of workplace, and attach importance to the impact of the prevention and control of the hazard factors of occupational disease on the health of working personnel during equipment maintenance.

The emergency response and rescue plan for occupational disease shall be established and made good after project is put into production; warning identification and notices shall be provided according to Warning Identification for the Hazard of Occupational Disease in Workplace (GBZ158-2003).

14.8 Occupational Health Authority and Facility

It is tentatively considered to set up an occupational health monitoring & supervision station and to equip conventional monitoring apparatus and devices in this project.

14.9 Comprehensive Assessment

After the above-mentioned measures are taken, the sanitary condition of the operation personnel of the power plant in workplace can meet the requirements of relevant standards.

15. Analysis for Utilization of Resources and Energy Conservation

15.1 Principle Requirements

The guideline "paying equal attention to development and saving, and rationally utilizing and optimizing the allocated resources" will be carefully carried out in this project. The applicable regulations and standards to be executed in the design of main process systems and in the selection of main and auxiliary equipment as well as material are as follows:

1. *Standard for the Energy-saving Design of Public Buildings (GB50189-2015)*;
2. *Code for the Design of Large & Medium-sized Thermal Power Plant (GB50660-2011)*;
3. Other design standards and control indexes regarding energy conservation

15.2 Utilization of Energy Source

15.2.1 Coal Resources at Project Site

This project is located in Gwadar City, Baluchistan Province in Pakistan; this region is short of coal resource.

15.2.2 Fuel Source

The firing coal required for this project is mainly imported from South Africa and Indonesia; design coal is RB3 from South Africa, and check coal is 50% South Africa RB3+50% Indonesia NAR4700.

See section 3.1 source of firing coal about the situation of the coal resources of South Africa and Indonesia.

15.2.3 Coal Transportation

In accordance with the comprehensive comparison of dock design contractor, it is believed that the freight volume of coal of the supporting dock is only one million tons at present, and it is uneconomic to build a new dock. The recommended proposal is to use the existing dock of Gwadar Port as the preferred proposal at present, which not only can save investment, but also can speed up the implementation of this project. Although there is the risk of environmental pollution due to coal dust, this condition can be improved after a series of environmental protection measures are implemented. In the future, when market condition becomes mature and the planned common-user dock is constructed, a new dock can be built or the areal common-user dock can be used, and coal-unloading point can be moved to the location near the plant area, to save land transportation cost. Therefore, it is recommended to transport coal to the existing dock of Gwadar Port by sea at present; and then, trucks are used to transport the coal to the power plant.

15.2.4 Supply of the fuel oil used for boiler ignition and combustion support

The fuel oil used for the boiler ignition and combustion support of this project will be of 0# diesel oil; since the consumption of the fuel oil is little, the transportation mode of the fuel oil is tentatively considered as road transportation. The fuel oil for the boiler ignition and combustion support will share a set of oil supply system, and will be purchased in local market.

15.3 Land Utilization

Elaborately planning the general arrangement of the plant area of this project as well and rationally saving land are the important and comprehensive means for saving project investment. The following land-saving measures are taken for the general arrangement of the plant area in combination with the situation of this project and process arrangement:

1. Combined buildings are used as practical as possible to minimize land.

Combined buildings and arrangement are used to compress the quantity of single building, which constitutes the main measures for saving land.

2. Make the best of spare and unoccupied land to arrange the auxiliary production facilities of the power plant.

The space between two boilers of this project is fully used to arrange central control building, the drain tank of the Units, the power distribution room of electric precipitator and the like, thus greatly reducing land area.

3. Control the floor space of road, piazza and greening facility strictly.

Control the floor space of road and piazza strictly; special greening piazza will not be provided; the underground pipelines having identical or similar nature will be arranged adjacently to save land.

4. Optimize main process systems, and rationally compress the floor space of various workshops.

Since power plant is a systematic engineering with strong integrity, and various workshops and modules constitute the foundation stone of power plant, optimizing main process systems and rationally compressing the floor space of various workshops and modules are the headstream work for reducing the land of the plant area.

5. Use new land-saving technologies to reduce land.

Novel design and new technologies are used; these new technologies are characterized by saving land and safety and reliability, and can greatly save the land of plant area.

6. Rationally simplify the building (structure) of plant area.

Minimize the arrangement of non-productive buildings. Rely on social forces to simplify the auxiliary and accessory production facilities of this project.

7. Adopt comprehensive pipe rack.

Depending on the nature of various types of piping in the plant area, comprehensive pipe rack is used to unitedly plan and arrange the pipeline in the plant area in a three-dimension manner, which not only saves land, but also creates good condition for operation and maintenance.

15.4 Utilization of Water Resources

15.4.1 General

Based on the condition of water source, direct-flow water supply system will be adopted for the cooling of the Units of this project; water source is Arabian Sea near the plant site. The makeup water treatment system of boiler, industrial firewater, domestic water and drinking water will be supplied from seawater desalination system.

For the sake of rationally utilizing water resources, the principle "water saving, multi-purpose for one water, comprehensive utilization and repeated utilization" will be carried out in the design of plant-wide water service management and water balance in this project, to accomplish the full utilization of water resources.

15.4.2 Water-saving Measures

The water supply in the plant area will be designed in such a manner that water will be supplied as per different quality, and will be used by class and circularly to improve the recycle rate of water; rationally utilize the drainage of power plant to minimize the consumption of makeup water, thus making the best of "waste".

A separate flowing system will be adopted for the drainage in the plant area, i.e., clean rainwater and sewage are transferred in separate piping systems. Wastewater and sewage will be collected and centrally treated as per different nature.

It intends to use the following water-saving measures in this project:

1. Use dry ash-handling and slag-handling systems to save water.
2. Domestic sewage is used for watering greening belts and road after being treated.
3. Oily sewage is used as part of the spray water of the coal yard of the plant area after being treated.
4. Coal-containing wastewater is used as part of the spray water of the coal yard of the plant area after being treated.
5. It intends to monitor and control the capacity of various kinds of different quality of water supply & drainage of this project; Necessary metering & controlling facilities such as flow meters and level control valves and the like will be equipped in the system to strengthen supervision and management, thus avoiding unnecessary waste.

15.4.3 Analysis for designed water consumption index and water-saving effect

After the "multi-purpose for one water, graded use and repeated utilization" measures are taken and the optimization design of water service management and the comprehensive water balance is performed in this project, the water consumption index of the 2×150MW Units of this project in summer is 0.12m^3/s.GW.

The utilization of the water resources of this project is rational.

15.5 Utilization of Building Material

With respect to the utilization of the building material of this project, the following principles will be adhered to:

1. Adhere to the guideline "addressing matter according to local condition and getting raw materials from local resources" to preferentially use locally excellent building material. Meanwhile, adhere to popularizing and using excellent and cheap new-type energy-saving building material.
2. The enclosing construction of exterior wall and interior wall will be made of the light-weight masonry unit produced locally; The part above the operating layer and the pediment on the expansion end of the steam turbine house in the main power building will be made of single-layer metal profiled sheet.
3. The insulation material of building will be of pearlite, rock wool product or extruded plastic polyphenylene board.
4. With respect to suspended ceiling, high-quality thistle board will be used.
5. The doors and windows on exterior wall will be of energy-saving new-type colourful steel and glass-reinforced door and window.
6. Carry out design optimization to save the resources of building material. The following main measures will be taken in architectural design:
    a. Optimize and choose the equipment that can be arranged in the open air to reduce partial auxiliary buildings in cooperation with the type selection of process optimization equipment.
    b. Use combined buildings to merge the buildings that having similar functions, to reduce the scale of building and land occupation.
    c. Optimize the plan layout of building: Minimize the plane dimension and story height of building under the precondition that process requirement is met, to make architectural arrangement compact and rational, thus reducing the volume of building.

15.6 Energy Consumption Indices

The main energy consumption indices of the Project are shown in the table below.

Table 17.1 – Main Energy Consumption Index

	Description	Unit	Value
1	Plant-wide net efficiency	%	36.16
2	Standard coal consumption of power generation	g/kWh	308.1
3	Rate of power used by plant	%	9.3
4	Coal Consumption of Power Supply	g/kWh	339.7

15.7 Energy-saving measures and effect

15.7.1 Energy-saving measures for equipment and process system

Based on the demonstration of the type selection of Units in this Feasibility Study Report, it is recommended to adopt 2×150MW ultra-high-pressure fired coal units, and to construct desulfurization and denitration units synchronously, which minimizes the coal consumption of Units in the aspect of the type selection of Units.

