华能山东如意(巴基斯坦)能源有限公司 Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited

Ref: NEPRA-1 Date: 09 March 2015

THE REGISTRAR National Electric Power Regulatory Authority OPF Building, Shahrah-e-Jamhuriat G-5/2 Istamabad

SUBJECT:

APPLICATION FOR A GENERATION LICENSE OF HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED FOR ITS 2 x 660 MW IMPORTED COAL FIRED POWER PROJECT AT SAHIWAL PAKISTAN

I, Mr. Liu Youliang s/o Mr. Liu Xiaofeng, holding Chinese Passport No. PE0343353, the Chief Executive Officer of Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited (the "Company") being the duly authorized representative of the Company, hereby apply to the National Electric Power Regulatory Authority (NEPRA) for the grant of a Generation License to the Company pursuant to Section 7(2)(a) read with section 15 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 for the construction, operation and maintenance of a 2 x 660 MW coal fired condensing power generation plant (the "Project").

I certify that the documents-in-support attached with this application are prepared and submitted in conformity with the provisions of the NEPRA Licensing (Application and Modification Procedure) Regulation, 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.11988296) in the sum of Rupees 400,000, being the non-refundable license application fee calculated in accordance with Schedule II to the National Electric Power Regulatory Authority Licensing (Application and Modification Procedure) Regulations, 1999, is also attached herewith.

As this Project falls under Category-1, we are targeting to achieve Financial Close by 31 March 2015. Therefore, we shall be grateful if you could kindly grant us a generation license at the earliest to facilitate the Company to achieve Financial Close by our targeted deadline.

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Your continued support in this matter is highly appreciated.

Sincerely,

Name: Mr. Liu Youliang DESIGNATION: Chief Executive Officer Huaneng Shandong Ruyi (Pakistan) Energy (Pilvare) Limited

CC: Managing Director, Punjab Power Development Board Riaz Ahmad and Company, Chartered Accountants HaidermotaBNR & Co.

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SECURITIES AND EXCHANGE COMMISSION OF PAKISTAN

COMPANY REGISTRATION OFFICE, LAHORE

CERTIFICATE OF INCORPORATION

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

Corporate Universal Identification No.0088524

I hereby certify that <u>HUANENG SHANDONG RUYI</u> (<u>PAKISTAN) ENERGY (PRIVATE) LIMITED</u> is this day incorporated under the Companies Ordinance, 1984 (XLVII of 1984) and that the company is Limited by Shares.

Thousand and Fourteen.

Fee Rs.14,000

Given under my hand at Lahore this Twenty Eighth day of May, Two

19/2/15

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(LIAQAT ALI DOLLA) Additional Registrar of Companies

CERTIFIED TQ BE TRUE COPY

DEPUTY REGISTRAR OF COMPANIES COMPANY REGISTRATION OFFICE LAHORE.

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- To carry on all or any of the business of retailing, trading, importing (3) and exporting, supplying, distributing, designing, developing, manufacturing and assembling, installing and testing, transforming, converting, repairing, maintaining, contracting, switching. constructing, operating, using, inspecting and reconditioning, altering, removing and hiring products and services of any kind and description in connection with power plants, energy projects, systems and facilities including but not limited to cables, wires, lines, meters, pylons, tracks, rails, pipelines, transmission facilities and systems, grid stations, cables, overhead lines, sub-stations, switching stations, tunnels, cable bridges, link boxes, heat pumps, dry ceils and any other plant, apparatus, equipment, and engineering goods of any kind and description whatsoever for any of the aforesaid purposes.
- (4) To import, purchase, or otherwise acquire, prospect, explore for, produce, exploit, refine, compound, treat, process, manufacture, purify, blend, reduce, distil, store, transport, market, distribute, supply, buy sell, transfer and otherwise deal in raw and other materials and their by-products of every kind and description for or in connection with any of the aforesaid activities including but not limited to coal, coal-bed methane, petroleum, petroleum products, oil, gas, hydrocarbons, petrochemicals, bituminous substances and any other similar materials of any kind whatsoever.
- (5) To obtain, procure, purchase, take on lease or sublease, exchange or otherwise howsoever acquire in any part of the world any concessions, grants, claims, licences, leases, option, rights or privileges for any mining objects or purpose or any mines, mining rights or concessions, or any metalliferous lands, gravels of rivers, or any lands containing or believed to contain any metals or minerals (including fossilised minerals), mineral ores or products and to explore, work, exercise, develop let lease sublease out or otherwise howsoever turn to account, deal with or dispose of any such concessions, grants, claims, license, lease, mines, lands, option, rights or privileges and the produce thereof.
- (6) To carry on the business of electricians, electrical engineers and mechanical engineers and of manufacturers, designers, workers, Lence repairers of, and dealers in, electrical and electronic apparatus, machinery and goods of every kind and description.
- (7) To carry on all or any of the business of electrical, mechanical, motor and general engineers, manufacturers and merchants of agents for, and dealers in engineering specialities of every description.
- (8) To purchase or otherwise acquire offices, workshops, buildings, and premises and any fixed and movable machinery, tools, engines boilers, plant implements, patterns and other tooling, stock-in-trade. patents and patent rights, drawings, designs and copyrights convenient or necessary for any of the above activities.
- (9) To manufacture, produce, process, refine, develop, buy, sell, distribute and otherwise deal in all kinds of chemicals, fine chemicals, industrial and pure chemicals, organic and inorganic chemicals and allied products, formulations and articles.
- (10) To carry on research and development work and experiments relating to any new material and substance or the application of any chemical, organic or other process to any material or substance and to undertake, establish, provide and conduct scientific technical and industrial research or otherwise sponsor or subsidise such

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laboratories and experimental workshops or projects for such research on a commercial scale.

(11) To carry out investigations, and to carry on and undertake basic, fundamental and advanced research, in all branches of science, engineering and technology including without limiting the generality of the foregoing, bio-technology waste treatment technology environmental technology, mining geophysical and geological methods and techniques and other allied and related fields of study, and to discover inventinvest produce manufacture make improvements, modify and scale up plants machinery equipment appliances apparatus' processes chemical substances goods articles and things of every kind and description.



To own, establish, construct, set up, run, operate, manage, administer, finance, promote, invest in or support universities, colleges, schools and training and research centres for providing education and training, whether general, professional, technical or vocational, in any and all fields related to or associated or connected with electric and power generation and allied industries including without limiting the generality of the foregoing production generation and distribution activities, operations and services and the administration management and financing thereof. But NY ID and a dener purchase.



To carry on the business of commercial, industrial, business, manufacturing, technical, -financiaf, marketing, distribution, supply chain, logistics, transportation, managerial, personnel, organizational, administrative, information technology and software, consultants and advisers and in connection therewith or in relation thereto to provide advice, training, services and assistance of all kinds and every description and for or in connection with any of the forgoing.

- (14) To carry on the business as advisors, consultants, engineers and technical experts for any trade or industry and to render such advice and services as are usually rendered by technicians, engineers, commercial, economical, industrial and business consultants, and to prepare, plan, explore, conduct tests and market research, collect data or otherwise assist in the execution of such schemes as may be thought desirable in conjunction with the business of the Company.
- (15) To carry on any other business, whether manufacturing, services or otherwise, which may seem to the Company capable of being conveniently carried on or calculated directly or indirectly enhance the value of, or render profitable, any of the Company's properties or rights.
- (16) To own, purchase, acquire, build, construct, alter, establish, install, lay out, improve, maintain, work, manage, operate, carry out, control, or aid in, contribute or subscribe to the construction, erection, maintenance and improvement or working of, any roads, ways, tramways, railways, aerodromes and landing fields, docks, wharves, piers, bridges, jetties, breakwaters, dredging facilities, moorings, harbour abutments, viaducts, aqueducts, canals, water courses, wells, tanks, storage installations, refineries, pipes, pipelines, conveyors, telegraphs, telephone, communication apparatus and systems, wireless, gas works, steam works, electric lighting and power works, power houses, hydroelectric plants, laboratories, factories, mills, foundries, workshops boilers, machine shops, warehouses, shops, stores, fuel stores, hangers, garages, guard towers, machinery equipment and other appliances, hotels, clubs, restaurants, lodging houses, baths, places of workshop, hospitals, dispensaries, places of amusement, pleasure grounds,



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parks, gardens, reading rooms, dwelling houses, offices and other buildings, works and conveniences which may be calculated, directly or indirectly, to advance the Company's interests and to contribute to, subsidise or otherwise assist or take part in, the construction, improvement, maintenance, working, management, carrying out of control thereof, and to take any lease and enter into any working agreement in respect thereof.

- (17) To purchase, build, charter, affreight, hire and let out for hire, or for chartering and affreightment and otherwise to obtain the possession of, and use, operate and dispose of, and employ or turn to account ships, lighters, barges, tugs, launches, boats and vessels of all kinds, automobiles, lorries, motor trucks and tractors, airplanes, helicopters, locomotives, wagons, tank cars, and other forms of transport and rolling stock, and otherwise to provide for and employ the same in the conveyance of property and merchandise of all kinds and the transportation of personnel, employees, customers and visitors and to purchase or otherwise to acquire any ship, lighter, barge, tug, launch, boat or vessel of any kind, automobile, lorry, motor truck or tractor, airplane, helicopter, locomotive, wagon, tank car, and other form of transport.
- To buy, sell, manufacture, make up, prepare, repair, alter, (18)exchange, let on hire, import, export and deal in all kinds of articles and things which may be required for the purposes of any of the businesses aforesaid or commonly supplied or dealt in by persons engaged in any such business or which may seem capable of being Registratio profitably dealt with by the Company. 19any

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- To carry on business or branch of a business, which the company is authorised to carry on, by means, or through the agency (except (19)as managing agency) of any subsidiary company or companies, and mpany for to enter into any arrangement with such subsidiary d taking the profits and bearing the losses of any business of basis as carried on or for financing any such subsidiary correany of guaranteeing its liabilities or to make any other arrangement which may seem desirable with reference to any business or brance searce Comment carried on, including power at any time and either temporarily or permanently to close any such branch or business.
- To purchase, acquire, take on lease or tenancy, sell, dispose of, (20) mortgage or sub-lease, let any estate or interest in and to take and acquire options over any property, immovable and movable, or rights of any kind, and to develop, improve, turn on account, mortgage, sub-lease, sell or otherwise dispose of the same in such manner as may be thought expedient.
- (21) To manage, improve, develop, sell, exchange, mortgage, pledge, hypothecate, assign, transfer, or deal with all or any part of the property and assets, immovable and movable, corporeal or incorporeal, tangible or intangible, and any right, title and interest therein of the Company, including rights, licences, privileges, concessions and franchises as may seem expedient.
- (22)To acquire from sovereign state, government or authority in Pakistan or elsewhere, any concessions, grants, decrees, rights, powers and 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.
- (23) To obtain any legislative, judicial, administrative or other acts or authorisations of any government or authority competent in that

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behalf for enabling the Company to carry any of its objects into effect and for effecting any modification of the Company's constitution, or for any other purpose which may seem expedient, to take all necessary or proper steps with the authorities, supreme, national, local, municipal or otherwise, of any place in which the Company may have interests and to carry on any negotiations or operations for the purpose of directly or indirectly carrying out the objects of the Company or furthering the interests of its Member and to oppose any proceedings, applications, actions or steps taken by any Governmental authority or body, or any company, association, firm or person, which may seem calculated, directly or indirectly, to prejudice the interests of the Company or its Members.

- (24) To enter into any arrangements and contracts with any government or authority (supreme, municipal, local or otherwise), or any corporation, company, or persons that may seem conducive to the Company's objects or any one of them and to obtain from such government, authority,corporation, company or person any charters, contracts, decrees, rights, privileges, options, concessions and licences, and to carry out, exercise or comply with any such arrangements, agreements, charters, contracts, decrees, rights, privileges, concessions and licenceswhich the Company may think it desirable to obtain, and to procure the Company to be registered or recognised in any part of the world.
- (25) To apply for, purchase, or otherwise acquire, and protect and renew in any part of the world any patents, patent rights, copyrights, trademarks, designs, formulae, licences, concessions and the like, conferring any exclusive or non-exclusive or limited right to their use, or any secret or other information as to any invention, process, matter or thing which may seem capable of being used for any of the purposes of the Company, or the acquisitions of which may cus seem calculated directly or indirectly to benefit the Company and to use, exercise, develop, or grant licences in respect of, or otherwise turn to account the property, rights or information so acquired, and to expend money in experimenting upon, testing or improving any such patents, inventions or rights.
- (26) To enter into partnership or any arrangement for sharing profile, union of interests, co-operation, joint venture, recorder concessions, or otherwise with any company, association, furr or, person carrying on or engaged in, or about to carry on or engage in, any business or transaction which this Company is authorised to carry on or engage in, or any business or transaction capable of being conducted so as directly or indirectly to benefit the Company, and to guarantee the contracts of, or otherwise assist any such company, association firm or person, and to purchase, take, or otherwise acquire, shares and securities of any such company or association, firm or person, and to sell, hold, reissue, with or without guarantee, or otherwise deal with the same as permissible under law.
- (27) To amalgamate with any other company having objects altogether or in part similar to those of the Company.
- (28) To acquire and undertake the whole or any part of the business, property and liabilities of any person or company carrying on or proposing to carry on any business which the Company is authorised to carry on, or possessed of property suitable for the purposes of the Company, or which can be carried on in conjunction therewith or which is capable of being conducted so as directly or indirectly to benefit the Company.

- (29) To establish or promote or concur in establishing or promoting any company or companies for the purpose of acquiring all or any of the property, rights and liabilities of the Company or for any other purpose which may seem directly or indirectly calculated to benefit the Company, to amalgamate or consolidate or merge with a view to effecting union of interest either in whole or in part, with or into any other companies, association, firms or persons, and to place or guarantee the placing of, subscribe for or otherwise acquire all or any part of the shares, debentures or other securities of any such other companies, associations, firms or persons.
- (30) To sell, mortgage or otherwise dispose of the property, assets or undertaking of the Company or any part thereof for shares, stock, debentures, or other securities or obligations of any institution, corporate or governmental body, person or company, whether or not having objects altogether or in part similar to those of the Company, or for any other consideration.
- (31) To invest the money, surplus or otherwise money of the Company not immediately required in such manner as may from time to time be thought fit.



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To receive money on lean and to borrow money in such manner as the Company shall think fit, and in particular by the issue of debentures or debenture stock (perpetual or otherwise) and to secure the repayment of any money borrowed, raised or owing by mortgage, charge or lien upon all or any of the property or assets of the Company (both present and future), and also by a similar mortgage charge or lien to secure and guarantee the performance by the Company or any other person on company of any upiloation undertaken by the Company or any other person or company as the case may be for the purpose of or in connection with the business of the Company.