Since the unit capacity of this project is 150MW, the raw material of equipment is plentiful and system is complicated. In order to further decrease the coal consumption of the Units under the condition that the type selection of the Units is clear, various kinds of optimization measures are to be taken for this project in the aspect of the design of process system, which mainly includes the following:

1. With respect to the main equipment of this project, it is recommended to use the advanced boilers, steam turbines, power generators and the like made in China because these items of equipment are technically advanced and mature as well as economic in the aspect of engineering investment and operation.
2. Auxiliary equipment shall be of the energy-saving and high-efficiency products with high efficiency at load variation, e.g., air blower, primary fan and ID fan can be of adjustable vane axial flow fan.
3. In order to ensure that the Units can have good efficiency under load-varying condition or at low load, the operation mode of fixed pressure - sliding pressure - fixed pressure will be adopted for the Units; Sliding parameter start-up mode will be used to shorten the start-up time of the Units.
4. The selection of the parameters and capacities of various kinds of auxiliary equipment will be based on relevant design procedures and codes without unprincipled expansion of capacity and retaining excessive margin. High-reliability feedwater heater will be chosen to ensure the high availability of feedwater heating system and to ensure that this system is in the most economic operation state for a long time.
5. Equipment and system shall be arranged compact as practical as possible to minimize the energy loss of various kinds of fluid under the precondition that safety operation and convenient maintenance can be accomplished.
6. Rationally make the optimization arrangement proposal of system to save raw material.
7. The working fluid such as steam and water that can be recycled shall be considered to be recovered or reused in system design.
8. Use the insulation material having good insulation performance, to reduce heat radiation loss and to improve operation environment as well.
9. Provide insulation for outdoor equipment and piping to reduce heat radiation loss.
10. Keeping the heating surfaces of furnace and tail clean to improve heat transfer efficiency is the effective measures for decreasing the coal consumption of boiler. For this reason, a reliable and complete soot-blowing system is equipped in the design of boiler body so that soot blower can be periodically used to keep heating surface clean during operation.
11. Advanced control algorithm is used in combustion control system to make combustion be in optimal condition and to make the operation of auxiliary equipment be in optimum operation condition, thus saving firing coal and the energy consumption of auxiliary equipment.
12. The motors of main auxiliary equipment shall be of the motors with high efficiency and power factor.
13. The main transformer, high-voltage house transformer and low-voltage house transformer with low loss shall be used.
14. The outgoing lines of power generator and the conductors from the high-voltage side of main transformer to switchyard shall be chosen as per economic current density.
15. Reduce the corona loss produced on high-voltage equipment.
16. Select energy-saving light fixtures for lighting to improve the power factor of lighting system; Rationally set cluster switch; outdoor lighting device shall be optically controlled.
17. Rationally design power distribution system to avoid the existence of circuitous power supply structure; with respect to the auxiliary production areas that are away from main power building and are load concentrated, consideration will be given to locally provide special house transformer to centrally supply power, to avoid the existence of heavy-current long-distance current distribution, thus decreasing the loss of power distribution system.

18. The loads connected to concealed standby transformer shall be distributed evenly so that the transformer can operate in economic zone during operation.
19. Optimizing cable channel can minimize the total length of cable and can reduce the load loss of cable system.
20. Select new-type energy-saving light source and attachments, e.g., halogen lamp and fluorescent lamp are used in main power building to improve the illuminance of working surface and the colour development property of light; electron rectifier is used in central control room to decrease noise and to improve the environment of operation personnel.

15.7.2 Energy-saving and consumption-decreasing measures for buildings

The following energy-saving measures are to be taken for the buildings of this project:

1. The thermotechnical and energy-saving design of buildings shall be in accordance with local condition and shall comply with regional climate condition; Rational enclosing construction of building shall be used to save the energy consumption of building, to improve the utilization efficiency of energy source and to improve and to guarantee indoor environmental quality. Insulation material shall be used for the roofing of building, and the external surface of roofing shall be decorated with light-coloured finishing material. The doors and windows on exterior wall shall be of energy-saving door and window with good tightness to make them conform to the relevant regulations of the energy-saving design standards of buildings, and to ensure the heat comfortability of buildings under energy-saving precondition.
2. Natural ventilation and daylighting mode shall be adopted as far as possible in architectural design, to save energy consumption and to meet the natural ventilation and daylighting requirements of buildings, thus minimizing the energy consumption of buildings. In addition, to save energy source, consideration is given to make the best of natural daylighting in the main power building in day time; punctual daylighting hood will be used on the roof of steam turbine house to ensure the sufficient illuminance inside and in the middle of the operating story and to save artificial illumination cost.
3. All buildings in the plant area meets rainproof, ventilation and cooling requirements under the precondition that the requirements of operation, maintenance and management are met.

16. Labour Requirement of Power Plant

The "Notice on Issuing the Labour Requirement Standard of Thermal Power Plant (trial)" issued by the State Grid Corporation of China highlights the following principles regarding organizational framework and staffing principles of power plants:

1. New staffing standard is implemented according to the mode of Class A new-type thermal power plant, i.e., use modern management mode to organize production operation.
2. Set up keen-witted and capable authorities to accomplish structural rationality so that specialized skill can be generally expert in one thing and good at many and can fulfil many responsibilities in one post, thus reaching omnipotent duty level.
3. Implement new equipment maintenance system.
4. Based on Minute of the Intermediate Achievement Report Meeting of the Feasibility Study of Power Plan, and in accordance with the fact that the Owner requests to fully consider the local actual situation, the number of operation, maintenance, logistics and management personnel is considered as 350 persons, and security personnel are allocated as 200 persons to ensure the safety of the power plant during construction and operation; Meanwhile, the housing and living facilities for 50 overhaul personnel are reserved.

Overhaul personnel will not be allocated for the power plant; overhaul activity will be entrusted or contracted by means of bidding, and contract will be concluded with applicable maintenance company. The maintenance personnel of the power plant are mainly responsible for the temporary maintenance, emergency repair & maintenance and routine maintenance & management of equipment.

The required personnel quota in this project are considered according to the control level of the personnel quota of Class A unit of Labour Requirement Standard of Thermal Power Plant. The personnel quota of the Project is preliminarily estimated to be about 190 persons (excluding security personnel) with reference to the staffing of the similar power plant at present. The total number of operation, maintenance and logistics is expected to be 350 persons, and security personnel are estimated at 200 persons in accordance with Minute of the Intermediate Achievement Report Meeting of the Feasibility Study of Power Plan and the Sponsor's opinion. The Sponsor will promote employment in the region by hiring locals as well. The specific estimation of personnel quota is shown in the following table and is used as the informative data of the Sponsor; the final personnel quota has to be determined by the Sponsor.

Item	Persons	Description
Production Personnel	293	Includes maintenance personnel
a. Operation personnel of units	102	Includes 10% back-up operation personnel
i. Operation personnel of steam turbine, boiler and generator (central control room)	55	Recirculating water equipment is concurrently managed by the operation personnel of central control room and air compressor
ii. Operation personnel of ash-handling and dust removal	11	Two units share a control room
iii. Operation personnel of desulfurization and denitration	17	
iv. Chemistry operation	19	Control room in which on-line monitoring

personnel		system is available
1) Chemistry operation personnel	11	
2) Analysis personnel	8	
b. Maintenance of Units	114	
i. Thermotechnical	52	Include 4 persons of FGD system
ii. Electrical	30	
iii. I&C	32	
c. Fuel System	63	Includes 10% back-up operation personnel
i. Fuel Operation Personnel	24	
ii. Fuel Maintenance Personnel	24	
iii. Fuel Management Personnel	15	Land transportation and manual sampling of coal
d. Others	14	
i. Warehouse	6	
ii. Vehicle	8	
Management Personnel	30	Includes admin, production, business, logistics and management personnel
CCP and Mass Work Personnel	7	
Service Personnel	20	Includes cleanness-keeping personnel and the service personnel of dining hall and dormitory
Total Personnel	350	
Associated Security Personnel	200	Security personnel are allocated according to the Owner's opinion and responsible for the security guard during construction and operation
Personnel quota index of the Project	1.83 person / MW	Associated security personnel 0.67 person/MW

17. Construction Plan and Implementation of the Project

17.1 Construction Plan

The main objective of the construction plan is to ensure that the Project can be put into commercial operation as scheduled. The Project is envisaged to achieve commercial operations within 30 months from commencement of construction (Unit 1: 24 months; Unit 2: 30 months). The table below shows the activities and timeline associated with the construction plan.

Table 18.1 – Construction Plan

	Milestone	Unit 1 (months)	Unit 2 (months)	Remark
I.	**Civil Works**			**Assuming construction commences on 30th September 2017**
1	Completion of site levelling	2.5	2.5	Site levelling and pile foundation works are completed, and foundation excavation condition is available (the construction of enclosing wall of border is completed synchronously)
2	Completion of construction of pile foundation	6.0	6.0	
3	Completion of the first concrete cast in the main power building	7.5	7.5	
4	Boiler foundation turnover to installation	12.0	17.0	
5	Water cut-off of the roofing of steam turbine house and foundation turnover to installation	16.0	16.0	The installation condition of the bedplate of steam turbine is available
6	Central control building turnover to installation	16.5	16.5	
7	Construction of stack shell to top	18.0	18.0	
II.	**Installation Engineering**			
1	Beginning of handling of steel frame of boiler	13.5	19.5	
2	Completion of handling of steam drum of boiler	15.5	21.5	
3	Beginning of the handling of heating surface of boiler	16.0	22.0	
4	Placement of the bedplate of steam turbine	17.5	22.5	
5	Handling of stator of power generator	18.0	24.0	
6	Energization of house transformer	19.0	25.0	
7	Acceptable chemistry water produced	19.5	25.5	
8	Water pressure of boiler ready for test	20.0	26.0	