- (34) To open accounts with any bank or banks and to draw, make accept,indorse, negotiate, buy, sell, deal in, discount, execute and issue cheques, promissory notes, bills of exchange, bills of lading, warrants, debentures, letters of credit and other negotiable or transferable instruments in connection with the businesses and affairs of the Company.
- (35) To subscribe for, purchase or otherwise acquire and to hold, dispose of and deal in shares, stocks, bonds, debenture stocks, annuity or other obligations of any other company, person, institution or corporate or governmental body, whether secured or unsecured.
- (36) To pay, satisfy, or compromise any claims made against the Company which it may seem expedient to pay, satisfy or compromise, notwithstanding that the same may not be valid in law.
- (37) To remunerate Directors, officials, agents (except managing agents), employees and servants of the Company and others and toestablish and support or aid in the establishment and support of associations, institutions, funds, trusts and conveniences, calculated to benefit employees or ex-employees of the Company, or the

dependants or connections of such persons, and to grant pensions, gratuities and allowances, and to remunerate employees and to provide houses, amenities and conveniences of all kinds and to make payments towards insurance and to subscribe or guarantee money for charitable or benevolent objects or for any exhibition or for any public, general or useful purpose and for the purpose of this paragraph the words "employees" and "ex-employees" shall include, respectively, present and former directors and other officers, agents, employees, trainees and servants.

- (38) To pay out of the funds of the Company all expenses which the Company may lawfully pay with respect to the formation, promotion and registration of the Company or the issue of its capital, including brokerage (except as brokerage house) and commissions for obtaining applications for or taking, placing or underwriting or procuring the underwriting of shares, debentures or other securities of the Company.
- (39) To pay for any rights or property acquired by the Company and to remunerate any person or company whether by cash payment or by the allotment of shares, debentures or other securities of the Company credited as paid up in full.
- (40) To adopt such means of making known the products of the Company as may seem expedient and in particular by undertaking educational, training and demonstration programmes and by advertising in the press, by circulars and exhibition of works of art or interest, by publication of books and periodicals and by granting prizes, rewards and donations.
- (41) To get insured against loss or damage on land or in the air or at sea. and or otherwise and insurable property of the Company and to insure against or in respect of any liability on the part of the Company, to pay compensation to any workers imposed by any act of egislature and to insure any servants of the company against or in respect of fidelity or otherwise in the course of their employment, by the Company and to effect insurance for the purpose of indemnifying the Company in respect of claims by reason of any such risks or fidelity insurances and to pay premiums on any insurance.
- (42) To join or become members of any association company or society formed or to be formed for the protection or advancement of the interests of the Company or its employees or otherwise engaged in any trade or business and to promote subscribe to or subsidies any association, company or society.
- (43) To make a donation of any belongings of the Company ofwhatsoever kind or where so ever situated to any person, persons, corporation or corporations to achieve the objects of the Companybut sothat no gift involving reduction of capital shall be madeexcept with the sanction (if any) for the time being required by law.
- (44) To act as agents except managing agents, brokers (except as stock brokers), commission agents representatives or consultants of and to provide services to any business or concern that the Company may find convenient oradvantageous.
- (45) To undertake, assist and participate in commercial and industrial operations and undertakings in any part of the world, and both

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singly and in conjunction with other persons, firms, associations and companies and corporations.

- (46) To carry out all or any of the objects of the Company and do all or any of the above things in any part of the world and either as principals, agents, trustees, contractors, or otherwise, and either alone or in conjunction with others, and either by or through agents, sub-contractors, trustees or otherwise.
- (47) To distribute among the Members in specie any property of the Company in the event of winding up, or any proceeds of sale or disposal of any property of the Company, but so that no distribution amounting to a reduction of capital be made except with the sanction (if any) for the time being required by law.
- (48) To do all such other things as may be deemed incidental or conducive to the attainment of the above objects or any of them.

AND IT IS HEREBY DECLARED THAT

(i) the objects specified in each of the several clauses of the above Article III shall be regarded as independent objects, and accordingly all the powers thereof are to be cumulative and in no case is the generality of any one clause to be narrowed or restricted by any particularity of any other clause (except where otherwise expressed in such clause) nor any general expression in any clause to be narrowed or restricted by any particularity of expression in the same clause or by the application of any rule of construction ejusdem generis or otherwise.

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- (ii) the word "Company" save when used in reference to this Company, in this clause shall be deemed to include any syndicate, paryechip or other body of persons, whether incorporated or not incorporated, and whether domiciled in the country of the Company's incorporation or otherwise.
- (iii) the Company shall not engage in any other business including the business of banking as defined in the Banking Company on Exchange Ordinance 1962 or the business of insurance as defined in the Insurance Ordinance 2002 business of an investment finance company or the business of leasing or the business of managing agent or commercial builder and developer and in any event the Company shall not engage in any unlawful business. Also the Company shall not indulge in multilevel marketing, pyramid or ponzi schemes.
- (iv) notwithstanding anything stated in any object clause, the Company shall obtain such other approval or licence from the competent authority, as may be required under any law for the time being in force, to undertake a particular business.

IV. The liability of the Members is limited.

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The authorised capital of the Company is Rs. 1,000,000 (Rupees One Hundred divided into 100,000 ordinary shares of PKR 10 each with power to increase the capital and to divide the shares in the capital for the time being into several classes, and to attach thereto any preferential, deferred, qualified or special rights, privileges or conditions. We, the several persons whose names and addresses are hereto subscribed, are desirous of being formed into a Company in pursuance of this Memorandum of Association, and we respectively agree to take the number of Ordinary Shares in the capital of the Company set opposite our respective names.

	Name and Surname (present and former) in full (in Block) letters	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	
	Huaneng Shandong Ruyi (HK) Energy Limited (through its authorised representatives Mr. Qiu Yafu holder of Chinese passport No. E35861666		Hong Kong Special Administrative Region, P. R. China		RM No. 1201, 12/F, Empire Centre, 68 Mody Road, Tsim Sha Tsui, Kowloon, Hong Kong	99,995 (ninety-nine thousand, nine hundred and ninety-five)	(m) Jai
Le Set	WANG WENZONG POIN 5224	Wang Qiyue	Chinese	Executive Director, General Manager Huaneng Shandong Power Generation Co., Ltd.	Room 601, Unit 4, Building 4, Zifengyuan Residential Quarter, No. 14900, Jingshi Road, Lixia District, Jinan, Shandong, P.R. China		
25/57	LI PING 101641595	Shan Weiguo	Chinese	Deputy General Manager of Huaneng Shandong Power Generation Co., Ltd.	Room 801, Unit 4, Building 4, Zifengyuan Residential Quarter, No. 14900, Jingshi Road, Lixia District, Jinan, Shandong, P.R. China	CE (One)	An N
10576	LI XIDE PO 1363624	Li Zhankui	Chinese	Chief Accountant and Member of Huaneng Shandong Power Generation Co., Ltd.	Room 501, Unit 4, Building 4, Zifengyuan Residential Quarter, No. 14900, Jingshi Road, Lixia District, Jinan, Shandong, P.R. China	1 (one)	建腹
h¢_ x(≤	Qiy LJ	Qi yunfu Qi y	Chinese	Chairman of the board of Shandong Ruyi Group	Rm 301, Unit 1, Building 20, Ruyi Garden, 2 Hongxing East Rd, Jining, Shandong, China	1 (one)	Grant &
					DEPULY	REGISTRAR O	TRUE COPY Islit F COMPANIES TION OFFICE

Rm 304, Unit 2, QIU CHENRAN 1 Qiu Yafu Executive Chinese Building 13, Ruyi Garden, 2 Hongxing East Rd, Jining, Shandong, 528 90322 Director of (one) M Flert Shandong Ruyi Group China 100,000 (one hundred thousand) There Lahura Dated this 33 day of MAY 2014 Witness to the above Signatures:-Signature Nationality Occupation **Full Address** Father's Name **Full Name** (in Block Letters) 148, 18th East Street, Phase Pakistani Irfan Mehmood Advocate RIZWAN IRFAN I, Defence Officers' BUTT Butt Housing Authority, CNIL Karachi-75500, Pakistan. 4201-5337 F

THE COMPANIES ORDINANCE, 1984

ARTICLES OF ASSOCIATION

OF

HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

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Interpretation

- (1) The Regulations in Table A in the First Schedule to the Companies Ordinance 1984, shall not apply to the Company except in so far as they are repeated or contained in these Articles.
- (2) The Company is a Private Company and accordingly:
 - the right to transfer shares of the Company is restricted in the manner hereinafter appearing;
 - (ii) the number of Members for the time being of the Company (not including persons who are for the time being in the employment of the Company) shall not exceed fifty; but where two or more persons hold one or more shares in the Company jointly, they shall for the purposes of this paragraph be treated as a single Member; and
 - (iii) no invitation shall be issued to the public to subscribe for any shares, debenture or debentures-stock of the Company.
- In these Articles, unless there be something in the subject or context inconsistent therewith:-

"in writing" and "written" include printing, lithography, and other modes of representing or reproducing words in a visible form.

"Member" means a person whose name is for the time being entered in the Register of Members by virtue of his being a subscriber 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.

"Month" means calendar month according to the Gregorian calendar.

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

"Register of Transfers" means the Register of Transfer of Shares to be kept pursuant to Section 76(4) of the Ordinance.

"SECP" means the Securities and Exchange Commission of Pakistan

"Special Resolution" has the meaning assigned thereto by clause (36) of Section 2(1) of the Ordinance.

"the Chief Executive" means the Chief Executive for the time being of the Company.

"the Company" means HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

"the Directors" means the Directors for the time being of the Company or the Directors present at a duly convened meeting of Directors at which a quorum is present.

"the Office" means the Registered Office for the time being of the sto Company.

"the Ordinance" means the Companies Ordinance 1984 *

"the Register" means the Register of Members to be knot pursuant to Section 148 of the Ordinance.

"the Seal" means the Common Seal for the time being of the Corogany.

"the Secretary" means the Secretary for the time being of the Company.

"these Articles" means these Articles of Association as originally framed or as from time to time altered by Special Resolution.

"affiliates" means, with reference to any company, a holding company or subsidiary of the first company, or any subsidiary of the first company's holding company, or, any company or other entity which directly or indirectly controls, is controlled by, or is under common control with the first company by others through one or more intermediate companies. For purposes of this definition, the word "Control" (including "Controlling", "Controlled" and "under the common control with others") means, by holding voting security, or by contract or other means, the power of directly or indirectly, directing or causing the direction of the management and policy of a person.

"Huaneng Parties" means Huaneng Shandong Power Generation Co., Ltd. ("Huaneng Shandong"), Huaneng Shandong (HK) Investment Limited and their affiliates.

"Ruyi Partles" means Shandong Ruyi Science & Technology Group Co. Ltd.,("Ruyi Shandong"), Forever Winner International Development Limited and their affiliates.

"Pakistani Project" means the 2×660 MW coal-fired power plant project In Sahiwal, Pakistan.

"Business Plan" means the plan for investing in the company and the investment plan of the company, including but not limited to the cost and expenditure (including cost overrun) of the development, construction and operation of the Pakistan Project, as well as all other issues related thereto.

"Financier(s)" means one or more banks that provide Bank Financing for the Pakistan Project.

"Financing Documents" means loan agreements made for Bank Financing and other agreements made to create security interest for the loan agreements, including any changes, revisions, transfer and grant of such agreements (including the rights and obligations thereunder) made from time to time.

"Bank Financing" means the bank financing provided by the Financier(s) to the Pakistan Project.

"Project Partners" means any party which signs Project Decuments with the Company.

"Project Documents" means the following documents signed for the development, construction and operation of the Pakietani Project, including any changes, revisions, transfer and grant of such documents (including the rights and obligations thereunder) made from time to time:

- (a) Power Purchase Agreement (PPA);
- (b) Implementation Agreement (IA);
- (c) Engineering, Procurement, and Construction Contract (the EPC Contract);
- (d) Subcontracts related to the EPC Contract;
- (e) Operation and Maintenance Agreement;
- (f) Fuel Supply Agreement;
- (g) Fuel Transport Agreement;
- (h) Transfer Agreement for Land Ownership or Land Lease Agreement (including interim land lease agreement, where applicable); and
- (i) Other documents as agreed from time to time by Huaneng Shandong and Ruyi Shandong to be Project Documents.

"Major Assets" means:

- (a) Interests such as shares held by the Company in its subsidiary;
- (b) An asset with a total value or an accumulative value for 12 consecutive months exceeding one million (1,000,000) US dollars; or
- (c) For purposes of the Pakistani Project, any asset that has significant impact on the development, construction and operation of the Pakistani Project;

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

Words importing the masculine gender include the feminine gender. Words importing persons include corporations.

The marginal notes are inserted for convenience and shall not affect the construction of these Articles.

The Office shall be at such place as the Directors shall from time to time

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The Office.

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determine.

Directors may undertake or discontinue any business. BUSINESS
4. Any branch or kind of business which the Company is either expressly or by implication authorised to undertake may be undertaken by the Directors at such time or times as they shall think fit, and further may be suffered by them to be in abeyance whether such branch or kind of business may have been actually commenced or not so long as the Directors may deem it expedient not to commence or proceed with such branch or kind of business.

SHARES

Power to issue shares of different classes.	5. Si O ci si M N	ubject to Section 90 of, and any rules in that regard made under, the ordinance, and without prejudice to any special rights previously onferred on the holders of any existing shares or class of shares, any hare in the Company may be issued with such rights and restrictions as may from time to time be determined by the Company in General feeting.
Redeemable shares and securities.	6. Si ti o n	ubject to Section 95(4)(a) of, and any rules in that regard made under, ne Ordinance, the Company may issue shares which are to be redeemed r any other redeemable security, on such terms and in such manner as nay be provided in the sald section and rules.
No partly paid shares to be issued.	7. Ti o n d	he Company shall not issue partly paid shares. In the case of an issue f shares for cash, the amount payable on application shall be the full ominal amount of the share, except where shares are issued at a iscount.
Issue of shares at discount.	8. W Si O Si	Vith the previous authority of the Company in General Morting and the anction of the SECP and upon otherwise complying with the provisions f Section 84 of the Ordinance it shall be lawful for the Directors to issue nares in the capital of the Company at a discount.
issue of shares.	9. Ti ai si d ai ti ti D b D	the shares in the capital of the Company for the time being, including my new shares resulting from an increase in the authorised share capital, hall be under the control of the Directors who may allot or otherwise ispose of the same or any of them to such persons (subject to Article 33) and on such terms and conditions and at such times as the Directors may hink fit and either at par or at a premium or subject to Section 84 of the ordinance at a discount with powers to the Directors to give any person he right to call for and be allotted shares of any class of the Company at ar or at a premium or, subject as aforesaid, at a discount, such option eing exercisable at such times and for such consideration as the irectors may think fit.
Ailotment of shares.	10. A tł cł tł	s regards any allotment of shares, the Directors shall duly comply with the directions of the Company in General Meeting, and with the conditions, if any, specified in that behalf by the SECP and with such of the provisions of Sections 68 to 73 of the Ordinance as may be applicable thereto.