9	Oil circulation of steam turbine	20.0	26.0	
10	Closing of the cover of steam turbine	21.0	27.0	
11	Completion of the chemical cleaning of boiler	21.5	27.5	
12	Initial ignition for steam-blowing pipeline	22.5	28.5	
13	Combined start-up	23.5	29.5	
14	Initial synchronization succeeded	23.6	29.6	
15	Completion of 168-hr test run of unit at full load	24.0	30.0	Unit #1 COD: 2nd Oct 2019 Unit #2 COD: 30th Mar 2020
Total construction period		24.0	30.0	

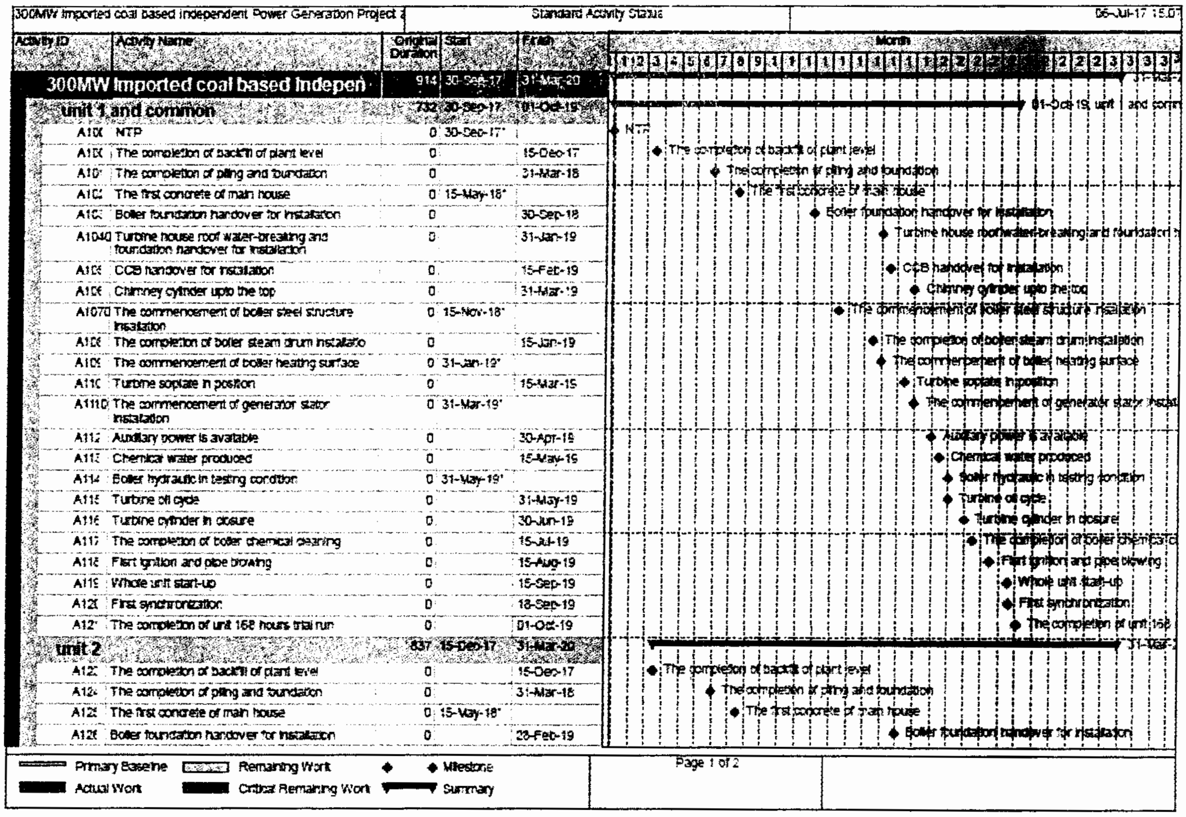
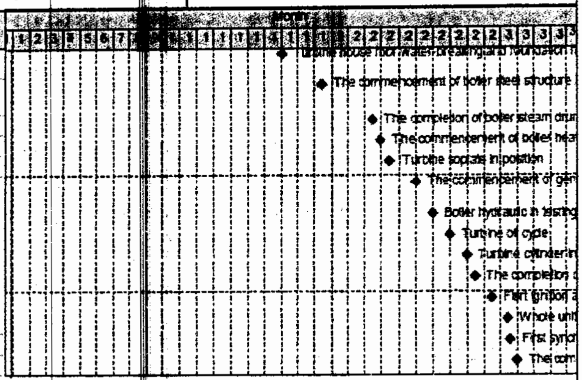


Figure 14.1 – Construction Timeline

300MW Imported coal based Independent Power Generation Project | Standard Activity Stats | 06-Jul-17 15:07

Activity ID	Activity Name	Original Duration	Start	Finish
A1270	Turbine house roof water-breaking and foundation handover for installation	0		31-Jan-19
A1300	The commencement of boiler steel structure insalation	0	[illegible]-Apr-19*	
A13[illegible]	The completion of boiler steam drum installatio	0		15-Jul-19
A13[illegible]	The commencement of boiler heating surface	0	[illegible]-Jul-19*	
A13[illegible]	Turbine soplate in position	0		15-Aug-19
A1340	The commencement of generator stator instalation	0	[illegible]-Sep-19*	
A13[illegible]	Boiler hydraulic in testing condition	0	[illegible]-Oct-19*	
A13[illegible]	Turbine oil cycle	0		30-Nov-19
A13[illegible]	Turbine cylinder in closure	0		31-Dec-19
A14[illegible]	The completion of boiler chemical cleaning	0		15-Jan-20
A14[illegible]	First ignition and pipe blowing	0		15-Feb-20
A14[illegible]	Whole unit start-up	0		15-Mar-20
A14[illegible]	First synchronization	0		18-Mar-20
A14[illegible]	The completion of unit 168 hours trial run	0		31-Mar-20



Primary Baseline | Remaining Work | Milestone | Page 2 of 2
Actual Work | Critical Remaining Work | Summary

17.2 Implementation Period

17.2.1 Construction

The Sponsors will sign contracts with acceptable EPC contractor to carry out design, procurement, execution and commissioning for the power plant facility. The following will explain the activities to be executed under the EPC agreement.

Design

Design service covers all design activities, including rock & soil research, environment research, the establishment of preliminary design report, the establishment of technical performance and equipment specification, description prior to invitation for bid, technical evaluation for bidding, description prior to award of bid; the review, initiation, support, acceptance and inspection of detailed design, technical document and technical coordination; the coordination of technical support and training as well as the preparation of the design data manual of power plant.

The relevant data and research findings of the project will be reviewed prior to construction. The job scope and preliminary design of the project will be established according to the results of review and additional investigation. General design parameters will be specified in the job scope to standardize the installation of the project, including the installation of foundation buildings and auxiliary facilities; the job scope will also be used as financing document. A typical job scope will describe the project scope, project design standard and responsibility division. In addition, job scope will also include the equipment capacity of power plant, operation characteristics, main features and layout as well as design and inspection standards. Job scope will also include hydrologic investigation, soil engineering as well as the pile foundation design standard that is based on rock & soil investigation analysis. Job scope will also describe site preparation, site access, the requirements of fuel and facility as well as environment simulation and test, and will discuss the rationality of the locations of various kinds of structure as well as any recommended modification regarding layout. Job scope will also include the establishment of execution plan and the planning chart used for the recommended estimation of cost.

The final design will include the investigation, analysis and calculations required for establishing specifications for equipment and services. These specifications will describe the competitive bidding of international manufacturers and suppliers in considerable details. The final design will also include environment research so as to establish the standards and requirements of executive specifications required for the supply and installation of environment monitoring equipment, as well as environmental impact report; the final design also includes the technical specifications and executive specifications of required for the equipment and systems of the project, and also includes general arrangement and the layout of pile foundation structure. The final design also includes the design of the civil and architecture of steam turbine house, boiler house, dispatching room, water treatment building and air intake plenum, construction access road and fencing. EPC contractor will carry out the design of the pedestal of steam turbine generator; the basis design of stack, steam turbine house, boiler house, control room, heater room, air intake plenum and water treatment building as well as the design of other buildings and structures. EPC contractor's design also includes the design of underground facilities (including underground pressure pipe, sewage pipe and structures, etc.), flow chart, piping & instrument flow diagram, as well as the mechanical design of model calculations; and includes the electrical design of single-line, three-line and wire raceway diagram, the layout of line and wire raceway, etc. EPC contractor will prepare system instructions and the list of machineries, and will design large-diameter pipe (nominal size: at least 65cm) for critical and non-critical services; and will carry out stress analysis, and will design large-diameter and small-diameter pipe for critical services as necessary.

The design services provided at construction stage include reviewing supplier's design data, drawings, instruction manuals, inspection methods and reports to meet the requirements of contract, specification and interface. Project Company will provide engineering support for the project construction team; review the requests of design change and deviation, and set out treatment recommendations; help start-up team to inspect if the performance of Units conforms to project specifications, and assess ant change of design, and make suggestions on rational measures.

Procurement

Procurement team will coordinate the services such as delivery expedite, transportation and the inspection of equipment and material, etc., e.g., the procurement team will establish commercial terms, conditions, contract evaluation criteria and purchase order. The procurement team will also appropriately establish and issue request for proposal ("RFP") document, including the supply of environment monitoring, civil works, structural steel, plank, grille, bolted connection; steam turbine generator, heat exchanger, feedwater heater, deaerator, condenser, water pump and driver, steam-driven generator, mechanical element, accessory boiler, bridge crane, water treatment system and wastewater treatment system, storage tank, piping, valve, electrical and instrument, instrument board and controller as well as transformer. The procurement team will hold pre-bidding meeting, and will coordinate site investigation. The procurement team will provide pre-bidding instructions, and will prepare and issue the appendixes of IFB document as necessary. The procurement team will assess bid, and coordinate the work of project team, and will hold pre-bidding clarification meeting, and will draw up and execute contractual agreements.