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Shares may be 11. The Directors may allot and issue shares in the capital of the Company as issued for payment or part payment of any property sold or transferred, or for consideration services rendered, to the Company in the ordinary course of its business, other than cash. and shares so allotted shall be issued as and shall be deemed to be fully paid shares. The Company may from time to time pay a commission to any person for 12. **Commission for** subscribing or agreeing to subscribe (whether absolutely or conditionally) placing shares, for any shares or debentures of the Company or procuring or agreeing to etc. procure subscriptions (whether absolute or conditional) for any shares or debentures of the Company. in case any commission shail be paid the Company shail comply with the provisions of Section 82 of the Ordinance. The Company may also pay such brokerage as may be lawful on any issue of shares or debentures. No Loans or 13. Except as provided in Section 95 and Section 95A of the Ordinance and security for any rules or regulations in that regard made under the Ordinance, no purchase of part of the funds of the Company shall be employed in the purchase of Company's its own shares or the shares of its holding company (if any) or In giving, shares. whether directly or indirectly and whether by means of a loan, guarantee, security or otherwise, any financial assistance for the purpose of or inconnection with a purchase made or to be made by any person of ar any and a connection with a purchase made or to be made by any person of <math>ar any and a connection with a purchase made or to be made by any person of a purchase made or to be made or to be made by any person of a purchase made or to be made by any person of a purchase made or to be made or to beshares in the Company or its holding company (if any) or any/lean uponthe security of any shares of the Company or those of its holding company (if any). ŝ Except as required by law, no person shall be recognised by the Company **Trusts not** 14. as holding any share upon any trust, and the Company shall not be recognised. bound by or be compelled in any way to recognise (even when having notice thereof) any equitable, contingent, future or partial interest in any share or any interest in any fractional part of a share or (except only as by these Articles or by law otherwise provided or under an order of a court of competent jurisdiction) any other rights in respect of any share except an absolute right to the entirety thereof in the registered holder. Who may be 15. Shares may be registered in the name of any limited company or other registered as corporate body but not in the name of a minor or a person of unsound shareholders. mind. Not more than four persons shall be registered as joint holders of any share. Joint 16. If any shares stand in the name of two or more persons, the person first shareholders. named in the Register shall, as regards receipt of dividend or bonus or service of notices and all or any other matters connected with the

Company except voting at the meeting and the transfer of shares, be deemed the sole holder, provided, however, that anyone of such persons may give effectual receipts for any dividends or other moneys payable in respect of such shares.

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Death of joint shareholders.

17.

In the case of the death of any one or more of the persons named in the Register as the joint-holders of any share, the survivor of survivor share be the only person or persons recognised by the Company as having any title to or interest in such share.



CERTIFICATES

Every person whose name is entered as a Member in the Register shall 18. **Member's right** without payment be entitled to receive after allotment or registration of to certificate. transfer one certificate for all his shares or several certificates each for one or more of his shares upon payment of such charge, if any, as the Directors may determine for every certificate after the first. The certificate of title to shares shall be issued under the Seal of the 19. issue of Certificate. Company. The Company shall not be bound to issue more than one certificate in 20. **Certificates in** respect of a share or shares held jointly by two or more getsons and the case of joint delivery of a certificate for a share to any one of joint holders shall be holders. sufficient delivery to all. Unless the conditions of issue of any shares, debentures or debenture Time for Issue 21. of Certificates. stock of the Company otherwise provide, the Company shall within ninety days after the allotment and within forty-five days after receipt by the Company of the application for transfer of any such shares, debentures or debenture stock complete and have ready for delivery the certificate of all shares, the debentures and 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.

Certificates lost,

defaced, etc.

22. If a certificate of shares, debentures or debenture stock is proved to the satisfaction of the Company to have been iost or destroyed or, being defaced or mutilated or torn, is surrendered to the Company, and the Company is requested to issue a new certificate in replacement thereof, the Company shall, after making such enquiry as it may deem fit, advise the applicant within thirty days from the date of application the terms and conditions (as to indemnity and otherwise and as to payment of the actual expenses incurred on such enquiry and of a fee not exceeding ten rupee) on which the Company is prepared to issue a new certificate and a time for compliance therewith or of the reasons why the Company is unable to issue a new certificate, as the case may be, and in the former case if the applicant shall within the time allowed comply with the terms and conditions specified the Company shall issue a new certificate to the applicant within forty-five days from the date of application.

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TRANSFER OF SHARES

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Execution of transfer.	23. The instrument of transfer of any share in the Company shall be duly stamped and executed both by the transferor and transferee, and the transferor shall be deemed to remain holder of the share until the name of the transferee is entered in the Register in respect thereof. The application for the registration of the transfer of a share may be made either by the transferor or the transferee.
Form of transfer.	24. The Instrument of transfer of any share shall be in writing in the following form or in any usual or common form which the Directors shall approve: "I, A.B., of in consideration of the sum of Rs. paid to me by gist. C.D., of
Restricted right of transfer.	 25. (1) No Member shall, except in accordance with the following provisions of this Article (a) pledge, mortgage (whether by way of fixed or floating charge) or otherwise encumber its legal or beneficial interest in its shares; (b) sell, transfer or otherwise dispose of any of such shares (or any legal or beneficial interest therein); or (c) enter into any agreement in respect of the votes attached to shares; or (d) agree, whether or not subject to any condition precedent or subsequent, to do any of the foregoing. (2) Notwithstanding clause 25(1), a Member may: (a) pledge, mortgage (whether by way of fixed of floating charge) or otherwise encumber its legal or beneficial interest in its shares to the Financier(s) for the purposes of Banking Finance; (b) sell, transfer or otherwise dispose of any of such shares (or any legal or beneficial interest therein): (i) with the unanimous approval of the Board; or (ii) as part of the enforcement of the pledge, mortgage (whether by way of fixed of floating charge) or

other encumbrance granted to the Financier(s) for the purpose of Banking Finance;

- (c) transfer shares to a Director representing the Director's interest in the Company as may be required to make the Director a Member of the Company and as such eligible for appointment as Directors, or (where the Member transferring the shares is a nominee Director) to the Member or any other nominee of such Member.
- (3) The transfer of a share otherwise permitted under this Article may be refused by the Directors where the instrument of transfer is defective or invalid or is not accompanied by the certificate of the share to which it relates. The Directors may also decline to recognise any instrument of transfer unless:
 - (a) a fee not exceeding twenty rupees is paid to the Company in respect thereof; and
 - (b) the instrument of transfer is accompanied, in addition to the certificate of the shares to which it relates, by such other evidence as the Directors may reasonably require to show the right of the transferor to make the transfer.
- (4) If the Directors refuse to register a transfer of any shares they shall, within thirty (30) days after the date on which the instrument of transfer was lodged with the Company, send to the transferee and the transferor notice of the refusal indicating the reason for such the transferor notice of the refusal indicating the reason for such or refusal; provided that if the Directors refuse to register a transfer of transfer, the transferee shall be entitled, after removal of such defect or invalidity, to re-lodge the instrument of transfer with the Company.

Register may be closed.

26. On giving seven (7) days previous notice by advertisement in some newspaper circulating in the areas specified in Section 151 of the Ordinance the Register of Transfers may be suspended and the transfer books and the Register may be closed during such time as the Directors think fit, not exceeding in the whole forty-five (45) days in each year but not exceeding thirty (30) days at a time.

TRANSMISSION OF SHARES

Nomination

27. Any Member may make and deposit with the Company a nomination in writing specifying one or more eligible persons who or each of whom, in the event of the death of the Member, may be entered in the Register as the holder of such number of shares specified in the nomination for such nominee or each such nominee of which the Member remains the

registered holder at the date of his death. A person shall be eligible for nomination for the purposes of this Article only if he is a spouse, parent, brother, sister or child (including step or adopted child) of the Member nominating him and the applicable relationship shall be specified in the nomination in respect of each nominee. A Member may at any time by notice in writing cancel, or by making and depositing with the Company another nomination before his death vary, any nomination already made by him pursuant to this Article. In the event of the death of a Member any person nominated by him in accordance with this Article may, on written application accompanied by the relative share certificates and evidence establishing the death of the Member, request the Company to register himself in place of the deceased Member as the holder of the number of shares for which the nomination in his favour had been made and deposited with the Company, and if it shall appear to the Directors that it is proper so to do, the Directors may register the nominee as the holder of those shares in place of the deceased Member.

Person entitled on death of Member. 28.

the survivor or survivors shall be the only persons recognised by the Company as having any title to his interest in the shares. If the deceased Member was a sole holder of shares, the nominee or nominees of the deceased where a nomination under Article 27 is effective, and the legal personal representatives of the deceased where no such nomination has been made and deposited with the Company Labor shall be the only persons recognised by the Company as having any title, to his interest in the shares. Before recognising any legal representatives the Directors may require him to obtain a succession certificate, grant of probate or letters of administration or other legal representation, as the case may be, from a court of competent jurisdiction. Werevided nevertheless that in any case where the Directors in their apsaulte discretion think fit, it shall be lawful for the Directors to dispense with the production of probate, letters of administration, succession certificate or other legal representation upon such terms as to indemnity or otherwise as the Directors in their absolute discretion, may consider necessary.

In the case of the death of a Member who was a joint holder of shares

Person entitled on death or Insolvency may elect to be registered or to transfer. 29. Any person becoming entitled to a share in consequence of the death or insolvency of a Member may upon such evidence being produced as may from time to time properly be required by the Directors and subject as hereinafter provided, elect either to be registered himself as the holder of the share or instead of being registered himself to make such transfer of the share as the deceased or insolvent person could have made, but the Directors shall, in either case, have the same right to decline or

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suspend registration as they would have had in the case of a transfer of the share by that Member before his death or insolvency as the case may be.

30. If the person so becoming entitled shall elect to be registered himself, he shall deliver or send to the Company a notice in writing signed by him stating that he so elects. If he shall elect to have another person registered he shall testify his election by executing to that person a transfer of the share. All the limitations, restrictions and provisions of these Articles relating to the right to transfer and the registration of transfers of shares shall be applicable to any such notice or transfer as aforesaid as if the death or insolvency of the Member had not occurred and the notice or transfer were a transfer signed by that Member.

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

ALTERATION OF CAPITAL

	32.	with the requirements of Section 92 of the Ordinance:-
		(a) increase the authorized share capital by such sum, to be divided
		(b) consolidate and divide its share capital into shares of larger amount
		than its existing shares;
		(c) by sub-division of its existing shares or any of them, divide the whole or any part of its share capital into shares of smaller amount
		than is fixed by the Memorandum of Association;
		(d) cancel any snares which, at the date of the passing of the resolution, have not been taken or agreed to be taken by any person.
	33.	The Directors may from time to time increase the issued share capital by such sum as they think fit. All shares intended to be issued by the
		proportion to the amount of the issued shares held by each Member
		(irrespective of class); provided that fractional shares shall not be offered
		and all fractions less than a share shall be consolidated and disposed of

Effect of election.

Rights of person entitled by transmission

Power to alter capital - increas e, consolidation, sub-division and canceliation

When shares to be offered to existing Members.

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by the Company and the proceeds from such disposition shall be paid to

such of the entitled Members as may have accepted such offer. Such 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 fit. In respect of each such offer of shares the Directors shall comply with the provisions of Section 86 of the Ordinance and in particular with the provisions of sub-sections (3), (4) and (5) thereof. Any difficulty in the apportionment of shares amongst the Members, shall, in the absence of any directions given by the Company in General Meeting, be determined by the Directors.

34. Except so far as otherwise provided by the conditions of issue, or by these Articles, any capital raised by the creation of new shares shall be considered part of the original capital, and shall be subject to the provisions herein contained with reference to transfer, transmission, right to dividend, bonus and otherwise.

35. The Company may, by Special Resolution, reduce its share capital, or any share premium account in any manner and with, and subject to, any incident authorised, and consent required, by law.

36. The share premium account maintained pursuant to Section 83(1) of the Ordinance 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 bonus shares.

How far new shares to rank with shares in original capital.

Reduction of capital.

Share Premium Account.

MODIFICATION OF RIGHTS

Power to modify rights.

Other meetings.

Extraordinary

General

Meeting.

37.

If at any time the share capital is divided into different classes of shares, the rights attached to any class (unless otherwise provided by the terms of Issue of the shares of that class) may, subject to the provisions of Section 108 of the Ordinance and whether or not the company is being wound up, be varied extended or abrogated with the consent in writing of the holders of three-fourths of the issued shares of that class passed at a separate general meeting of the holders of the shares of the class. To every such separate general meeting the provisions of these Articles relating to general meetings shall mutatis mutandis apply, except that the necessary quorum shall be holders of that class in holding or representing by Proxy twenty-five percent of the issued shares of the class (but so that if at any adjourned meeting of such holders a quorum is not present, the holders present shall form a quorum), and any holder of shares of the class present in person or by Proxy may demand a poll-

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GENERAL MEETINGS

Annual General Except as may be allowed under Section 158(1) of the Oppnance the 38. Meeting. Company shall hold a General Meeting, designated as the west Annual General Meeting within eighteen Months from the date of incorporation, and thereafter within four Months following the close of each brancial year of the Company, but so that an Annual General Meeting is held in every calendar year and not more than fifteen Months elapse between any two consecutive Annual General Meetings, and subject as aforesaid each such Annual General Meeting shall be held at such place and at such time as may be determined by the Directors, provided that the Company may, for any special reason and with permission of the Registrar of Companies, extend the time within which such Annual General Meeting, not being the first such meeting, shall be held by a period not exceeding thirty days.

- 39. All General Meetings other than Annual General Meetings shall be called Extraordinary General Meetings.
- 40. The Directors may, whenever they think fit, call an Extraordinary General Meeting and Extraordinary General Meetings shall also be called on such requisition, or in default, may be called by such requisitionists, as provided by Section 159 of the Ordinance.

NOTICE OF GENERAL MEETINGS

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Notice of Meetings. 41.

- (1) Notice of a General Meeting shall be sent in the manner hereinafter mentioned at least twenty-one (21) days before the date on which the meeting is to be convened to all such persons as are under these Articles or the Ordinance entitled to receive such notices from the Company and shall specify the place and the day and hour of the meeting and the nature of the business to be transacted thereat.
 - (2) In the case of an emergency affecting the business of the Company, an Extraordinary General Meeting may be convened by such shorter notice than that specified in Article 41(1) as the Registrar of Companies may authorise.
 - (3) Where any special business, that is to say, business other than consideration of the accounts, balance sheet and the reports of the Directors and Auditors, the declaration of dividend, the appointment and fixation of the remuneration of Auditors and the election of Directors (all such matters being herein referred to as ordinary business) is to be transacted at a General Meeting, there shall be annexed to the notice of such meeting a statement setting out all such facts as may be material for the consideration of such business including the nature and extent of the interest twether direct or indirect) of any Director, and where the item of business involves approval of any document, the time and place appointed for inspection thereof, and to the extent applicable such a statement shall be annexed to the notice also in the case of ordinary business to be transacted at the meeting.
- (4) Where a resolution is intended to be proposed for consideration a a General Meeting in some special or particular form, a copy thereof shall be annexed to the notice convening such meeting.
- (5) If a Special Resolution is intended to be passed at a General Meeting, the notice convening that meeting shall specify the intention to propose the resolution as a Special Resolution.
- (6) A notice for a General Meeting convened for the election of Directors shall state the number of Directors to be elected at that meeting and the names of the retiring Directors.
- (7) The notice of every General Meeting shall prominently specify that a Proxy may be appointed who shall have the right to attend, demand and join in demagding a poli and vote on a poll and speak

at the meeting in the place of the Member appointing him and shall be accompanied by a form of Proxy acceptable to the Company.

Omission to give notice.

42. The accidental omission to give notice of a meeting to, or the non-receipt of notice of a meeting by, any person entitled to receive notice shall not invalidate the proceedings at that meeting.

PROCEEDINGS AT GENERAL MEETINGS

Quorum.

43. No business shall be transacted at any General Meeting unless a quorum is present at the time when the meeting proceeds to business; save as herein otherwise provided Members present in person or by Proxy or through representatives, representing not less than twenty-five (25%) per cent of the voting power shall be a quorum provided that at least two (2) such Members are present in person.