The procurement team will carry out site procurement and manage construction subcontractors at construction stage. The procurement team will carry out inspection, acceptance, customs clearance and inland transportation, and provide help for site storage, and when required, will arrange the technology representatives of suppliers to investigate the site at installation, test and start-up stages.

The procurement team will also review the design and fabrication activity reports submitted by suppliers and contractors to verify if the design deliverables to be reviewed have been issued in time, and if relevant products are fabricated, tested and shipped to conform to specified delivery date. In order to control transportation links, the procurement team will establish detailed transportation lines and packing requirements for contractors and mail instructions. The procurement team will coordinate the shipment plan and arrangement of various suppliers to accomplish the optimal economic efficiency during construction, and will review the shipping document required for rational payment, review shipping/receiving report, and solve excess/shortage and damage problems.

Installation

Before construction is begun, EPC contractor will participate in making material allocation plan, and will introduce the source of goods as per current experience and price. EPC contractor will make suggestions on the early procurement location and superintendent of material as well as design change to decrease project cost, and will ensure the implementation of construction plan. EPC contractor will assist to review and develop the scope and content of the material packages being bidden. Construction team will make construction plan, and will review design to improve construction possibility, and will participate in reviewing the material packages that are finally bidden, before integrity, interface continuity and plan interpretation are requested to be verified. When required, the construction team will also participate in bid evaluation and clarification meeting, and will assist to determine front-end long-term project and to make plan to complete delivering.

EPC contractor will supervise the construction operation of civil/structure of labour at construction stage. EPC contractor will, for this project, establish the construction inspection methods conforming to engineering, and will provide engineering support and supervision for site construction operation, field investigation, test and experiment services, and will review/approve the site changes required by subcontractors.

EPC contractor will manage the reception, storage and distribution of material, and will review and verify the invoices issued by subcontractors. EPC contractor will also manage subcontractor's matters, such as quality, safety and stability, etc.

Focusing on control, cost, plan and report, construction management team can carry out effective management for the project.

Commissioning

Various project teams need to make efforts in turning start-up activity into synergetic full initial operation. The commissioning and performance test of the power plant include all tests and inspections required for demonstrating the reliability and performance of the power plant. These activities will be performed after the completion of system installation. The Units will be permitted to be put into commercial operation and will be accepted temporarily after commissioning, performance test and the reliability operation of various Units are completed. Chemicals, fuel and feedback electric power will be provided by the

Owner free of charge during the commissioning, performance test and the reliability operation of various Units.

The following tests shall be performed before the facility of the power plant is synchronized with power grid system:

1. Automatic voltage regulator shall be set and regulated in stop state, and power generator shall be in no-load operation;
2. Inspect the control function of steam turbine /power generator governor;
3. Carry out open-circuit and short-circuit tests for each power generator;
4. Carry out function test and governing for the high-voltage switchgear of the switchyard;
5. The Company and the power purchaser shall verify if the settings of the following protection levels have been approved by Operation Committee:
    a. The ground fault of stator;
    b. Negative phase sequence; the over-current and ground fault of generator transformer as well as high-voltage bus protection;
    c. Carry out voltage phasing inspection between the power distribution station of the power plant and power grid system;
    d. Inspect all internal trip circuits between the power plant and power purchaser.

Tests and commissioning when and after the synchronization of the power plant. EPC contractor will carry out the following tests to accomplish the commercial operation of the power plant:

1. Overspeed test;
2. Initial test and capacity test;
3. Reliability operation test;
4. The operation test of automatic voltage regulator;
5. The operation (drop) test of steam turbine/generator governor;
6. Reactive capacity;
7. Minimal load capacity;
8. Reflection of the power plant to load step;
9. Full load rejection;
10. Performance test;
11. Reliability operation

Performance test will be performed prior to steady operation; this test will be based on relevant national and international standards.

Design office will prepare a detailed start-up plan and manual, including main start-up systems and activities. The management and coordination of this project will be carried out on site by EPC contractor and operation & management team.

EPC contractor will be responsible for the operation of the power plant prior to turnover; the operation & management team will provide working personnel. These working personnel will work under the supervision of EPC contractor during turnover, and the teams of the both parties will participate in the start-up activity, including the establishment of plan; instrument & control; the inspection of control system, the start-up of boiler and turbine; work quality, documentation; contact with other participants of this project. EPC contractor will prepare a series of turnover content for this Project Company, and will review start-up plan, and will prepare a copy of comprehensive start-up management plan. The EPC contractor will also review the operation & management instructions provided by suppliers and contractors.

EPC contractor will carry out performance test and accept test requirements to allow the power plant to have good performance under actual operation condition, and to allow the power plant to conform to the established engineering design standards; they are in duty bound to help operation personnel to be familiar with these procedures.

EPC contractor will, in accordance with the description of EPC agreement, prepare coordination activities and plans, and will provide power plant test, the testing parts of power plant, clean system and the instructions for initial operation; they are in duty bound to review if various parts conform to design standards and size.

Start-up and initial operation will be performed together with late construction installation and test till all systems and parts are accepted by the Owner/operation organization and the project is completed as per required size.

EPC execution measures

In order to accomplish the above-mentioned functions, the Project Company will ensure that EPC contractor follows the accepted engineering management principles, including control, valuation, plan and schedule report.

1. Engineering control

Engineering control includes plan, evaluation, coordination, inspection, and the research & development report of fabrication cost, plan and engineering evaluation. The teams address themselves to accomplish this function will provide plans, schedule, coordination and design management to support actual activities, to recheck and to estimate actual variation, and to monitor engineering progress and cash flow. The estimation of these activities will be entered into progress report; in this way, progress, procurement and construction progress can be reviewed and analysed, which can allow managers to oversee the engineering from broader angle, and allow the front-line supervision personnel to take actions as required.

2. Construction cost

Definition of cost control: facilitate actual control, and address important control factors that need to be controlled (e.g., non-artificial cost, subcontracting cost, and the cost of raw material). The key tools in cost control items are as follows:

Engineering dynamic: management body can compare the existing or potential cost and plan to engineering plan and budget by means of analysing engineering dynamic, to provide early deviation notice. This project is an internal project, and allows the Project Company to have adequate time to take suitable actions, and necessary communication can be performed for all dynamics that are varied within certain range.

Scope control: the scope change initiated by the Owner will be trended, and will be communicated via the monthly progress report. The Project Company will minimize the scope change resulted from the Owner; all confirmed scope changes will be assessed, e.g., the impact on cost and plan will reviewed by various interest-related parties.

3. Project plan

The plans of grading system will be executed to supervise and to control design, procurement, construction and start-up activity. The tools of this system are different from project sum-up plan to the task list of each item; the detail of each tool is very appropriate and sufficient to control various aspects of work, and to have sufficient communication and coordination among the members of project team.

The plan control system will be consisted of the following tools:

Project milestone sum-up plan: this plan will take project milestone as border to sum up the work of design, construction, start-up activity and critical paths. This plan will provide the overview of activity situation, and will provide management body with effective communication regarding project situation. Project milestone sum-up plan will be updated every month, and will be issued in monthly progress report.

Intermediate plan: this plan will be consisted of detailed design, procurement, construction and start-up activity, and will be based on critical path analysis and plan assessment; this plan will also be used as the base for studying the load capacity of engineering resources. Intermediate plan will be updated every month and will be issued as required.

Scrolling plan: the scrolling plan of the work to be carried out is the product of intermediate plan; the plans in the design, procurement, construction and start-up activity of every week and everyday as well as the working tools used in control will be listed in this plan.

4. Progress report

Engineering progress and the events occurring during engineering construction will be recorded in monthly progress report; the engineering progress report will describe the actual work progress of measurable and calculable engineering rather than the design and construction of planned engineering, engineering procurement and engineering construction; this report will include pictures and start-up plan.

Personnel

EPC contractor will provide experienced management personnel and supervision personnel to support the schedule and plan of the project as required. A part of local labour will be employed to promote local employment and local economic development during the project implementation.

Large-sized construction equipment

EPC contractor is in duty bound to obtain sufficient large-sized construction equipment to implement this project. EPC contractor needs to confirm which large-sized construction equipment can be obtained in Pakistan, and which equipment needs to be imported from foreign countries; EPC contractor shall investigate local contractors to confirm what equipment they possess and which equipment will be used in other projects.

Small equipment (including small-sized crane, truck and forklift) can be obtained from local market; large-sized equipment (e.g., large-sized crane) needs to be imported, and can be sold or exported again after the completion of the project. Because large-sized equipment would affect the work of critical path, it is vital to provide equipment in time.

Temporary construction facility – camp and temporary buildings

EPC contractor is in duty bound to provide subcontractors with labour lodging and material storerooms during project implementation. It is expected that the storage area will be in the eastern and northern areas of the future power plant.

17.2.2 Operation

With the development of the test-run of the project, the Project Company will provide operation and management services itself or may employ other specialized authorities to provide operation and management services. The objective of the services provided by operation and management personnel is to accomplish the safe, effective and reliable operation of equipment. To accomplish this objective, the following tasks are to be executed:

- Relationship between the staff and labours of the power station;
- Personnel training;
- Health, safety and environment management;
- Program development, including budget and cost control;
- Management to parts and components as well as material;
- Preliminary operation management and acceptance;
- Energy sales contract, maintenance and fuel supply agreement;
- Efficiency objective of availability and production value

The operation of the power plant will be executed according to operation and management agreement, including operation budget control, contractor management, insurance maintenance; operation management personnel operate the control system, and report the completion of operation standards. Finally, necessary training will be provided to ensure labour safety and to protect environment.

Requirements to operation authority and personnel

Operation and management personnel need to be consisted of experienced and trained personnel, and the personnel within Pakistan will be employed; some critical positions may be assumed by dispatched personnel; however, the all staff will be consisted of Pakistani according to long-term plan. Personnel can be divided into the follow categories as per qualification: manager, engineer, operation personnel/technical personnel, clerk, skilled labour and non-technical personnel.

1. Skills and qualification required

As for the operation of modern coal-fired power plant, competent and experienced manager, and some engineers, operation personnel/technical personnel, management personnel, skilled workers and unskilled workers are required.

Manager must be experienced in leading others to complete departmental objectives, and his/her management level generally needs at least 15 years of working experience and 5-10 years of leadership experience.

Engineer shall be available with experience and qualification; highly technological capability may compensate the inadequacy of experience under proper condition; however, it is generally preferred to have at least more than 5 years of working experience in similar position.

Operation personnel and technical personnel shall be available with suitable professional technology and several years of working experience in similar positions; generally, they must be available with relevant technical qualification and have powerful capability in previous work.

As the working personnel of office, management personnel shall be available with all-around capability to manage operation offices, e.g., staff need to carry out the following activities: reception, accounting, addressing affairs, and carrying out office management.

Technical personnel shall be consisted of skilled worker of different work types, e.g., electrician, woodworker, mechanic and piping worker; these personnel shall be available with more than 5 years of working experience and adequate capability, as well as several years of apprentice experience.

The work done by non-technical personnel does not need sufficient training and experience, e.g., the positions of non-technical personnel are generally assumed by maintenance assistant, driver, the cleanness keeper of power plant, and the service personnel of dining hall.

2、Recruitment resources

It is optimum if experienced operation and maintenance personnel of power plant can be recruited; if possible, local labourers will be given preference. It is estimated that some critical positions will be assumed by dispatched personnel at the first; however, many local staff that only have basic skill will be still recruited; it is hoped that their qualification can be improved by means of training and experience to reach desired level.

The local labours who have no power plant experience will directly assume elementary positions after being trained; The local labours who have some power plant experience will directly assume the positions of higher level after being trained; working personnel will be obtained from existing power company, or if possible, it is preferred to obtain the staff who have been working as Pakistani emigrants in the power plants of other countries.

Training project

The Project Company will set up a training project with wide coverage. The function of training institution is to meet the training demands of different crowds, and to provide training courses as required. Contractor will provide necessary training at the start-up and test-run stages of the project according to EPC agreement. The initial objective is to make operation and maintenance personnel to be more familiar with the design of the power plant by means of receiving dense training course.

EPC contractor will be in duty bound to provide instructions and training manuals, and to facilitate this process. The Project Company thinks these teaching materials are suitable, and will continually provide training for staff during project construction.

The on-the-job training for testing the turnover function of system can allow operation and maintenance personnel to get familiar with and to understand the system and operation situation of the power plant. Standard training modules include air pressure, air temperature, basic electric power theory, hydrochemistry etc. If required, the personnel of manufacturer or construction contractor who have been trained by the manufacturer will provide special training.

Training will be conducted in the locations where good equipment is available, so that study becomes easier and easier; the training location may be on construction site; the professional operation knowledge and knowledge on the training of this Company will be used, e.g., computer-based self-study. All trainings will be evaluated, and trainees will be examined periodically if progress has been made. Classroom study will be supplemented by means of visiting power plant and on-the-job training as required.

Management concept and notices about operation and maintenance

The purpose of operation and maintenance plan is to accomplish high power utilization rate and to improve stability; the key point is to minimize interruption time of operation by means of preventative and planned maintenance. The Project Company will make the best of computerized management tools to deal with the availability of various parts and to provide time for the replacement of parts. Take measures to ensure there are sufficient parts and components in the warehouses on project site, and provide training continually. With the accumulation of experience, the Project Company will research the best practice system to minimize emergency outage time at operation stage. Tools and practice will make the power plant maintain high availability, including well-behaved monitoring, e.g., vibration monitoring, thermal imaging apparatus, thermography and computerized maintenance system.

The efficient management to fuel supply will be the key part for the Project Company to succeed; reduce demurrage charge and closely control fuel delivery time to prepare for the supply interruption resulted from natural gas (e.g., due to monsoon); make effective fuel prediction, and optimize fuel cost. All the above are the factors for balancing production demand and fuel supply.

18. Project Agreements

As is the case with projects of this size and complexity, the Project will be financed under a typical non-recourse project finance structure. Project lenders and investors look towards the project documentation and the inter-linkages between various project agreements and coverages provided under such documentation to cover any project related risks which may affect the feasibility and bankability of the project. In such a case, various project agreements such as long term PPAs (at pre-determined tariffs), land leases, EPC contracts, operation and maintenance contracts, long term fuel supply agreements, government and multi-lateral guarantees etc. come together to form a security package which makes the project bankable to the lenders and feasible in terms of returns to the investors. Only in a case where above-mentioned documentation is satisfactory to the lenders and acceptable to the sponsors and investors will a project be considered viable; therefore, in any project evaluation, the role of these agreements is fundamental. A summary of agreements specific to the Project are provided below.

18.1Power Purchase Agreement

The Power Purchase Agreement includes and addresses typical aspects covered by such long-term contracts. The PPA has a thirty-year term and covers all phases; design, construction, operations as well as end of term conditions.

A Power Purchase Agreement ("PPA") is executed between the Company and CPPA-G, the Power Purchaser. The PPA contains details of the generation and dispatch methodologies, operating procedures and practices, and commercial terms including billing and payments. The term of the PPA from the date of financial close and extends throughout the life of the project. The Tariff determined by NEPRA forms the base of the PPA and allows the necessary revenue predictability and consistency that is the key to any investment.

After COD, the Project Company will receive monthly energy charges (indexed to change in US CPI), fuel charges (indexed to change in fuel cost) and capacity charges adjusting for any short capacity, low availability etc. The energy charges will include fuel cost and variable O&M. Capacity charges will include fixed O&M, working capital, insurance, debt servicing and return on equity.

The PPA incorporates provisions of liquidated damages, delayed payments, force majeure events; change in law; change in tax scenarios.

18.2Implementation Agreement

The Implementation Agreement ("IA") is signed between the project company and the Government of Pakistan ("GoP") and its term commences from the execution of the PPA and continues till the expiration of the PPA. The IA defines the GoP's obligations with respect to the guarantee for payment of amounts due by the Power Purchaser, compensation payments in case of termination due to Power Purchaser event of default or Force Majeure and provisions such as additional security, fast-track clearance of imports equipment at port, provision of consents etc. The IA also includes provisions related to protection against any discriminatory action by the GoP or public entity which materially and adversely affects the Project or its ownership. Moreover, the IA has provisions for Seller's event of default, GoP's event of default and for force majeure events.

18.3 Engineering, Procurement and Construction Agreement

The Engineering, Procurement and Construction ("EPC") Agreement will ensure delivering the Plant as per specifications and time schedules. The EPC Contractor will be responsible for delivering the goods to Project Site, their installation as well as testing and commissioning. The scope will be comprehensive and the contractor shall be responsible for engineering and procurement outside Pakistan; supply of equipment, material and services required for the Project; and contracts with other local or international vendors.

The EPC contract shall have a typical payment stream starting with an advance payment secured by an advance payment guarantee. The EPC Contractor and its parent are expected to provide the necessary warranties and securities to meet the design, construction, commissioning, testing and delivery requirements of the Plant at the agreed specifications, within the stipulated period, to avoid any penalties or additional costs to the Project Company. These commitments will be secured by bank/performance guarantees, which are typical for project finance transactions of this magnitude. The EPC contract shall also secure performance guarantees for post COD period for net electrical output, fuel and lubricant consumptions. The language and structure of the EPC contract and accompanying securities are expected to be acceptable to financiers and will be in line with standard international practices.

18.4Operations and Maintenance Agreement

The Project Company intends to enter into a long-term contract with the selected Operations and Maintenance ("O&M") operator for enlisting services to ensure continuity of operations and risk mitigation. The scope of the contract shall include routine operation and maintenance of the Plant as well as services and spares required during scheduled outages and major overhauls. The contract will clearly define performance parameters of the O&M contractor in terms of availability as well as efficiency. It will also define liquidated damages in case of non-compliance and securities typical of such transactions.

In routine operation and maintenance, the O&M contractor will deploy a full time, experienced team of professionals at the Plant, who will perform daily operation, preventive maintenance, fault diagnostics and rectification. The O&M contractor will be expected to mobilize its team on the Project Site six months before commissioning and also witness testing and commissioning to provide its opinion to the Project Company as well as be trained by the EPC Contractor to enable a smooth takeover of the Plant.