44. 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 a quorum is not present within half an hour from the time appointed for the meeting, the Members present personally or by Proxy, being not less than two persons, shall be a quorum.

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Chairmanof45. The Chairman, if any, of the Board of Directors shall preside as
chairman at every General Meeting of the Company, or if there is no
such Chairman, or If he shall not be present within fifteen minutes after
the time appointed for the holding of the meeting or is unwilling to act
any one of the Directors present may be elected to be chairman of the
meeting, or if no Director be present, or if all the Directors present
decline to take the chair, the Members present shall choose one of their
number to be chairman of the meeting.

46. The chairman may, 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 a meeting is adjourned for ten (10) days or more, notice of the adjourned meeting shall be given as in the case of an original meeting, but it shall not be necessary to specify in such notice the nature of the business to be transacted at the adjourned meeting. Save as aforesaid it shall not be necessary to give any notice of an adjournment or of the business to be



Adjournments.

transacted at an adjourned meeting.

How questions to be decided.

47.

At a General Meeting a resolution put to the vote of the meeting shall be decided on a poil.

- Poll how taken.
 48.
 The poll shall be taken in such manner as the chairman of the meeting directs. The votes given on a poll shall be scrutinized by the chairman or a scrutineer nominated by him The result of the poll shall be announced by the chairman and shall be deemed to be the decision of the meeting on the resolution in respect of which the poll was demanded.
- Casting of49.In the case of an equality of votes, the chairman of the meeting shall notVotes.be entitled to a second or casting vote.
- When poll50.A poll demanded on the election of chairman or on a question of
adjournment shall be taken forthwith. A poll demanded on any other
questions shall be taken at such time, not being more than fourteen days
from the day on which the poll is demanded, as the chairman of the
meeting directs. The demand of a poll shall not prevent the continuance
of the meeting for the transaction of any business other than the
question on which a poll has been demanded. The demand for a poll
may be withdrawn at any time before such poll is taken. In case of any
dispute as to the admission or rejection of a vote, the chairman shall
determine the same, and such determination made in good faith shall be
final and conclusive.

VOTES OF MEMBERS

- Right to vote.
 51.
 On a poll every Member present in person or by Proxy shall have one vote in respect of each share held by him.
 Provided always that in the case of an election or removal of a Director, the provisions of Articles 68and 69respectively shall apply.
 - 52. On a poll a Member entitled to more than one vote may use all his votes or cast all the votes in a manner as he may deem fit.
 - 53. In the case of joint holders, the vote of the senior present, whether in person or by Proxy, shall be accepted to the exclusion of the votes of the other joint holders; and for this purpose seniority shall be determined by the order in which their names stand in the Register.
- Member of unsound mind.

Voting shares in

different ways.

Joint holders.

54. A Member of unsound mind, or in respect of whom an order has been made by any court having jurisdiction in lunacy may voteon a poli, by his



committee or other legal guardian and any such committee or guardian may, on a poll, vote by Proxy.

 Objections to
 55.
 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, and every vote not disallowed at such meeting shall be valid for all purposes. Any such objection made in due time shall be referred to the chairman of the meeting, whose decision shall be final and conclusive.

- Votes by Proxy.
 56.
 On a poll votes may be given either personally (including without limitation a representative of a company or corporation authorised under Article 62) or by Proxy.
- Proxy to be in
 57. The instrument appointing a Proxy shall be in writing under the hand of the appointer or of his attorney duly authorised in writing, or, if the appointer is a corporation, either under seal or under the hand of an officer or attorney duly authorised. A Proxy need not be a Member of Strain the Company.
- Instrument
 58.
 The Instrument appointing a Proxy and the power of atterney or other authority (if any), under which it is signed or a notarially certified copy of that power or authority, shall be deposited at the Office vot letuthen deposited.

 forty-eight hours before the time for holding the meeting person named in the instrument proposes to vote, and in details the instrument of Proxy shall not be treated as valid.
 - 59. An instrument appointing a Proxy may be in the following form, or In any other form which the Directors shall approve:-

HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

I, of in the district of...... being a Member of HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED, hereby appoint of............ as my Proxy to vote for me and on my behalf at the (Annual or Extraordinary, as the case may be) General Meeting of the Company to be held on the day of and at any adjournment thereof.

Proxy may demand poll.

Form of Proxy.

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The instrument appointing a Proxy shall be deemed to confer authority 60. to demand or join in demanding a poll.

61. A vote given in accordance with the terms of an instrument of Proxy shall be valid notwithstanding the previous death or Insanity of the principal or revocation of the Proxy or of the authority under which the Proxy was executed, or the transfer of the shares in respect of which the Proxy is given, provided that no intimation in writing of such death, insanity, revocation or transfer as aforesaid shall have been received by the Company at the Office before the commencement of the meeting or adjourned meeting at which the Proxy is used.

62. Any company or other corporation which is a Member of the Company may by resolution of its directors or other governing body authorise such person as it thinks fit to act as its representative at any meeting of the Company or of any class of Members of the Company, and the person so authorised shall be entitled to exercise the same powers on behalf of the company or corporation which he represents as that company or corporation could exercise if it were an individual Member of the Company, present in person. The production before or at the meeting of a copy of such resolution purporting to be signed by a director or the an secretary of such company or corporation and certified by him as being a true copy of the resolution shall be accepted by the company as sufficient evidence of the validity of the appointment of sure representative. A company or corporation which is a Member of the Company but which is not resident in Pakistan may appoint a representative as aforesaid by telex message or facsimile transmission or electronic mail which, if purporting to be sent by such company or corporation, need not be certified as a true copy as aforesaid.

DIRECTORS

Directors to be elected.

63.

Number of Directors.

Subject to the provisions of these Articles and the Ordinance the Directors shall all be elected by the Members in General Meeting. 64.

(1) The Board of Directors of the Company shall comprise five Directors. Subject to the said minimum, the number of Directors that the Company shall have shall be determined by the Directors themselves in the manner prescribed in this Article. Before every General Meeting at which Directors are to be elected, and not later than thirty-five days preceding the date of such meeting, the Directors shall fix the number of elected Directors that the

Revocation of authority.

Corporation acting by representative. Company shall have from the effective date of the election at such meeting and the number of such Directors who shall be elected Directors. Except with the prior approval of the Company in General Meeting, the number of Directors so fixed shall not be increased or reduced by the Directors so as to have effect before the effective date of election at the next such General Meeting at which Directors are to be elected.

- (2) The Huaneng Parties and Ruyl Parties have the right to alternately nominate three Directors of each term of the Board of Directors. When one party has the right to nominate three directors of a term of the Board of Directors, the other party shall have the right to nominate the remaining two Directors for the said term of the Board of Directors. Three Directors of the first term of the Board of Directors, which will commence after the first election of directors to be held at the first Annual General Meeting of the Company, will be nominated by the Huaneng Parties, and the Ruyi Parties will nominate the remaining two Directors. For the second term of the Board of Directors, three Directors will be nominated by the Ruyi Parties and two by the Huaneng Parties, and so on. A Director nominated by the Ruyl Parties will act as the Chairman of the Company and the Ruyl Parties shall have right to replace the a Chairman.
- (3) The following are the first Directors:
 - 1. MS Li Ping
 - 2. Mr Li Xide
 - 3. Mr Wang Wenzong
 - 4. Mr Qiu Yafu
 - 5. Ms Qiu Chenran

Each of the first Directors named in this Article shall hold office until the dissolution of the first Annual General Meeting unless he earlier resigns, becomes disqualified or otherwise ceases to hold office. At the first Annual General Meeting there shall be an election of Directors of the first term of the Board of Directors and the Directors elected at that meeting shall assume office on the dissolution of the meeting.

A Director elected by the Members in General Meeting shall hold office for a period of three years following the date from which his election is effective unless he earlier resigns, becomes disqualified from being a Director or otherwise ceases to hold office.

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Period of office

65.

of elected Directors. Directors may fill up casual vacancies. 66.

Eligibility for election as Director. Subject to Article 64 (2), any casual vacancy occurring among the elected Directors may be filled up by the Directors, but a person so appointed shall hold office for the remainder of the term of the Director in whose place he is appointed.

67. The Members in General Meeting shall elect the Directors from amongst persons who, not being ineligible in accordance with Section 187 of the Ordinance, offer themselves for election as Directors in accordance with this Article. Any person claiming to be eligible who desires to offer himself for election shall, whether he is a retiring Director or not, file with the Company not later than fourteen days before the date of the General Meeting at which Directors are to be elected, a notice that he, being eligible, intends to offer himself for election as a Director at that meeting. If and for so long as the Company shall be a subsidiary of a public company, every person notifying his intention to offer himself for election as a Director shall together with the notice aforesaid deliver to the Company in the form prescribed for this purpose his consent and certificate consenting to act as a Director and certifying that he is not ineligible to become a Director and the Company shall file such consent and certificate with the Registrar of Companies as required by Section 184 of the Ordinance. A person offering himself for election as a Director strain may withdraw his candidature at any time before the holding of the election and may do so by withdrawing the notice in which he offered himself for election. Not later than seven days before the date of the meeting the Company will notify the Members of the persons of the themselves for election as Directors at such meeting and shall so meting the Members in the manner hereinafter mentioned. Exchang

- 68. The provisions of this Article shall apply for the election of Directors by the Members in General Meeting from amongst the candidates eligible for election, namely:-
 - (a) every Member present in person or by Proxy shall have such number of votes as is equal to the product of the number of shares carrying the right to vote held by him and the number of Directors to be elected;
 - (b) the number of votes calculated in accordance with the preceding clause (a) may be given to a single candidate or may be divided between any two or more candidates in such manner as the person voting may choose; and
 - (c) the candidate who gets the highest number of votes shall be declared elected as Director and then the candidate who gets the next highest number of votes shall be so declared and so on until

Procedure for election of Directors. the total number of Directors to be elected has been so elected.

Removal of Directors.

Special

Remuneration.

69.

The Company in General Meeting may remove a Director from office by a resolution passed with the requisite number of votes determined in accordance with the provisions of Section 181 of the Ordinance.

The qualification of an elected Director, in addition to his being a 70. Qualification of Member, where required, shall be his holding at least 1 shares in his own **Directors.** name, but a Director representing the interests of a Member or Members holding at least fifty percent of the issued share capital of the Company shall require no such share qualification. A Director shall not be qualified as representing the interests of a Member or Members holding shares of the regulsite value unless he is appointed as such representative by the Member or Members concerned by notice in writing addressed to the Company specifying the shares of the requisite value appropriated for qualifying such Director. Shares thus appropriated for qualifying a Director shall not, while he continues to be such representative, be appropriated for qualifying any other Director. A Director shall acquire his share qualification within one (1) month from the effective date of his appointment. For so long as only subscriber Cont shares are in issue no share qualification shall be required.

Remuneration of 71. The remuneration of a Director (other than the Chief Executive and the Directors. The remuneration of a Director who is an employee of the Company for attending meetings of the Directors shall from time to time be determined by the Directors. A Director shall also be paid all travelling, hotel and other expenses properly incurred by him in attending and returning the meetings of the Directors or any committee of Directors or General Meetings of the Company or in connection with the business of the Company.

72. Any Director who serves on any committee or who devotes special attention to the business of the Company, or who otherwise performs services which in the opinion of the Directors are outside the scope of the ordinary duties of a Director, may be paid such extra remuneration as the Directors may determine.

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ALTERNATE DIRECTORS

Alternate Directors.

A Director who is about to leave or is absent for a period of three 73. Months or more from Pakistan may with the approval of the Directors appoint any person who is eligible under Section 187 of the Ordinance for appointment as a Director to be an Alternate Director during his absence from Pakistan and such appointment shall have effect and such appointee, whilst he holds office as an Alternate Director, shail be entitled to notice of meetings of the Directors and to attend and vote thereat and to exercise in place of his appointer all the functions of his appointer as a Director of the Company but he shall ipso facto vacate office as and when his appointer returns to Pakistan or vacates office as a Director or removes the appointee from office. Any appointment or removal under this Article shall be effected by notice in writing under the hand of the Director making the same. Such Alternate Director may be one of the Directors of the Company. In such case he shall be entitled to act in both capacities including the right to vote on behalf of his appointer in addition to his own right to vote. An Alternate Director need not hold any share qualification.

BORROWING POWERS

Borrowing powers.

74.

(1) The Directors may exercise all the powers of the Comparison raise there is undertaking or property or any part there and to the same debentures and other securities whether outright or assecurity for any obligation or liability or debt of the Company or any sales, party.

(2) In exercising the powers of the Company aforesaid the Directors may, from time to time and on such terms and conditions as they think fit, raise money from banks and financial institutions and from other persons under any permitted system of financing, whether providing for payment of interest or some other form of return, and in particular the Directors may raise money on the basis of mark-up on price, musharika, modaraba or any other permitted mode of financing, and without prejudice to the generality of the foregoing the Directors may exercise all or any of the powers of the Company arising under Section 19(2) of the Ordinance.

(3) Subject to the provisions of Article 74(1), in regard to the issue of securities the Directors may exercise all or any of the powers of the Company arising under Sections 19(2), 87 and 120 of

the Ordinance and in particular the Directors may issue any security distraas defined in Section 2(1)(34) of the Ordinance or may leave any instrument or certificate representing redeemable capital as defined in Section 2(1)(30A) of the Ordinance or participation redeemable capital as defined in Section 2(1)(25) of the Ordinance

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General powers of Company vested In

Directors.

75.

POWERS AND DUTIES OF DIRECTORS

(1) The business of the Company shall be managed by the Directors, who may pay all expenses incurred in promoting and registering the Company, and may exercise all such powers of the Company as are not by the Ordinance or any statutory modification thereof for the time being in force or by these Articles or by a Special Resolution required to be exercised by the Company in General Meeting, subject nevertheless to any regulation of these Articles, to the provisions of the Ordinance, and to such regulations being not istration inconsistent with the aforesaid regulations or provisions as may be prevision of the Company in General Meeting; but no regulation made by the Company in General Meeting shall invalidate art prior act of the Directors which would have been valid if that regulation had not been made.

- (2) A resolution at a meeting of the Directors duly convened and held. Con shall be necessary for exercising the powers of the Company specified in Section 196(2) of the Ordinance.
- (3) Except for the following actions, a decision can be made by a majority vote of the Directors present at the meeting of the Board of Directors duly convened (in person or through audio/video conferencing as permitted under Article 99). A decision on the following actions should not be taken unless unanimously agreed by all Directors present at the meeting of the Board of Directors duly convened (in person or through audio/video conferencing as permitted under Article 99):
 - Enter into, terminate any Project Documents and Financing Documents, and make any material change thereto;
 - (b) Select, remove or approve any Project Partner and Financier;
 - (c) Develop and implement any financing plan (including but not limited to Bank Financing), dispose of any Major Asset, including but not limited to sell, assign, transfer, pledge, mortgage or create or permits to have security interest in other forms or encumbrance, or provide any externai assurance or guarantee, and approve any cost overrun for the development, construction, operation, or maintenance of the Pakistani Project, including any capital contribution or shareholder loan to the Pakistani Project due to such cost overrun (if applicable);
 - (d) Make any change to the business scope of the Company, including starting or ending activities in any field, changing

the location of business of the Company or expanding or narrowing their business; develop Business Plan or change the existing Business Plan or approve any deviation from the **Business Plan:**

- (e) Calculation, decision on, approval on or variation of the tariff of the Pakistani project:
- (f) Appoint and change the Chief Executive, deputy chief executives, chief financial officer and head of financial department of the Company or determine the compensation of such persons, or create any rights and interests for them, or change the number of deputy chief executive;
- (g) increase the issued share capital, and issue, allot or otherwise dispose of the shares of the Company;
- (h) recommend any amount of dividends which will be declared by the Company In General Meeting under Article 109, and exercise any power of the directors under Articles 110, 113, 119 and 120:
- (i) make any recommendation to the Company under Article 128; Rogistration and

The Directors may from time to time and at any time by power of

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(i) exercise its power under Article 25.