18.5Coal Supply Agreement

The Sponsors will purchase the fuel required for the operation of the power plant through various kinds of fuel supply agreement. The existing circumstance of coal industry and the proposal to be adopted in this project are deeply analysed in section 5 of this Feasibility Study Report. Although the terms of fuel supply agreement have not been determined yet, the analysis already reached a conclusion as follows: firing coal will be imported from selected foreign coal production location; various kinds of contract available with cross period of validity and different coal suppliers so as to minimize the negative influence resulted from the unavoidable fluctuation in coal market.

18.6Financing Agreements

To be finalized.

19. Financial Analysis

The purpose of this section is to ascertain and quantify the financial benefits of the proposed coal-fired power project.

19.1 Project Parameters

Table 19.1 – Project Parameters

Gross Capacity per Unit	150.0 MW
No. of Units	2
Total Gross Capacity	300.0 MW
Auxiliary Consumption	9.3%
Total Net Capacity	272.1 MW
Availability	85%
Total Annual Generation	2,026 GWh

19.2 Project Tarff

The total Project Tariff is US ¢ 7.7426 per kWh (based on an 85% availability factor), and is the sum of Energy Payments and Capacity Payments. Energy Payments can be further divided into the fuel component, ash disposal and desulfurization and variable O&M. Capacity Payments can be further divided into fixed O&M, cost of working capital, insurance, return on equity and debt servicing.

19.3 Proposed Project Tarff

Table 19.2 – Proposed Project Tariff

	Parameter	Tariff		Indexation
		Year 1-10	**Year 13-30**	
1	Fuel Component	3.8214	3.8214	Delivered Fuel Price at Power Complex
2	Ash & Desulfurization	0.3100	0.3100	Local CPI
3	Variable O&M (Foreign)	0.1244	0.1244	US CPI, PKR/USD
4	Variable Foreign (Local)	0.0829	0.0829	Local CPI
	Total Energy	**4.3387**	**4.3387**	
3	Fixed O&M (Foreign)	0.2073	0.2073	US CPI, PKR/USD
4	Fixed O&M (Local)	0.2073	0.2073	Local CPI
5	Insurance	0.1772	0.1772	PKR/USD
6	Working Capital	0.1463	0.1463	3-month KIBOR and coal price
7	Return on Equity	1.4779	1.4779	PKR/USD
8	Debt Servicing	2.1337	-	6-month LIBOR, PKR/USD
	Total Capacity	**4.3497**	**2.2160**	
	Total Tariff	**8.6884**	**6.5547**	
	Levelized Tariff (PKR/kWh)		**8.1297**	
	Levelized Tariff (US cents/kWh)		**7.7426**	

Table 19.3 - Reference Tariff Table																
Year	Energy Purchase Price - EPP (Rs./kWh)					Capacity Purchase Price - CPP (Rs./kW/Hour)								Capacity Charge @ 85% PF	**Total Tariff**	
	FCC	Ash Disposal & Desulfurization	Variable O&M (Foreign)	Variable O&M (Local)	Total	Fixed O&M (Foreign)	Fixed O&M (Local)	Insurance	Working Capital	ROE	Loan Re-Payment	Interest Charges	Total CPP	Rs. Per kWh	**Rs. Per kWh**	**US ¢ per kWh**
1	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	0.9387	0.8750	3.6973	4.3497	**8.6884**	**8.2747**
2	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	0.9906	0.8231	3.6973	4.3497	**8.6884**	**8.2747**
3	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.0453	0.7684	3.6973	4.3497	**8.6884**	**8.2747**
4	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.1030	0.7106	3.6973	4.3497	**8.6884**	**8.2747**
5	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.1640	0.6497	3.6973	4.3497	**8.6884**	**8.2747**
6	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.2283	0.5854	3.6973	4.3497	**8.6884**	**8.2747**
7	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.2961	0.5176	3.6973	4.3497	**8.6884**	**8.2747**
8	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.3677	0.4460	3.6973	4.3497	**8.6884**	**8.2747**
9	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.4433	0.3704	3.6973	4.3497	**8.6884**	**8.2747**
10	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.5230	0.2907	3.6973	4.3497	**8.6884**	**8.2747**
11	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.6072	0.2065	3.6973	4.3497	**8.6884**	**8.2747**
12	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	1.6959	0.1177	3.6973	4.3497	**8.6884**	**8.2747**
13	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	0.8828	0.0241	2.7904	3.2828	**7.6215**	**7.2586**
14	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
15	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
16	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
17	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2552	-	-	1.8836	2.2160	**6.5547**	**6.2425**
18	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
19	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
20	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2150	**6.5547**	**6.2425**
21	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
22	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
23	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
24	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
25	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
26	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
27	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
28	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
29	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
30	3.8214	0.3100	0.1244	0.0829	4.3387	0.1762	0.1762	0.1507	0.1243	1.2562	-	-	1.8836	2.2160	**6.5547**	**6.2425**
Levelized																
1 - 30 Years	3.8214	0.3100	0.1244	0.0829	4.3387	0.1692	0.3948	0.1507	0.1243	1.2562	0.9005	0.4383	3.2223	3.7910	**8.1297**	**7.7426**

19.4 Project Cost

Table 19.4 –Project Cost

Item	Cost (USD million)
Capital Cost (incl. Custom Duties & Withholding Tax)	412.71
Other Costs	52.54
Interest during Construction	27.69
Total Project Cost	**492.94**

19.5 Project Funding

The Project is expected to be financed at a debt to equity ratio of 75:25 on a non-recourse basis. The equity will be subscribed to by the Sponsors i.e. CCCC and Tianjin. Long-term debt will be in the form of SINOSURE-backed Long Term Debt equivalent to 85% of EPC Cost, Custom Duites, Sinosure Fee and Construction Interest. Below is a summary of the project funding plan:

Table 19.5 –Project Funding

Funding Source	USD million
Equity	123.24
Long-term Debt	369.71
Total Funding	**492.94**

19.6 Funding Parameters

Table 19.6 – Funding Parameters

Facility Type	Senior Secured Long-term Facility
Facility Provider	Industrial & Commercial Bank of China
Amount	85% of EPC Cost, Custom Duites, Sinosure Fee and Construction Interest
Term	Up to 15 years (Including 2.5-year grace period)
Reference Rate	6-month London Interbank Offered Rate
Margin	4%
Payment Frequency	Semi-Annual
Export Credit Insurance	Sinosure

19.7 Project Timeline

The model assumes a 30-month construction period following financial close ("FC"), which has been used for the purpose of calculation of Interest during Construction ("IDC") and equity return for the shareholders.

19.8 Project Term

The model assumes a project life of 30-years and equivalent term for the power purchase agreement with the power purchaser

19.9 Project Revenue

Based on an 85% plant load factor and a net capacity of 272.1 MW, the Project is expected to generate approximately 2,026 GWhs annually. Based on the un-indexed Project tariff, annual revenues of the Project Company are expected in the range of USD 168 million.

19.10 Project Fuel Cost

Based on an efficiency of 37%, annual generation of approximately 2,026 GWhs, annual coal consumption is expected to be approximately 950,000 MT. This translates into a fuel cost of approximately USD 74 million per annum.

19.11 Project O&M Cost

Project O&M Costs have been estimated based on projects of similar in nature, i.e. capacity, technical parameters, etc. Given the above parameter, O&M Costs have been estimated at USD 12 million per annum. 75% of O&M has been assumed as fixed and rest as variable. Given the above parameters, annual Fixed O&M costs are USD 8 million and annual Variable O&M Costs are USD 4 million. Fixed O&M can be further split into 50% foreign and 50% variable while Variable O&M can be further split into 60% foreign and 40% variable.

19.12 Working Capital Assumptions

The Project Company expects a 30-day payment cycle with CPPA-G and the working capital requirement of the Project has been based on the same. A 90-day coal inventory has also been budgeted in working capital requirement. The facility will be arranged locally by the Project Company at an assumed rate of KIBOR plus two (2) % per annum.

19.13 Debt Service Reserve

As part of the lenders' requirement, a Debt Service Reserve Account ("DSRA") equivalent to the prospective six (6) months debt instalments have been provisioned in the Project cost.