Power of Attorney. 76.

Official seal for use abroad.

attorney appoint any company, firm or person or body of persons, whether nominated directly or indirectly (including any Orectors) officer of the Company) by the Directors, to be the attorney on attorneys of the Company for such purposes and with such powers, authorities and the discretions (not exceeding those vested in or exercisable by the Directors under these Articles) and for such period and subject to such conditions as they may think fit, and any such powers of attorney may contain such provisions for the protection and convenience of persons dealing with any such attorney as the Directors may think fit and may also authorise any such attorney to delegate all or any of the powers, authorities and discretions vested in him; and without prejudice to the generality of the foregoing any such power of attorney may authorise the attorney to institute, conduct, defend, compound or abandon any legal proceedings by or against the Company, whether generally or in any particular case.

77. The Company may exercise the powers conferred by Section 213 of the Ordinance with regard to having an official seal for use abroad, and such powers shall be vested in the Directors.



- Conditions on A Director of the Company or a firm of which such Director is a partner 78. which Directors or a private company of which such Director is a director may with the may hold office consent of the Company in General Meeting hold any office of profit of profit. under the Company provided that no such consent is required where the office held is that of Chief Executive or legal or technical adviser or banker. Making of loans, in the matters of granting loans, giving guarantees and providing 79. etc. securities, the Company shall have due regard to the prohibitions and restrictions contained in Section 195 of the Ordinance. Directors may 80. Subject to authorisation being given by the Directors in accordance with contract with Article 75(2) and Section 196(2) of the Ordinance, a Director shall not be Company. disqualified from contracting with the Company either as vendor, purchaser or otherwise, nor shall any such contract or arrangement entered into by or on behalf of the Company with any company or partnership of or in which any Director of the Company shall be a member or otherwise Interested be avoided nor shall any such Director so contracting or being such member or so interested be liable to account to the Company for any profit realized by any such contract Registre arrangement by reason of such Director holding that office of the ahore fiduciary relation thereby established. 3
 - 81. A Director who, or whose spouse or minor child, is in any way, whether directly or indirectly, concerned or interested in any contract our arrangement or proposed contract or arrangement with the company shall disclose the nature of such concern or interest in accordance with or Comp Section 214 of the Ordinance.

82. Where by any contract or resolution of the Directors an appointment or a variation in the terms of an existing appointment is made (whether effective immediately or in the future) of a Chief Executive, whole-time Director or Secretary of the Company, in which appointment any Director of the Company is, or after the contract or resolution becomes, in any way, whether directly or indirectly, concerned or interested, the Company shall inform the Members of such appointment or variation in the manner required by Section 218 of the Ordinance and shall comply with the requirements of that Section in regard to the maintaining of such contracts and resolutions open for inspection by Members at the Office, the provision of certified copies thereof and extracts therefrom and otherwise.

Where Director's interest lies in appointment of Chief Executive,

etc.

Directors to

disclose

interest.

Prohibition of voting by Interested Directors.

Register of contracts, arrangements and appointments.

Director holding office with companies in which the **Company** is interested.

Signing of cheques, etc.

Directors to comply with the provisions of the Ordinance.

83. Except as provided in Section 216 of the Ordinance, a Director shall not vote in respect of any contract or arrangement in which he is personally and directly concerned or interested nor shall his presence count for the purpose of forming a quorum at the time of any such vote; and if he does so vote, his vote shall not be counted.

The Company shall comply with the provisions of Section 219 of the 84. Ordinance in regard to the keeping of a register and the entry therein of the particulars of all contracts and arrangements or appointments of the kind referred to in Sections 214, 215, 216 or 218 of the Ordinance separately for each Section, and in regard to the maintaining of such register open for inspection by Members at the Office, the provision of certified copies thereof and extracts therefrom and otherwise.

A Director of the Company may be or become a director of any other 85. company promoted by the Company or in which the Company may be interested as a vendor, shareholder or otherwise and no such Director shall be accountable for any benefits received as a director or member of such other company.

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86. All cheques, promissory notes, drafts, bills of exchange and other negotiable instruments, and all receipts for moneys paid to the Company, shall be signed, drawn, accepted, endorsed, or otherwise executed as the case may be, in such manner as the Directors shall from time 30 time by resolution determine.

87. The Directors shall duly comply with the provisions of the Ordinance or any statutory modification thereof for the time being in force, and in particular with the provisions in regard to the registration of the particulars of mortgages and charges affecting the property of the Company or created by it, and to keeping a register of the Directors and Officers of the Company (including the Chief Executive, Secretary, chief accountant, auditors and legal adviser), and to sending to the Registrar of Companies an annual list of Members, and a summary of particulars relating thereto and notice of any consolidation or increase of share capital or any sub-division or cancellation of shares and copies of Special Resolutions and a copy of the register of the Directors and Officers of the Company and notifications of any changes therein. The Directors shall further comply with such general or special orders of the SECP issued from time to time under Section 246 of the Ordinance as may be applicable to the Company in regard to the submission of periodical statements of accounts, information and other reports as specified in such orders.

	88.	 The Directors shall cause minutes to be made in books provided for the purpose and kept at the Office: (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 Directors; (c) of the names of the Members or their proxies or representatives present at each meeting of the Company;
		 (d) of all resolutions and proceedings at all meetings of the Company, and of the Directors, and of committee of Directors; and the Directors present at any meeting of Directors or committee of Directors and all Members and proxies of Members present at any General Meeting shall sign their names in books to be kept for that purpose; provided that in the case of a meeting of the Directors held through audio or video conferencing, a record of such meeting will be retained by the Company; and any such minute of such a meeting if purporting to be signed by the chairman thereof, or by the chairman of the next succeeding meeting of the same body, shall be sufficient
		evidence without any further proof of the facts therein stated.
Payments of pensions, etc., to Directors.	89.	The Directors on behalf of the Company may pay a gratuity or pension of egistral allowance on retirement to any Director who has held any other ratified ahore office or place of profit with the Company or to his widow or dependents and may make contributions to any fund and pay premiums for the purchase or provision of any such gratuity, pension or allowance.
		DISQUALIFICATION OF DIRECTORS
Disqualification	90.	A Director shall ipso facto cease to hold office if:
or Directors.		(a) he becomes ineligible to be appointed as a Director on any one or more of the grounds specified in clauses (a) to (h) of Section 187 of the Ordinance, or
		(b) he absents himself from three consecutive meetings of the Directors or from all meetings of the Directors for a continuous period of three Months, whichever is the longer, without leave of obsence from the Directors or
		 (c) he or any firm of which he is a partner or any private company of which he is a director without the sanction of the Company in General Meeting accepts or holds any office of profit under the Company other than that of a Chief Executive or a legal or technical adviser or a banker, or
		 (d) he or any firm of which he is a partner or any private company of which he is a director accepts a loan or guarantee from the

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- (e) he fails to obtain within one month from the effective date of his appointment, or at any time thereafter ceases to hold, the share qualification necessary for his appointment, or
- (f) the Member or Members who appointed him as a representative under Article 70 or any of them revoke his appointment by notice in writing to the Company or for any reason cease to hold any of the shares appropriated for qualifying him.

PROCEEDINGS OF DIRECTORS

Meetings of Directors.

91.

Ouorum of Directors.

Directors may act notwithstanding vacancy.

Reference to **General Meeting** where no quorum.

Chairman.

- The Directors may meet together for the despatch 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 of the Directors present and voting which majority must include the Chairman or in the Chairman's absence, the deputy chairman's concurring vote, if a chairperson and/or deputy chairperson has been appointed pursuant to Article 95 and each Director has one vote. In case of an equality of votes, the chairman shall have 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. A copy of the minutes of Directors meetings shall be furnished to each Director within fourteen days of such meeting.
- 92. The quorum necessary for the transaction of the business at meetings of the Board of Directors shall be three Directors, Mctuding least one Director nominated by the Huaneng Parties and the Director nominated by the Ruyi Parties. An Alternate Director whose appointment is effective shall be counted in a quorum.

93. The continuing Directors may act notwithstanding any vacancy in their body so long as their number is not reduced below the number fixed by or pursuant to these Articles as the necessary quorum of Directors.

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94. If as a consequence of the Directors or some of them being concerned or interested in any contract or arrangement a quorum is not available for the transaction of any business relating thereto on account of the provisions of Section 216 of the Ordinance, such business shall be referred to the Company in General Meeting whose decision shall be carried into effect.

95. (1) The Board of Directors elect one of the Directors nominated by Ruyi Parties as Chairman of the Board of Directors and may determine the period for which the Chairman will hold office. The Directors may elect one Director nominated by Huaneng Parties as deputy

Chairman so that the elected deputy Chairman may act as the Chairman in the Chairman's absence and the Directors may determine the period for which the deputy Chairman will hold office.

(2) The Chairman or in his absence the deputy Chairman shall preside at all meetings of the Board of Directors.

of 95. A meeting of the Directors at which a quorum is present shail be competent to exercise all or any of the authorities, powers and discretions by or under these Articles for the time being vested in or exercisable by the Directors generally.

to 97. The Directors may delegate any of their powers to committees consisting of such member or members of their body as they think fit. Any committee so formed shall in the exercise of the powers so delegated conform to any regulations that may be imposed on it by the Directors. Save as aforesaid the meetings and proceedings of a committee consisting of more than one member shall be governed by the provisions of these Articles regulating the proceedings and meetings of the Directors.

98. All acts done at any meeting of the Directors, or of a committee of Directors, or by any person acting as a Director shall notwithstanding is that it shall afterwards be discovered that there was some fetect in the appointment or continuance in office of any such Directors or person acting as aforesaid, or that they or any of them were discuslified or had vacated office, or were not entitled to vote, be as valid as a every such person has been duly appointed or had duly continued in office and was qualified and had continued to be a Director and had been entitled to vote.

99. Subject to any rules framed under or any regulations or directives issued pursuant to the Ordinance, the Directors or members of a committee of Directors may take part in a meeting of the Directors or a committee by using any communication equipment which allows everybody participating in the meeting to speak to and hear each other. Taking part in this way will count as being present at the meeting in person. Meetings will be treated as taking place where the largest group of the participants are or, if there is no such group, where the chairman of the meeting is.

Powers of quorum.

Power to delegate.

When acts of Directors or committee valid.

Attendance at Board Meetings through audio/video conferencing. Resolution in writing.

100. Subject to the provisions of Article 75(2), a resolution in writing, signed by all Directors (or In their absence their Alternate Directors) or by all the members of a committee shall be as valid and effectual as if it had been passed at a meeting of the Directors, or as the case may be of such committee, duly called and constituted. Such resolution may be contained in one document or in several documents in like form each signed by one or more of the Directors or members of the committee concerned. A cable or telex message or facsimile transmission or electronic mail or other electronic communication sent by a Director or a member of the committee shall be deemed to be a document signed by him for the purposes of this Article. The resolution is passed when the last Director entitled to vote on the resolution signs.

CHIEF EXECUTIVE

Appointment of Chief Executive.

101. The Company shall have an office of Chief Executive which shall be filled from time to time by the Directors who shall appoint one of the Directors nominated by Huaneng Parties or (subject to Section 201 of the Ordinance) any other person nominated by Huaneng Partles to be the Chief Executive of the Company for a period not exceeding three years (or prior to the first Annual General Meeting for a period or periods not egistr: Lahore extending beyond the date of such meeting) and on such the main and conditions as the Directors may think fit, and such appointment shall be made within fourteen days from the date on which the office of chief Executive falls vacant. Prior to each such appointment the Company with secure and shall file with the Registrar of Companies as required by Section 184 of the Ordinance in the form prescribed for this purpose the consent of the person concerned consenting to act as the Chief Executive of the Company. If the Chief Executive of the Company at any time is not already a Director he shall be deemed to be a Director of the Company notwithstanding that the number of Directors for the time being fixed in accordance with Article 64shall thereby be increased. The Chief Executive may be removed from office in accordance with the provisions of Section 202 of the Ordinance.

102 The Company shall have four deputy chief executives, who will be recommended by the Chief Executive, two of them will be recommended by the Huaneng Parties and the other two by the Ruyi Parties. If additional deputy chief executives are required, the number of such additional deputy chief executive shall be even, who will be recommended by the Huaneng Parties and Ruyl Parties respectively at a

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ratio of 50%:50%. The Chief Executive and deputy chief executives shall be appointed by the Board of Directors of the Company.

- 103 As authorized by the Board of Directors and in accordance with the regulations of the Company, the Chief Executive will have the full powers to:
 - (a) take charge of the operations and management of the Company, and enforce the resolutions of the Board of Directors;
 - (b) implement the annual Business Plans and investment plans of the Company:
 - (c) develop the plan for setup of Internal management of the Company;
 - (d) develop the fundamental regulations of the Company;
 - (e) develop the detailed rules of the Company;
 - (f) propose candidates for deputy chief executives, chief financial officer and head of financial department as recommended by Huaneng Parties and Ruyi Parties under Article 102 and Article 107 respectively to the Board of Directors for approval;
 - (g) decide to appoint or remove executives other than those whose appointment or removal is subject to decisions of the Board of Directors;
 - (h) keep the seals, stamps, registration documents, articles of association, contracts, internal documents, financial documents and gistrag other documents of the Company; and Lahore

Board of

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exercise other powers as may be authorized by the (1) Directors.

104. A Chief Executive shall receive such remuneration as the Directors

determine and it may be made a term of his appointment that he be paid a pension and/or gratuity and/or other benefits on retirement some

Remuneration of Chief Executive.

Powers of Chief

his office.

105. The Directors may entrust to and confer upon the Chief Executive any of the powers exercisable by them, except those required by Article 75(2) to be exercised by a meeting of the Directors, upon such terms and conditions and with such restrictions as they may think fit and may from time to time revoke, withdraw, alter or vary all or any of such powers.

SECRETARY

106. The Secretary shall 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. Where there is no Secretary capable of acting, the Directors may appoint an assistant or

Executive.

Appointment of Secretary.

deputy secretary or any other officer of the Company to perform the duties of Secretary.

Chief Financial Officer and Head of Financial Department

107 The Company shall have a chief financial officer and a head of financial department. Their duties and authorities are subject to the regulations and rules of the Company. The chief financial officer will be recommended by the Huaneng Parties and the Head of Financial Department will be recommended by the Ruyi Parties, both subject to proposal by the Chief Executive and appointment by the Board of istrati Directors. Lahore

THE SEAL

108. Common Seal.

The Directors shall provide a Seal for the purposes of the Company and shall have the power from time to time to destroy the same and substitute a new Seal in lieu thereof and the Directors shall provide for the safe custody of the Seal which shall only be used by the authority of the Directors or of a committee of the Directors authorized by the Directors on their behalf; and every instrument to which the Seai shall be affixed shall either be signed by one Director and a second Director or by some other person appointed by the Directors for the purpose or be signed by the Chief Executive alone, but so that the Directors may by resolution determine either generally or in any particular case, that the signature of the Chief Executive, any Director may be affixed by some mechanical means to be specified in such resolution including without ilmitation by printing, lithography or stamping.

DIVIDENDS AND RESERVES

Declaration of

109. The Company in General Meeting may declare dividends, but no dividends shall exceed the amount recommended by the Directors.

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

111. No dividends shall be paid otherwise than out of profits of the year or any other undistributed profits and in the determination of the profits available for dividends the Directors shall have regard to the provisions

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dlvidend.

Interim dividends.

Dividends payable out of profits.

of the Ordinance and in particular to the provisions of Sections 83, 235 and 248 of the Ordinance.

112. The declaration of the Directors as to the amount of the net profits of

the Company shall be conclusive.

Reserved fund.

What to be deemed net profits.

Right to dividends

apportionment.

and

Effect of

transfer.

Payment by post.

113. (1) The Directors may before recommending any dividend, set aside out of the profits of the Company such sums as they think proper as a reserve or reserves which shail, at the discretion of the Directors, be applicable for meeting contingencies, or for equalizing dividends, or for any other purpose to which the profits of the Company may be properly applied, and pending such application, at the like discretion, either be employed in the business of the Company or be invested, subject to the provisions of the Ordinance, in such investments (other than shares of the Company) as the Directors may from time to time think fit.

- (2) The Directors may also carry forward any profits which they may gistrain think prudent not to distribute, without setting them as a a hore reserve.
- 114. All dividends shall be declared and paid according to the autounts shall on the shares. All dividends shall be apportioned and paid propertionally to the amounts paid or credited as paid on the shares during an portion or portions of the period in respect of which the dividend is paid; but the any share is issued on terms providing that it shall rank for dividend as from a particular date such share shall rank for dividend accordingly.
 - 115. A transfer of shares shall not pass the right to any dividend declared thereon after such transfer and before the registration of the transfer.

116. The dividend in respect of any share shall be paid to the registered holder of such share or to his banker or to a financial institution (as defined in Section 2(1)(15A) of the Ordinance) nominated by him for the purpose. Unless otherwise instructed in writing by the registered holder of a share, any dividend payable in cash in respect of such share may be paid by cheque or warrant sent through the post by registered mail or through courier or through such other means as may generally or specially be permitted by the SECP to the registered address of the holder or, in the case of joint holders, to the registered address of that one of the joint holders who is first named on the Register or to such banker or financial institution as may have been nominated by the registered holder. Every such cheque or warrant shall be made payable

to the order of the person to whom it is sent. Any one of two or more joint holders may give effectual receipts for any dividends payable in respect of the shares held by them as joint holders.

Time for payment of dividend.

Dividend not to bear interest.

Unclaimed Dividends.

> Payment of dividends in specie.

117. All dividends shall be paid within the periods specified in Section 251 of the Ordinance.

118. No dividend payable in respect of a share shall bear interest against the Company.

- 119. All dividends unclaimed for one year after having been declared may be invested or otherwise made use of by the Directors for the benefit of the Company until claimed, and the Company shall not be constituted a trustee in respect thereof. Provided that any dividend unclaimed after period of six years from the date of declaration of such dividend may be forfeited, and if so shall revert back to the Company.
- 120. With the sanction of a General Meeting any dividend may be paid with paid with or in part by the distribution of specific assets and in particular of paid-up shares or debentures of any other company or in the one of more of such ways. Where any difficulty arises in regard to such distribution, the Directors may settle the same as they think expedient, and in particular may issue fractional certificates and fix the value for distribution of such specific assets or any part thereof and may determine that cash payments shall be made to any Member upon the footing of the value so fixed, in order to adjust the rights of all Members, and may vest any such specific assets in trustees upon trust for the Members entitled to the dividend as may seem expedient to the Directors.

ACCOUNTS

Directors to keep accounts.

121. The Directors shall cause to be kept proper books of account with respect to:

- (a) all sums of money received and expended by the Company and the matters in respect of which the receipts and expenditures take place;
- (b) all sales and purchases of goods by the Company;
- (c) all assets of the Company;
- (d) all liabilities of the Company; and

(e) where the provisions of Section 230(1)(e) of the Ordinance are applicable, such particulars relating to utilisation of material or labour or to other inputs or items of cost as may be prescribed.



Where accounts to be kept.

Period for maintaining books of account.

Inspection by Members.

Annual Accounts and Reports.

- 122. The books of account shall be kept at the Office or at such other place in Paklstan as the Directors may decide and shall be open to inspection by the Directors during business hours. If the Directors decide to keep the books of account at a place other than the Office they shall comply with the directions contained in the proviso to Section 230(1) of the Ordinance.
- 123. The Company shall preserve in good order the books of account of the Company in respect of any financial year for a period of ten years following the close of that year.
- 124. The Directors shall from time to time determine whether and to what extent and at what times and places and under what conditions or regulations the accounts and books of the Company or any of them shall be open to the inspection of Members not being Directors and ho above Member (not being a Director) shall have any right of inspecting any account or books or papers of the Company except as conferred by the Ordinance or authorised by the Directors or by the Company in General Meeting.
- 125. (1) The Directors shall arrange to place before the Annual General Meeting of the Company in every year a duly audited balance sheet and profit and loss account, conforming to the requirements of Sections 234, 237, 238 and 240 of the Ordinance and made up to a date not more than four Months before the date of such meeting and having the auditor's report attached thereto, and a report of the Directors, conforming to the requirements of Section 236 of the Ordinance.
 - (2) As required by Section 241 of the Ordinance the balance sheet and profit and loss account shall first be approved by the Directors and when so approved shall be signed by the Chief Executive and at least one Director but if on account of his absence from Pakistan or other reason the signature of the Chief Executive cannot be obtained, the balance sheet and profit and loss account shall be signed by at least two Directors for the time being in Pakistan, and in every such case a statement signed by those two Directors shall be subjoined to the balance sheet and profit and loss account stating the reason why the signature of the Chief Executive was not obtained.

(3) The Directors may authorize the Chairman or the Chief Executive to sign the report of the Directors which may then be signed accordingly, but in the absence of any such authority the

6

report of the Directors shall be signed as required by Section 236(3) of the Ordinance in the same manner as the balance sheet and profit and loss account.

126. (1) A copy of the balance sheet, profit and loss account and the reports of the Directors and auditors shall be sent not less than twenty-one (21) days before the date of the Annual General Meeting to the Members and other persons entitled to receive notices of General Meetings in the manner in which notices are to be given hereunder and a copy thereof shall be kept for a period of at least twenty-one (21) days before the meeting at the Office for Inspection by Members.

127. The Directors shall in all respects comply with the provisions of Sections 230 to 247 of the Ordinance, or any statutory modification thereof in Registration the time being in force.

CAPITALIZATION OF PROFITS

Power to capitalize.

Effect of Resolution to capitalize. 128. The Company in General Meeting may upon the recommendat Directors resolve that It is desirable to capitalise any part of the another for the time being standing to the credit of any of the Company's reserve accounts or to the credit of the profit and loss account or otherwise available for distribution, and accordingly that such sum be set free for distribution amongst the Members who would be entitled thereto if distributed by way of dividend and in the same proportions on condition that the same be not paid in cash but be applied either in or towards paying up any amounts for the time being unpaid on any shares held by such Members respectively or paying in full unissued shares or debentures of the Company to be allotted and distributed credited as fully paid up to and amongst such Members in the proportion aforesaid, or partiy in the one way and partly in the other and the Directors shall give effect to such resolution; provided that a share premlum account may, for the purposes of this Article, only be applied in paying up of unissued shares to be allotted to Members as fully paid bonus shares.

129. Whenever such a resolution as aforesaid shall have been passed the Directors shall make all appropriations and applications of the undivided profits resolved to be capitalized thereby, and all allotments and issues of fully paid shares or debentures, If any, and generally shall do all acts and things required to give effect thereto, with full power to the Directors to make such provision by payment in cash or otherwise as they think fit for the case of shares or debentures becoming distributable

Copies of Annual Accounts and Reports to be provided.

Directors to comply with the Ordinance.

in fractions and also to authorise any person to enter on behalf of all the Members entitled thereto into an agreement with the Company providing for the allotment to them respectively, credited as fully paid up, of any further shares or debentures to which they may be entitled upon such capitalisation, or (as the case may require) for the payment up by the Company on their behalf by the application thereto of their respective proportions of the profits resolved to be capitalized of the amounts or any part of the amounts remaining unpaid on their existing shares and any agreement made under such authority shall be effective and binding on all such Members.

AUDIT

Audit.

Notices to

Member.

Notice to joint holders. 130. Auditors shall be appointed and their duties regulated in accordance with Sections 252 to 260 of the Ordinance.

NOTICES

- 131. (1) A notice may be given by the Company to any Manuber 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.
 - (2) 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 letter would be delivered in the ordinary course of post.
- When notice may
 132. if a Member has no registered address in Pakistan and has not supplied be given by

 advertisement.
 to the Company an address within Pakistan for the giving of notices to him, a notice addressed to him or to Members generally and advertised in a newspaper circulating in the neighbourhood of the Office shail be deemed to be duly given to him on the day on which the advertisement appears.
 - 133. A notice may be given by the Company to the joint holders of a share by giving the notice to the joint holder named first in the Register in respect of the share.

Notice to legal representative.

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

 Notice to
 135. Notwithstanding anything hereinabove to the contrary in addition to any other notice it or he shall be entitled to receive, a Member which is a shareholder.

 foreign
 other notice it or he shall be entitled to receive, a Member which is a foreign corporation a company or Individual shall be given notice by telex and or facsimile transmission or electronic mail addressed to such Member at its telex and or facsimile number or electronic mail addresses by it or him to the Company.

Persons entitled to receive notices of General Meeting. 136. Notice of every General Meeting shall be given in some marine, hereinbefore authorised to (a) every Member except those. Members who (having no registered address within Pakistan) have not supplied to the Company an address within Pakistan for the giving of notices to them. (b) every Member of the Company being a foreign corporation or company which has supplied to the Company a telex or facsimile number or electronic mall address for the sending of notices to it, (c) every person entitled to a share in consequence of the death or insolvency of a Member, who but for his death or insolvency would be entitled to receive, notice of the meeting, and (d) the auditors of the Company.

137. Every person who, by operation of law, transfer, or other means whatsoever shall become entitled to any shares shall be bound by every notice in respect of such shares which previously to his name and address being entered on the Register shall have been duly given to the person from whom he derived his title to such shares.

WINDING - UP

Distribution of assets in specie.

Transferees, etc.,

bound by prior notices.

> 138. If the Company shall be wound up, the liquidator may, with the sanction of a Special Resolution of the Company and any other sanction required by the Ordinance divide amongst the Members in specie or kind the whole or any part of the assets of the Company (whether they shall consist of property of the same kind or not) and may, for such purpose, set such value as he deems fair upon any property to be divided as aforesaid and may determine how such division shall be carried out as

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

SECRECY

No shareholder to enter the premises of the Company without permission. 139. Save as otherwise provided in the Ordinance no Member or other person (not being a Director) shall be entitled to visit and inspect any of the Company's premises or properties of the Company without the permission of the Directors of the Company for the time being or any person authorised in this behalf by the Directors or to require discovery of or any information respecting any detail of the Company's trading or any matter which is or may be in the nature of a trade secret, mystery of the conduct of the business of the Company and which in the opinion of the Directors will be inexpedient in the interest of the Members of the Company to communicate to the public.

INDEMNITY

Indemnity of Directors, etc.

140. Every Director or officer of the Company and every person employed by the Company as auditor shall be indemnified out of the funds of the Company against all liability incurred by him as such Director, officer or auditor in defending any proceedings, whether civil or criminal, in which judgment is given in his favour, or in which he is acquitted, or in connection with any application under Section 488 of the Ordinance in which relief is granted to him by the Court.

[intentionally left blank]

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

Name and Surname (present and former) in full (in Block) letters	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residentiai address in full	Number of shares taken by each subscriber	Signature
Huaneng Shandong Ruyi (HK) Energy Limited (through its authorised representatives Mr. Qiu Yafu holder of Chinese passport No. E35861666)		Hong Kong Special Administrative Region, P.R. China		RM No. 1201, 12/F, Empire Center, 68 Mody Road, Tsim Sha Tsul, Kowloon, Hong Kong	99,995 (ninety-nine thousand, nine hundred and ninety-five)	157
WANG WENZONG P01115228	Wang Qiyue	Chinese	Executive Director, General Manager Huaneng Shandong Power Generation Co. Ltd.	Room 601, Unit 4, Building 4, Zifengyuan Residential Quarter, No. 14900, Jingshi Road, Lixia District, Jinan Shandong, P.R. China	1 (Constants	R La
Li Ping P01641595	Shan Weiguo	Chinese	Deputy General Manager of Huaneng Shandong Power Generation Co. Ltd	Room 801, Unit 4, Building 4, Zifengyuan Residential Quarter, No. 14900, Jingshi Road, Lixia District, Jinan Shandong, P.R. China	1 (One)	In

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Name and Surname (present and former) in full (in Block) letters	Father's/ Husband's Name in full	Nationality with any former Nationality	Occupation	Residential address in full	Number of shares taken by each subscriber	Signature	
Li Xide P01363624	Li Zhanku	Chinese	Chief Accountant and Member of Huaneng Shandong Power Generation Co. China	Room 501, Unit 4, Building 4, Zifengyuan Residential Quarter, No. 14900, Jingshi Road, Lixia District, Jinan, Shandong, P.R. China	1 (One)	35	
Qiu Yəfu E35861666	Qju Yunfu	Chinese	Chairman of the Board of Shandong Ruyi Group	Room 301, Unit 1, Building 20, Ruyi Garden 2 Hongxing East Rd. Jining, Shandong, China	A Sector		いたい
Qiu Chenran G 52890322	Qiu Yafu	Chinese	Executive Director of Shandong Ruyi Group	Rm 304, Unit 2, Building 13, Ruyi Garden , 2 Hongxing East Rd, Jining, Shandong , China	1 (One)	in the	10
					100,000 (one hundred thousand	t	

Dated this 23 day of May 2014.



Witness to the above Signatures:-

Į

Full Name (in Block Letters) 全名 (大写印刷 体)	Father's Name 父亲姓名	Occupation I였신Ł	Full Address 详细地址 CONORNY ahuman	Signature 金名
RIZWAN IRFAN BUTT	Irfan Mehmood Butt	Advocate	148, 18th East Street, Phase 1 Defence Officers' Housing Authority, Karnetrensing Pakistani 75500, Pakistan.	Roz



No. PPDB/	<u>245</u>	/2015
PUNJAB POWE	R DEVELO	PMENT BOARD
ENERG	BY DEPAR 1	IMENT
1 st Floor, C	entral Desi	gn Building,
Irrigation Secre (Ph: 042-9921	tariat, Old / 3876 Fax: (Anarkali, Lahore 042-99212796)

Date_//03_/2015

M/s. Huaneng Shandong Ruyi Group Ruyi Industrial Park Jinning National High-Tech, No, 72, Guanghe Road, Jining Shandong Province, P.R.Chinas.