19.14 Projected Financial Statements

Projected Annual Financial Statements and Ratio Analysis for the Project are presented below:

Table 19.7 – Projected Income Statement

Income Statement (USD million)	1	2	3	4	5	6	7	8	9	10	11	12	13
Revenue	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**167.65**	**147.06**
Operating Costs	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**	**95.14**
Fuel	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*	*73.74*
Variable O&M	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*	*4.00*
Fixed O&M	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*	*8.00*
Insurance	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*	*3.42*
Limestone & Desulfurization	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*	*5.98*
EBITDA	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**72.51**	**51.92**
Depreciation	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43
Earnings Before Interest	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**56.08**	**35.49**
Long Term Interest Cost	19.86	18.69	17.44	16.13	14.75	13.29	11.75	10.12	8.41	6.60	4.69	3.19	1.60
Short Term Interest Cost	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
Net Income	**33.40**	**34.57**	**35.81**	**37.13**	**38.51**	**39.97**	**41.51**	**43.13**	**44.85**	**46.66**	**48.57**	**50.07**	**31.08**

Table 19.8 – Projected Balance Sheet

Balance Sheet (USD million)		1	2	3	4	5	6	7	8	9	10	11	12	13
Cash		-	-	-	-	-	-	-	-	-	-	-	-	-
Fixed Assets		476.51	460.08	443.65	427.22	410.78	394.35	377.92	361.49	345.06	328.63	312.20	295.76	279.33
DSRA		20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	20.59	-
Fuel Receivable		8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27	8.27
Other Energy Receivable		-	-	-	-	-	-	-	-	-	-	-	-	-
Capacity Receivable		-	-	-	-	-	-	-	-	-	-	-	-	-
Inventory		24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81	24.81
Total Assets		**530.18**	**513.75**	**497.32**	**480.89**	**464.45**	**448.02**	**431.59**	**415.16**	**398.73**	**382.30**	**365.87**	**349.43**	**312.42**
Working Capital Loan		33.08	33.08	33.08	33.08	33.08	33.08	33.08	33.08	33.08	33.08	33.08	33.08	33.08
Current Portion of Long Term Loan	21.31	22.49	23.73	25.04	26.42	27.88	29.42	31.05	32.76	34.57	36.48	38.50	20.04	-
Long Term Loan	369.71	325.91	302.18	277.14	250.72	222.83	193.41	162.36	129.60	95.02	58.54	20.04	0.00	0.00
Paid Up Capital		123.24	123.24	123.24	123.24	123.24	123.24	123.24	123.24	123.24	123.24	123.24	123.24	123.24
Accumulated Profit		25.46	31.52	38.82	47.43	57.42	68.87	81.86	96.48	112.81	130.95	151.01	173.08	156.10
Total Liability & Equity		**530.18**	**513.75**	**497.32**	**480.89**	**464.45**	**448.02**	**431.59**	**415.16**	**398.73**	**382.30**	**365.87**	**349.43**	**312.42**

Table 19.9 – Projected Cash Flows

Cash Flow (USD million)	1	2	3	4	5	6	7	8	9	10	11	12	13
Net Income	33.40	34.57	35.81	37.13	38.51	39.97	41.51	43.13	44.85	46.66	48.57	50.07	31.08
Add: Depreciation	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43	16.43
Change in A/R	(8.27)	-	-	-	-	-	-	-	-	-	-	-	-
Change in Inventory	(24.81)	-	-	-	-	-	-	-	-	-	-	-	-
Change in DSRA	(20.59)	-	-	-	-	-	-	-	-	-	-	-	20.59
CFO	**(3.84)**	**51.00**	**52.25**	**53.56**	**54.94**	**56.40**	**57.94**	**59.57**	**61.28**	**63.09**	**65.00**	**66.50**	**68.09**
Change in Long Term debt	(21.31)	(22.49)	(23.73)	(25.04)	(26.42)	(27.88)	(29.42)	(31.05)	(32.76)	(34.57)	(36.48)	(38.50)	(20.04)
DSRA Disbursement	-	-	-	-	-	-	-	-	-	-	-	-	-
Change in Working Capital Loan	33.08	-	-	-	-	-	-	-	-	-	-	-	-
CFF	**11.77**	**(22.49)**	**(23.73)**	**(25.04)**	**(26.42)**	**(27.88)**	**(29.42)**	**(31.05)**	**(32.76)**	**(34.57)**	**(36.48)**	**(38.50)**	**(20.04)**
Opening Cash	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Cash Flow	7.93	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.00	48.05
Dividend	7.93	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.00	48.05
Closing Cash	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 19.10 – Ratio Analysis

Ratio Analysis	Min	1	2	3	4	5	6	7	8	9	10	11	12	13
Revenue	126.48	167.65	167.65	167.65	167.65	167.65	167.65	167.65	167.65	167.65	167.65	167.65	167.65	147.06
EBITDA	31.34	72.51	72.51	72.51	72.51	72.51	72.51	72.51	72.51	72.51	72.51	72.51	72.51	51.92
Net Income	12.09	33.40	34.57	35.81	37.13	38.51	39.97	41.51	43.13	44.85	46.66	48.57	50.07	31.08
Dividends	7.93	7.93	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.52	28.00	48.05
Annual Interest Charge	-	19.86	18.69	17.44	16.13	14.75	13.29	11.75	10.12	8.41	6.60	4.69	3.19	1.60
Annual Repayment	-	21.31	22.49	23.73	25.04	26.42	27.88	29.42	31.05	32.76	34.57	36.48	38.50	20.04
Total Debt Servicing	-	41.17	41.17	41.17	41.17	41.17	41.17	41.17	41.17	41.17	41.17	41.17	41.69	21.64
Debt to Equity	0.12	2.57	2.32	2.07	1.82	1.57	1.33	1.10	0.89	0.69	0.50	0.33	0.18	0.12
Current Ratio	1.00	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.00
Times Interest Earned	3.65	3.65	3.88	4.16	4.49	4.92	5.46	6.17	7.16	8.62	10.99	15.47	22.73	32.55
Long Term Debt Service Coverage	1.74	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.76	1.74	2.40
Loan Life Cover Ratio	1.98	1.98	1.99	2.01	2.04	2.07	2.11	2.17	2.26	2.39	2.64	3.21	6.08	

19.15 Sensitivty Analysis

Based on key project parameters related to EPC cost and Constuction Period, sensitivity analyses have been carried out to evaluate the impact of changes in above mentioned parameters. The results of the same are presented in the tables below.

EPC Cost

	EPC Cost (USD million per MW)				
Equity IRR %	1.04	1.09	1.14	1.19	1.24
	19.87%	18.38%	**17.00%**	15.72%	14.53%

Construction Period

	Construction Period (Quarters)				
Equity IRR %	8Q	9Q	10Q	11Q	12Q
	18.44%	17.69%	**17.00%**	16.35%	15.75%

19.16 Profitability Parameters

As is evident from the above-mentioned projected financial statements, the Project generates positive retunrs for the sponsors after meeting all of its debt obligations.

Table 19.11 - Key Financial Parameters

Project Internal Rate of Return	11.12%
Equity Internal Rate of Return	17.00%
Minimum Debt Service Coverage Ratio	1.74
Weighted Average Cost of Capital	8.34%
Project NPV @ Weighted Average Cost of Capital	USD 107.93 Million

The key profitability determinant for equity investors of a project is the Equity Internal Rate of Return, which under base case assumptions is close to 17.00% and is expected to remain above the hurdle rate requirements of the equity investors and project developers. On an overall project basis, the Project IRR of 11.12% is greater than the weighted average cost of capital ("WACC") of 8.34%, which validates the financial feasibility of the Project. From the lenders' perspective, project cash flows provide significant margin in terms of debt service requirements, as can be concluded from the healthy debt coverage ratios listed above. The above sections related to sensitivity analysis also positively ascertain that even in scenarios where there are deviations from the base case, the Project remains feasible in terms of reasonable profitability for the investors and adequate debt coverage ratios for the lenders. It may be noted that a number of risk mitigants are being put in place in order to minimize the impact of such deviations in the base case assumptions as part of the project documentation/agreements.

20. Risk Analysis

An analysis of the key risks and their mitigants for the Project has been conducted; which have been summarized below:

20.1 PPA Specific Financial Risk

Liquidated Damages

Mitigation:

- Reputable EPC Contractor with technically sound and financially strong Parent.
- Back-to-back LDs from EPC Contractor for delayed completion [•] % of Contract Price per day for the period exceeding maximum construction period.

Performance Bond

Mitigation

EPC Contractor providing a performance bond equivalent to [•] % of Contract Price in form of a Standby L/C.

20.2 Power Purchaser Credit Risk

Non-payment by Power Purchaser of any due payments or obligations under indemnities / penalties

Mitigation

- GOP IA guarantees payments in case of default by Power Purchaser.

20.3 Cost Escalation (with successful delivery or non-completion)

Mitigation

- Lump sum fixed price EPC Contract thereby cost escalation unlikely.
- EPC Contractor liable for Delay related Liquidated Damages to cover additional costs due to delay in COD.
- Commercial Insurances to cover additional costs due to marine loss or other insurable events.
- Provisions under the PPA to cover any cost escalations due to Change in Tax, Change in Law, Political events through GOP, non-insurable Force Majeure.

20.4 Delay in achieving Commercial Operations

Mitigation

- Reputable EPC Contractor with technically sound and financially strong Parent. Lump-sum fixed price time certain agreement.
- EPC Contractor liable for Delay Liquidated Damages to cover additional costs due to delay in COD.
- EPC Contractor liable for Performance Liquidated Damages with buy down amounts securing life cycle costs, if COD delayed due to performance issues.
- EPC Contractor Performance Bond (equivalent to [•%] of Contract Price) & withheld Final Payment to cover obligation for liquidated damages.
- EPC Contractor to build in provisions for rejection & liability up to EPC contract Price in case of PPA Termination due to EPC Contractor Default.

20.5 Plant Capacity/Plant Heat Rate

Lower capacity of the plant at COD than the Contracted Capacity

Mitigation

- EPC Contractor liable for Performance Liquidated Damages for not meeting guarantees related to capacity, heat rate and other parameters.
- Buy down amounts securing life cycle costs applicable if applicable parameters not met.
- Plant to be rejected with obligation to make good or liability up to EPC contract if minimum functional specifications not met.
- Minimum functional specifications defined in line with Performance Liquidate Damages Liability Cap under the EPC contract.