Subject: REGISTRATION OF SPECIAL PURPOSE VEHICLE ("SPV")

Punjab Power Development Board has issued Letter of Intent ("LOI") to M/s. Huaneng Shandong Ruyi Group vide letter No. PPDB 638/2014 on 21.05.2014 for development of 2x 660 MW coal fired power project at Sahiwal in Punjab. As per stipulated clause-d of the LOI, the sponsors have to formalize SPV and registered with Securities Exchange Commission of Pakistan ("SECP") under the enabling laws of the Pakistan. M/s. Huaneng Shandong Ruyi Group have submitted copy of registration certificate on the name of M/s. Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited to PPDB.

In view of above, Please move forward and initiate the process with the National Electric Power Regulatory Authority ("NEPRA") for acceptance of upfront tariff and generation license.

A Charles A

MANAGING DIRECTOR

PUNJAB POWER DEVELOPMENT BOARD

<u>C.C</u>

1. P. S to Additional Chief Secretary Energy, Energy Department.





华能山东如意(巴基斯坦)能源有限公司 HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

Ref: NEPRA-4 Date: 10 March 2015

The Registrar, National Electric Power Regulatory Authority 2nd Floor, OPF Building, Sector G-5/2, Islamabad

SUBJECT: **ANNUAL RETURN CLARIFICATION LETTER**

I, Mr. Liu Youliang, Chief Executive Officer, being the duly authorized representative of Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited (the "Company"), hereby represent and warrant that the Company was incorporated on 28 May 2014 (as evidenced from the Certificate of Incorporation attached as a supplementary document to this upfront tariff acceptance application). As it has been less than twelve (12) months since the Company was incorporated, the Company has not yet filed Form A with the Securities and Exchange Commission of Pakistan. Therefore, please see as an alternative, as attached, a return comprising information as required pursuant to the Third Schedule to the Companies INITEDI * HU Ordinance, 1984.



Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited



华能山东如意(巴基斯坦)能源有限公司 HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED



EXTRACTS OF RESOLUTION BY CIRCULATION PASSED BY THE BOARD OF DIRECTORS OF HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED ("COMPANY")

"**RESOLVED** that a generation license application and an upfront tariff acceptance application (based on the unconditional acceptance of the upfront tariff dated 26 June 2014) be filed by and on behalf of the Company with the National Electric Power Regulatory Authority ("**NEPRA**") and to procure the grant by NEPRA of a Generation License for the Company's proposed 2 x 660 MW super-critical imported coal-fired condensing power generation plant to be located at Qadirabad, Sahiwal, Punjab, Pakistan, (the" **Project**"), and in relation thereto, enter into and execute all required documents, make all filings and pay all applicable fees, in each case, of any nature whatsoever, as required."

"FURTHER RESOLVED THAT in respect of filing a upfront tariff acceptance application and a generation license application for submission to National Electric Power Regulatory Authority, Mr. Liu Youliang, as the Chief Executive Officer of the Company, be and is hereby singly empowered and authorized for and on behalf of the Company to:

- (i) review, execute, submit, and deliver the upfront tariff acceptance application and a generation license application and any related documentation required by National Electric Power Regulatory Authority for the determination of the upfront tariff acceptance application and the generation license application, including any contracts, documents, powers of attorney, affidavits, statements, letters, forms, applications, deeds, guarantees, undertakings, approvals, memoranda, amendments, letters, communications, notices, certificates, requests, statements and any other instruments of any nature whatsoever;
- (ii) represent the Company in all negotiations, representations, presentations, hearings, conferences and/or meetings of any nature whatsoever with any entity (including, but in no manner limited, to National Electric Power Regulatory Authority, any private parties, companies, partnerships, individuals, governmental and/or semi-governmental authorities and agencies, ministries, boards, departments, regulatory authorities and/or any other entity of any nature whatsoever);
- (iii) sign and execute the necessary documentation, pay the necessary fees, appear before the National Electric Power Regulatory Authority as needed, and do all acts necessary for completion and processing of the upfront tariff acceptance application and the generation license application and procuring National Electric Power Regulatory Authority's upfront tariff determination and the generation license; and
- (iv) do all such acts, matters and things as may be necessary for carrying out the



华能山东如意(巴基斯坦)能源有限公司 HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED



purposes aforesaid and giving full effect to these resolutions."

"FURTHER RESOLVED THAT Mr. Mr. Liu Youliang, as the Chief Executive Officer of the Company, be and is hereby authorized to delegate all or any of the above powers in respect of the foregoing to any other officials of the Company or any other person as deemed appropriate."

"FURTHER RESOLVED THAT (i) the Chief Executive and the Company Secretary may sign and certify copies of this Resolution or documents giving effect to these resolutions to be true copies of the original; and (ii) receive/collect the original generation license and upfront tariff determination and related documents, from NEPRA, as required."

"AND FURTHER RESOLVED THAT any action taken by the Company or any of the authorized persons mentioned above in carrying out and giving effect to these resolutions, prior to the date hereof, be and is hereby authorized, approved, ratified and affirmed."

Certified to be a true copy of the original

Name: Gao Lei Company Secretary

Dated: 10 March 2015







HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



EXPRESSIONS OF INTEREST TO PROVIDE CREDIT OR FINANCING ALONG WITH SOURCES AND DETAILS (Section 11.2)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants



ORIGINAL



意向书

编号: 2014-025

致: 华能山东发电有限公司

地址: 山东省济南市玉函路 36 号

邮政编码: 250002

主题词: <u>华能山东如意巴基斯坦萨希瓦尔(Sahiwal)2×660MW 燃煤</u> 电站 项目

敬启者:

对于贵公司请求为题述项目出具_贷款_意向书的申请,中国进出口银行进行了审查,愿意为该项目按照下述贷款条件提供意向书。

中国进出口银行出具本意向书是基于该项目必须符合中国进出 口银行贷款政策及贷款条件,并且从本意向书出具日到贷款协议签署 日期间内在资本及资金市场上没有影响本意向书的不利情势发生。

本意向书对中国进出口银行不具有法律约束力,仅供贵公司投标 及核算成本之用。中国进出口银行有权根据国家法律法规、政策、客 户财务和经营情况及项目情况撤销本意向书。

本意向书有效期至 _2015年 2 月 21 日。有效期届满,未经中国进出口银行书面同意予以延期的,本意向书自动失效。前述有效期

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

ORIGINAL



规定不构成中国进出口银行对本意向书撤销权利的实质性限制。同时, 中国进出口银行保留根据市场变化情况,单方面更改贷款条件的权利。 该笔贷款的使用须通过中国进出口银行项目评审程序,中国进出口银 行视评审结果、项目建设条件落实等情况,有最终决定是否提供贷款 以及确定贷款条件的权利。具体意向性贷款条件如下:

贷款金额或比例:不超过境外投资项目中方应出资额的 70%,最 高不超过国家有关部门核准的项目总投资中银行融资比例且不超过 中方应出资额的 85%。



法定代表人(签字): (或有权签字人)

2014年8月76日

中国 北京市西城区复兴门内大街 30 号 凯良世贸中心西康 Tel: (010)

ICBC 国 中国工商银行

PRIVATE & CONFIDENTIAL

Industrial and Commercial Bank of China Limited Adress: 55 Fuxingmennei Avenue Xicheng District, Beijing, China Feb.2, 2015

Attention: Mr. Liu Youliang General Manager Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited

Dear Sir,

Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited (the "Borrower") Sinosure-backed Buyer's Credit (the "Facility") for Huaneng Shandong Ruyi Sahiwal 2×660MW Coal-fired Power Project.

Further to our recent discussions concerning financing up to 85% of the contract price for the captioned project, we, Industrial and Commercial Bank of China Limited ("ICBC") are pleased to confirm our keen interest to act as Financial Advisor and Arranger for the Borrower in relation to the Facility. In this regard, we set out the terms and conditions on which we are willing to arrange and underwrite the Facility in this letter and the attached term sheet (together, the "Proposed Terms").

1. GRANT OF MANDATE

- 1.1 The Borrower appoints **ICBC** as exclusive Arranger and Underwriter to arrange Chinese Export Credit in financing the contract price for certain equipments and services to be provided by the Exporter to the Importer pursuant to the Export Contract. Financial advisers could be decided by negotiation.
- 1.2 Unless and until this mandate terminates in accordance with the terms of this letter, the Company shall ensure that no title is awarded to a third party in connection with arranging and/or underwriting the Facility.

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2. SYNDICATION

The Arranger may invite participant lenders to provide proportion of the Facility.

3 CONFIDENTIALITY

The Proposed Terms are confidential and are not to be disclosed to or relied upon by anyone else, except with the Arranger's prior written consent and except that the Company may disclose those terms and conditions or a copy of any of them:

(a) to its advisers (on a "need to know" and confidential basis);

(b) to anyone else to the extent required by law or any applicable stock exchange; or

(c) to the extent necessary, to any applicable governmental or other regulatory authority, provided that (except for disclosure to those advisers) the Company shall give the Arranger reasonable prior notice of any intended disclosure to the extent practicable to give prior notice (or, if not practicable, promptly after the disclosure) and, if the Arranger requests, take into account its comments.

4. ANNOUNCEMENTS

No announcement regarding or reference to any or all of the Facility, Arranger or potential lender will be made by or on behalf of the Borrower (whether publicly or otherwise) without the prior consent of the Arranger, except to the extent required by law, regulation or any applicable stock exchange. The first such announcement which the Arranger make shall not be made without the Company's written consent (not to be unreasonably withheld or delayed), except to the extent required by law, regulation or any applicable stock exchange.

5. OTHER ROLES

- 5.1 The Borrower acknowledges that the Arranger or its affiliates may provide debt financing, equity capital or other services (including financial advisory services) to other companies in respect of which the Borrower or its affiliates may have conflicting interests regarding the transactions contemplated by the Proposed Terms or otherwise.
- 5.2 The Company acknowledges that the Arranger has no obligation to use in connection

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with the transaction contemplated by Proposed Terms, or to furnish to the Company or any of its affiliates, confidential information obtained from any other source.

5.3 The Arranger may delegate any or all of its rights and/or obligations under the Proposed Terms to any of its respective affiliates (each a "**Delegate**") and may designate in writing to the Company any Delegate of it as responsible for the performance of any of its appointed functions under the Proposed Terms.

6. TERMINATION

- Following the Borrower's agreement to the Proposed Terms, the Arranger may give the Borrower notice terminating its obligations under the Proposed Terms if :
- (a) the Facility Agreement is not entered into by [Feb., 2016]; or
- (b) the Borrower fails to pay any fee when due under any Proposed Terms or the Borrower or any of its affiliates otherwise fails to comply with the terms of any Proposed Terms; or
- (c) the Borrower fails to disclose to the Arranger material information which is relevant to its decision to arrange or underwrite all or any part of the Facility.
- The Borrower may terminate this letter with immediate effect by notifying the Arranger in writing at any time.

The provisions of this letter shall terminate on execution of the Facility Agreement.

7 AMENDMENTS

No waiver or amendment of any Proposed Terms shall be effective unless it is in writing and signed by the Borrower and the Arranger.

8. GOVERNING LAW

ICBC 図 中国工商银行

This letter is governed by English Law.

The Proposed Terms replace any previous oral and/or written understanding or agreement in relation to the Facility.

If the Company agrees to the above, please sign, date and return to the Arranger a copy of this letter before [Feb. , 2015].

We very much hope to have the opportunity of working with the Borrower on the Facility. In the interim, please do not hesitate to contact the following persons should there be any query on the Proposed Terms:

Industrial and Commercial Bank of China Limited Ms. Wang Qing

Regional Head Project,Export,Commodity and Shipping Finance Tel: (86) 10 66104203 Fax: (86) 10 66107712 Email: wangqing@icbc.com.cn

For and on behalf of

Industrial and Commercial Bank of China Limited

Shen Min Deputy General Manager Banking Department We agree to the terms set out above. For and on behalf of Huaneng Shandorg Rulf (Parstan) Energy (Private) Limited





HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



TECHNICAL AND FINANCIAL PROPOSAL FOR THE OPERATION, MAINTENANCE, PLANNING AND DEVELOPMENT OF GENERATION FACILITY (SECTION – 13)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TECHNICAL AND FINANCIAL PROPOSALS FOR THE OPERATION, MAINTENANCE, PLANNING AND DEVELOPMENT OF THE GENERATION FACILITY

01. This is not applicable as Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited is newly formed Private Company. The project will be developed in due course of time as detailed in profile China Huaneng Group Corporation is one of the five largest state-owned electric utility enterprises in China, administrated by the State Council of the People's Republic of China, engaged in the investment, construction, operation and management of power generation assets and the production and sale of electricity power. In 2012, the company ranked No. 246 on the Fortune 500 list. 



HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED

2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF THE FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

(SECTION - 14)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants






2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

Principles on Unit Selection

- > Main equipment will be Chinese-made equipment with proven design;
- The main and auxiliary equipment has advanced technology, good quality, high reliability and availability;
- > The unit has high efficiency.

01. The project is a newly built project. At this stage, it is proposed to construct 2×660 MW supercritical units and FGD device, with expansion being considered.

Main equipment and Parameters

Boiler

Mode: To be determined

02. Type: Supercritical pressure, single reheat, single furnace, balanced draft, dry bottom, steel structure, outdoor type, once-through and pulverized coal boiler

Air Pre-heater (APH): Regenerative trisector rotary

Combustion Mode: Opposite firing of front/rear wall or four comers tangential-firing

Boiler Ignition Mode: High-energy igniter light oil pulverized coal

Atomization Mode of Oil Igniter: Mechanical

Steam temp. Regulating mode:

- Superheater: two-stage spray de-superheating
- > Reheater: Flue gas baffle or spray de-superheating
- Minimum load of stable combustion: 35% BMCR





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

Description	Unit	Date	Date
		B-MCR	BRL
Flow of SH steam	t/h	2179	2074.7
Temperature of superheater outlet	°C	571	571
Pressure of superheater outlet	MPa (a)	25.5	25.5
Pressure of RH inlet	MPa (a)	5.722	5.456
Temperature of RH outlet	°C	345.1	342.6
Pressure of RH outle	MPa (a)	5.459	5.206
Temperature of RH outlet	°C	569	569
Flow of RH steam	t/h	1708.322	1628.057
Feedwater temperature of economizer inlet	°C	300	297

Main specification for Boiler (Tentatively)

Steam Turbine

Mode:N660-24.2/566/566 Type:Supercritical, Reheat, 3-Cylinder, 4-Exhaust, Condensing

Main Parameters of Steam Turbine (Tentatively)				
ITEM	UNIT	TMCR		
Mode		N660-24.2/566/566		
Rated power	MW	660		
Rated steam flow before main stop valve	t/h	1979		
Rated steam pressure before main stop valve	MPa	24.2		

f Steam Turbing (Tantativaly) 16 · D - 4 -





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

ITEM	UNIT	TMCR
Rated steam temp, before main stop valve	°C	566
Rated steam flow before reheated steam valve	t/h	1641.2
Rated steam pressure before reheated steam valve	MPa	5.105
Rated steam temp, before reheated steam valve	°C	566
Rated exhaust pressure	kPa	7.2
Rated speed	r/min	3000
Regenerative system		3 HP heaters, 4 LP heaters & 1 deaerator

Generator

03. The generator is directly coupled to the turbine shaft. The generator converts the mechanical energy developed in the turbine to electrical energy.