20.6 Force Majeure

Mitigation

- Insurable Force Majeure affecting Project Company/EPC Contractor covered through Project Commercial insurances.
- In case of any force majeure affecting CPPA-G, CPPA-G will pay to the Project Company:
    - Fuel Charges/Energy charges for Net Electrical Output delivered
    - Capacity Payments for the available that the Company can provide
    - Term of the PPA will be extended for duration of Force Majeure affecting the parties.

20.7 Environmental

Ensuring development is in-line with national standards

Mitigation

- EPC Contractor obligation to conform to national environmental standards based on the design coals.
- Highly experienced Environmental Consultant and Technical Advisor retained and already on site undertaking detailed environmental studies.
- Project to procure coal strictly in line with design specifications.
- On-site FGD and ESP are provided to scrub all the pollutants to bring exhausts, liquid and gaseous, in line with the local laws and lenders' covenants whichever are higher.
- The monitoring system will be in place to detect any excursion and to immediately rectify it.
- Sponsors envisage adhering to standards higher than the required national standards.

20.8 Fuel Availability and Security of Fuel supply

Mitigation

- Long-term CSAs to the satisfaction of Project consultants and the lenders.

- Project Design has provisions to operate over a reasonable range of coals. Multiple sources of coal to mitigate against single source interruption
- Project requires approximately 950,000 tons of coal per annum; a quantity which is easily manageable.
- The coal receival and unloading infrastructure designed in a manner whereby coal shall be unloaded at a rate higher than maximum coal consumption rate by the Plant.
- The Project port operated by an operator of sound experience and reputation.

20.9 Social / Political

Potential interruptions for the local community

Mitigation

- The Site has sparse settlements nearby and so the Project will not cause social upheaval.
- Sponsors will try and promote local employment by hiring locals.
- Project itself shall have a community living in a purpose-built colony to service the complex.
- The Plant shall act as a nucleus around which various economic activities and demand for goods and services will be generated
- First major step, towards development and transformation of Gwadar as part of the One Belt, One Road initiative.
- Growth of Gwadar local economy

20.10 Terminal Plant Performance

Design flaw significant operational deterioration leading to PPA termination

Mitigation

- Detailed design review to be conducted by the Project's technical advisor for all aspects, civil, mechanical, electrical, environmental etc.
- The Lenders' Engineer and the Owner's Engineer to continue to monitor actual construction and compliance to the agreed detailed design.
- Owner's Engineer to visit and inspect at least some major equipment production at some facilities.
- Key Plant Technical Parameters to be tested during commissioning tests and monitored during post COD periods.
- Buy down amounts securing life cycle costs applicable if applicable parameters not met.
- Design flaws will be reimbursed / rectified by EPC Contractor during basic warranty period, extended warranty period and warranty period for latent defects.
- Selection of renowned and experienced O&M operator.
- Seamless transfer from EPC Contractor to O&M contractor.
- O&M contractor on site even before the testing starts.
- Performance Guarantees by the O&M contractor to mitigate against significant operational deterioration.

20.11 Non-Terminal Plant Performance

Deterioration in the performance of the Plant leading to a reduction in revenues

Deterioration in plant performance leading to higher cost of operation; fuel, repairs & maintenance, general overhead

Mitigation

- Selection of renowned and experienced O&M operator.
- Performance Guarantees by the O&M contractor to mitigate against significant operational deterioration.
- Performance Liquidated Damages will be charged to the O&M operator for deterioration in plant performance. Typically, these include: Annual Availability Liquidated Damages, Heat Rate Liquidated Damages and Electrical Power Liquidated Damages.
- All operational penalties imposed by Power Purchaser on the Project Company will be transferred to O&M operator including Low Availability Penalty.

20.12 Security: Law and Order

Mitigation

- The Project Site shall be fenced in. Pickets and watch towers with security patrols shall provide added security.

20.13 Natural Disaster & Accidental Losses

Mitigation

- Project all risk insurance shall cover both for the assets as well as loss of profit.

21. Analysis for Economic and Social Impact

The Sponsors will engage a local, reputable consultant to complete the ESIA report of this project; see this report for details about the analysis for economic and social impact.

The construction of this project aims to further development in the following ways:

1. Gwadar power plant can guarantee the sovereignty and safety requirements of the free trade area, and can change the conjuncture that power supply is solely relied on Iran.
2. After Gwadar power plant is completed and put into production, power supply can be provided to the consumers nearby, which not only can reduce the power supply stress of state power grid, but also can decrease the loss of power transmission network.
3. Gwadar power plant can provide the free trade area and local residents with steady and reliable power supply, thus decreasing electricity utilization cost significantly.
4. The construction of this project is in favour of further continually deepening Sino-Pakistan strategic cooperative partner relationship and facilitating the joint development of the both countries in new period. By deepening the cooperation of China and Pakistan in the realm of energy sources and supporting Pakistan government to resolve energy shortage are in favour in facilitating the economic development of Pakistan, steadily pushing forward the construction of China-Pakistan Economic Corridor and the integrated progress of China and Pakistan. The construction of China-Pakistan Economic Corridor will bring about the interlock development of area economy, which is very significant for pushing forward the construction of "one belt and one road".

22. Conclusions and Recommendations

22.1 Conclusions

Engineering feasibility study has been performed for the Project on the site specified by the GoB as per the existing information, the Sponsor's requirements and the requirements for a thermal power plant. The following conclusions can be drawn:

1. The power shortage situation of Pakistan is severe. The construction of this power plant will not only meet the demand requirements of Gwadar but also adjoining areas. The construction and operation of the power plant can guarantee the sovereignty and safety requirements of the free trade area, and can be the first step in making Gwadar a trade hub.
2. The construction of the project can facilitate the economic development and social stability of Pakistan, and is in favour of further continually deepening Sino-Pakistan strategic cooperative partner relationship and facilitating the joint development of the both countries in new period.
3. The conceived proposal of the Project indicates that, the construction conditions of this project are mature and technically feasible. Environmental concerns are minimal due to the barren nature of the Project Site.

22.2 Recommendations

22.2.1 Tentative conditions

Since the available information is limited at present, part of main technical proposal can only be determined tentatively, and will be finally determined after condition is confirmed later. The information and affected technical proposals are as follows:

1. The water intake & drainage proposal is tentative because there is no information on the ocean current, sediment load and the like in site area and sea area;
2. The power accessing system proposal is tentative because there is no approved power accessing system report;
3. The ash yard proposal is tentative because there is not enough survey information on west-north ash yard;
4. Since coal source location and supplier have not been finalized, the HUBCO Project has been used as reference for the characteristics, ex-factory price and freight charges of the coal.

22.2.2 Recommendations

1. Further research the policies, laws and regulations of Pakistan related to power investment; Make clear the review & approval procedure of domestic and overseas investment projects as well as the responsibilities of various departments of Pakistan, and determine the competent department in charge of this project.
2. In accordance with international engineering implementation practices, the investor of PPA signature representative shall complete the following work after it obtains the implementation power of project and before PPA and Execution Agreement are signed:
   a. the matters to be internally resolved by investor are as follows:
      i. Make clear coal source, supply capacity and coal quality; sign coal supply contract;
      ii. Conclusion investor's jointly-funded agreement;
      iii. Obtain bank loan promise letter, and obtain low financing interest;
      iv. Communicate and coordinate with the existing operator of Gwadar Port to fulfil the proposal for utilizing the existing dock;
      v. Prepare a complete Feasibility Study Report and submit it to the relevant departments of the State Council of China for registration.
   b. Matters to be interfaced with Pakistan:
      i. Provide the permission authorization for the land and sea to be used for the project;
      ii. Conclude the service agreement of the peripheral infrastructure of the power plant with Pakistan government;
      iii. Conclude land agreement with GDA.
   c. The matters to be completed as soon as possible by the relevant parties entrusted by the investor:
      i. Employ an environmental assessment consultation authority to prepare Environmental Impact Assessment Report;
      ii. Carry out field investigation for the land area and sea area of the plant site and make clear the condition of the site to provide scientific basis for the optimization of general arrangement and foundation treatment proposal;

iii. Carry out topical digital simulation research for the ocean current, warm drainage and sediment load near the site to provide basis for water intake and drainage;
iv. Carry out earthquake safety evaluation;
v. Prepare accessing system report;
vi. Prepare the Feasibility Study Report of dock and firing coal transportation proposal;
vii. Employ law, insurance and financial advisers to prepare financial recommendations to conclude financing agreement;
viii. Set about researching the standard PPA and IA templates provided by Pakistan government, and tease out potential risks in the aspect of law, business and technology to prepare in advance.

3. With respect to the revampment construction of the supporting power transmission lines of power grid, the investor may take it as an independent item to negotiate with Pakistan government, asking for providing associated facility; or alternatively, the government may be suggested to introduce a third investor to undertake the engineering investment and construction even operation of the lines to have the initiative in the aspect of engineering interface and schedule match.
4. The Owner is requested to continually collect and make good the initial data and design input required for this project, and to complete relevant topic demonstration and review as soon as possible, to provide scientific basis for the project demonstration.