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

05. The generator rated power factor is 0.85(Lagging). The generator should be capable of providing 0.95 under excited power factor at rated load.

Туре	:	QFSN-660-2
Rated power	:	660MW
Rated voltage	:	22kV
Rated speed	:	3000r/min
Frequency	;	50Hz
Phase	:	3
Pole	:	2
Stator winding connection	:	YY
Connection terminal	:	6
Cooling type Excitation	:	Water-Hydrogen-Hydrogen
Excitation	:	Statistic excitation





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

Main Transformer

06. The rated capacity of main transformer will be selected as per Code for Design of Fossil Fired Power Plant GB 50660-2011. The main transformer will be single-phase oil immersed and double winding transformer, off-load tap changing type, forced-directed oil and forced-air cooling, with one standby single phase transformer for two units.

Main Electrical Wiring Scheme

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

08. 2×660 MW units will be connected into power grid with voltage level at 500 kV. 500 kV switchgear will be built inside the power plant.

09. 2×660 MW units will be connected to the switchgear in the form of generator-transformer unit, and 2×500 kV outgoing lines will be connected into power grid. 500 kV switchgear will have 2 complete bays. One incoming line and one outgoing line constitute 1 complete bay. One start-up/stand-by transformer is designed for 2 units, connects to 500 kV main bus I.

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

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

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

Structural and Architectural

Architectural design

Main Power House

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

Page 4





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

control building.

14. There will be 18 column spaces, each with column distance of 6.0m, 9.0m, 10.0m, 11.0m and 12.00m. One expansion joint, with width of 1.20m, will be set between two units. The total length of main powerhouse will be 169.20m. Turbine house will be designed with span of 28.00m and longitudinal length of 151.2m. The top elevation of crane rails will be 25.40m. The three-floor turbine house will be designed at elevations of $\pm 0.00m$, 6.900m and 13.70m respectively. The operation floor will be at elevation of 13.70m.

15. The four-floor deaerator bay will be designed at elevations of ± 0.00 m, 6.90m, 13.70m and 26.00m respectively. The deaerator bay will be designed with span of 9.00m and longitudinal length of 151.20m. Deaerator will be arranged at 26.00m floor.

16. Four-floor bunker bay will be designed at elevations of ± 0.00 m, 13.70m, 32.00m and 38.60m. The bunker bay will be designed with span of 12.00m and longitudinal length of 157.20m. The elevations of roof are 38.60m and 46.00m. Coal conveyors floor will be arranged at 32.00m floor while transfer station at 38.60 m floor.

17. Boilers will be arranged outdoors, with operation floor at elevation of 13.70m.

Other Main Production Buildings

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

Structural Design

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

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

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

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





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

benefits.

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

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

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

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

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

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

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

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

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





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

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

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

Buildings, Structures and Facilities of CW System

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

34. CW system shall include natural cooling towers, gravity return trench, fore bay, CW pump house and CW pipelines, etc.

Ash Yard

Cofferdam in Offsite Ash Yard

35. A cofferdam will be built around ash yard in the use of materials inside, with height of 3.0m, top elevation of 176.2m, internal and external side slop of 1:2, and top width of 2m. The cofferdam slope will be protected by using dry stone. Drainage channel will be set at cofferdam foot to prevent it from rainwater washing.

Environmental Protection

a) Protection of underground water resources

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

b) Greening





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

37. Green belt, growing with trees in 10m width, will be designed at exterior area of ash yard to reduce windy dust.

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

c) Ash Surface Spraying

39. To ensure the water supply for compaction and rolling, watering car will be used with spraying water taken from power plant. During windy season, ash surface exposed will be sprayed more frequently than usual, if necessary, covered with soil to avoid environmental pollution from fly ash.

Ash Yard Management

40. Ash will be stacked in blocks, minimizing stacking working surface. In order to facilitate comprehensive utilization in the future, fly ash and bottom ash will be stacked separately. When stacking, the ash will be rolled and compacted from bottom to top layer by layer. When ash yard is expected to reach full capacity, the ash surface shall be afforested or converted into cultivated land.

41. To facilitate the management of ash yard in operation period and the storage of machines and tools, a management station, covering an area of 1000 m^2 , which contains four (4) garages and two (2) offices, will be built nearby the ash yard.

42. The mobile equipments will be as followed:

NO.	Name of the Equipments	Quantity
1	Crawler-mounted bulldozer	2
2	Vibration roller	2
3	Small road roller	2
4	Towed scraper	2
5	Multifunction spraying car	2
6	Tool car	2

 Table 5-1 Mobile Equipments for Ash Disposal

Page 8





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

TYPE, TECHNOLOGY, MODEL, TECHNICAL DETAILS AND DESIGN OF FACILITIES PROPOSED TO BE ACQUIRED, CONSTRUCTED, DEVELOPED OR INSTALLED

FGD System

43. The flue gas system mainly consists of original flue gas duct, clean gas duct and gas dampers. The flue gas from the original flue gas duct behind ID fan will be drafted into SO2 absorption tower directly, and then discharged into atmosphere through clean gas duct and chimney. By-pass flue gas duct system is adopted for FGD system of this project. In the event of FGD failure and out of service, boiler can continue operating by by-pass flue gas duct system.





HUANENG SHANDONG RUYI (PAKISTAN) ENERGY (PRIVATE) LIMITED 2 X 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



FEASIBILITY REPORT

(SECTION - 15)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

FEASIBILITY STUDY

01. Feasibility report is attached separately in Section 17.16.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN **APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING** (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



PROSPECTUS

(SECTION - 16)

LEGAL CONSULTANT

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FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

INTRODUCTION OF THE APPLICANT

1. The power supply in Pakistan lags behind its economic development and has sustained tension. In March 2014, government of The Punjab, Pakistan advertised six 2X660MW coal-fired power development projects for invitation for bids. In order to implement the national strategy of "One Belt and One Road" and the vision of the China-Pakistan Economic Corridor, Huaneng Shandong Power Generation Co., Ltd. and Shandong Ruyi Technology Group Co., Ltd. bid for the projects as a consortium.

2. On May 16, 2014, Huaneng Shandong Power Generation Co., Ltd. and its subsidiary in Hong Kong and Shandong Ruyi Technology Group Co., Ltd. and its subsidiary in Hong Kong signed the agreement on the establishment of a joint venture for investment in power projects in Pakistan. On May 21, 2014, after submitting the performance guarantee and the application for the establishment of the project company, the consortium was granted the Letter of Intention (LOI) by the Government of Pakistan and thus officially obtained the right of development of Sahiwal 2 X 660MW Coal-fired Power Project. On May 22, 2014, Huaneng Shandong Ruyi (HK) Energy Limited was incorporated, with Huaneng Shandong Power Generation Co., Ltd. and Ruyi Group holding 50% of the shares respectively. On May 28, 2014, Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited was incorporated as a wholly owned subsidiary of Huaneng Shandong Ruyi (HK) Energy Limited. On July 23, 2014, the top management of the Project was in place.

PROJECT LOCATION

3. The site of Power Plant is located about 15km northeast to Sahiwal, Punjab province, Pakistan. (30°43'10"north latitude, 73°14'30"east longitude of Greenwich).

MILESTONES ACHIEVED TO DATE

Groundbreaking Ceremony

4. Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited, after its establishment, increased the efforts of coordination and made rapid progress. On May





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

30 2014, the groundbreaking ceremony was held at the project site near Sahiwal, with Mr. Nawaz Sharif, Prime Minister of Pakistan, and Mr. Shahbaz Sharif, Chief Minister of Punjab Province, personally attending the activity.

Approval of Feasibility Study by Punjab Power Development Board (PPDB)

5. In September and November, 2014, feasibility study report was approved after the assessment made by the experts of Electric Power Planning & Engineering Institute (EPPEI) and the experts organized by the Government of Punjab.

Land Acquisition

6. Government of The Punjab acquired the land for the Project and paid 10% of the land price as an advance and issued the letter of support for land use.

Approval of Environmental Impact Analysis Report (EIA) by Environment Protection Department, Punjab

7. The EIA report was approved with comments.

Appointment of EPC Contractor

8. On November 21, 2014, the EPC Contractor SEPCI I was selected through bidding. On January 30, 2015, the notice of invitation for bids for boilers, turbines and generators was published.

Commencement of Civil Works

9. On February 6, 2015, foundation soil replacement and pile foundation tests commenced.

Commitment from Sinosure and ICBC Expression of Interest

10. Sinosure has committed to reduce the premium rate from 9% to 7%, increasing the business insurance coverage for overseas projects from 50% to 65%. ICBC has





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

provided a letter of intent for loan financing and a preliminary financing scheme.

SALIENT FEATURES OF THE PROJECT

Scale of the Project

11. Planned project capacity is 2×660 MW+ 2×1000 MW. In this phase, 2×660 MW supercritical coal-fired units will be built. First and second units are planned to be put into operation on December 31 2017 and June 30 2018 respectively.

Construction Conditions and Principles

12. The following construction conditions are established as per requirements of IPP project and the sponsors on the basis of full investigation and analysis.

Plant site

13. The project site is about 15km away in northeast of Sahiwal city of Punjab province. Available land on the site consists of two parts, the government land of about 240 hectares and private land of about 450 hectares.

Coal Source and coal Transportation

14. Coal will be procured from Indonesia and South Africa. Annual coal consumption of the project is 448×104t. Coal will be shipped from Indonesia and South Africa to Karachi Port and Port Bin Qasim. After unloading on port, coal will be transported to project site through Railways. Total rail transport mileage is 1,100km approx. A railway siding, to be built specially for the purpose, will link Sahiwal's Yusaf wala station to the coal unloading area within the plant boundary. Total length of the siding is 8km approximately.

Water source

15. Annual water demand of the project: 20,340,000m3 from LBDC Canal which is





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

about 600m away to south of the site. Groundwater is supplementary and alternate source of water.

Site

16. The site is located in a relatively stable area suitable for building of large-scale projects.

17. Basic seismic intensity of the district is 7. Foundation treatment will be necessary for the site. Pile foundation will be used for main power building, chimney, boiler, turbine foundation and other important buildings (structures) of the plant.

Equipment Selection

18. Chinese made 660MW supercritical coal-fired condensing power generation units shall be used.

Inter-Connection system

19. In this project, 2×660 W class units will be connected to the new 500kV substation of the plant via double-coil step-up main transformer. Number of 500kV circuits will be 2. 500kV Lahore-Sahiwal line will be available for the connection.

Ash handling and Ash yard

20. Dry pneumatic ash handling and mechanical slag handling will be used; special vehicles will be used to transport the ash and slag to ash yard for compaction and piling.

Thermal system

21. Except auxiliary steam system which uses common header system, all other systems shall use unit system.





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

FGD Facilities

22. FGD facilities will be built together with the power generation units.

I&C

23. This project uses centralized control of boiler, mechanical equipment, electrical equipment, grid and auxiliary equipment. One centralized control room shall be set for two units. Boiler, turbine and I&C devices are arranged in a decentralized way. Main plant control uses Decentralized Control System (DCS), and auxiliary plant uses PLC control.

PLANNED INVESTMENT

24. According to the technical program for the Project, the estimate of the total investment is 11,209,650,000 RMB yuan (1.808 billion USD), with a dynamic investment of 11,050,140,000 RMB yuan (1.782 billion USD), a unit dynamic investment of 8371 RMB yuan/kWh (about 1,350USD/kW), an initial working capital of 159,510,000 RMB yuan, total interests of 728,930,000 RMB yuan for the construction period, a static investment of 10,046,980,000 RMB yuan, and a unit static investment of7611 RMB yuan/kW.

SOCIAL AND ENVIRONMENTAL IMPACTS

Social Impacts:

25. The Project can effectively alleviate the power shortage in Pakistan and promote the local economic development. The total installed capacity is 23,718MW in Pakistan, with an annual growth in electricity demand of about 6.23%. The peak power shortage is up to 6000MW. The power shortage is very prominent and power rationing is often. The Project near Sahiwal will generate 800GWh each year and can effectively alleviate the power shortage in Pakistan and promote local economic development.

Environmental Impacts





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

26. The EIA report has been approved by the environmental protection department. The Project is designed tentatively with the FGD systems provided and installed according to the limestone - gypsum wet FGD technology. The FGD systems are tentatively with an efficiency of not lower than 80%, with the expected SO2 emissions much lower than the Pakistani standard limit of 1700 mg/Nm3 and thus meeting the requirements of the EIA approval. The Project is designed tentatively with the systems and spaces reserved for the installation of DeNOx systems.

27. Five-field dry electrostatic precipitators are tentatively designed for the Project, with dust removal efficiency of not lower than 99.7%. In case of firing the design coal, the expected dust emissions will be 49.15 mg/Nm3, which is much lower than the Pakistani standard limit of 500 mg/Nm3 and can also meet the requirement of the EIA approval for 50 mg/Nm3.

28. The ash, pyrite and FGD gypsum produced by the Project total to about 427,000 tons/year. The ash is removed in a dry mode to a yard with an area of about 30.4 hectares outside the power plant, and the area can meet the storage requirement of ash, pyrite and FGD gypsum for about 5.1 years. Currently, the ash storage yard is tentatively designed to be surrounded with a 10m wide green belt. Water spray is required periodically on the ash stored in the yard. When heaped to the design elevation, the ash shall be covered with soil for agriculture. The future ash storage yard is in the west of the power plant and included in the acquired land this time, and can meet the storage requirement of ash, pyrite and FGD gypsum for about 22 years.

29. The wastewater produced in the power plant mainly includes domestic sewage effluent, oil-polluted water, coal handling system flush water drainage, FGD wastewater, chemical wastewater, circulating sewage water. The wastewater produced by the Project will be treated on the principle of "separation between clean water and dirty water", "treatment according to types" and "discharge to standard". Priority shall be given to the re-use of the treated wastewater. The remaining treated wastewater may be discharged to the outside when its temperature and quality meet the relevant requirements of the NEQS standards.





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROSPECTUS

30. Coal Dust Pollution Prevention and Control: An anti-wind and dust-suppression net is provided around the coal storage yard. Sprinklers are provided to spray water onto the coal pile periodically to maintain the moist of the coal pile surface and effectively reduce coal dust spreading. Water flush facilities are provided for each transfer station, silo bay and conveyor trestle, and the treated wastewater shall be re-used. The coal storage yard ground is hardened, and sedimentation ponds are arranged to collect water. The treated wastewater shall be re-used after separation from coal, to reduce the impact on the groundwater around the power plant.

31. As to the noise protection measures for thermal power plants, the requirements for noise control shall be first brought forth during invitation for bids for equipment on the principle of source control, and then other comprehensive measures are taken to insulate, eliminate, absorb and damp noise and reduce vibration according to the characteristics and transmission of noise sources. With the mentioned noise control measures, the noise contribution, according to the preliminary forecast, can meet the requirements of Pakistani noise standards.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN **APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING** (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



SCHEDULE III

(SECTION - 17)

LEGAL CONSULTANT

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FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



LOCATION (LOCATION MAPS, SITE MAP), LAND

(SECTION 17.1)

LEGAL CONSULTANT HAIDERMOTABNR

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2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - LOCATION AND LAND

SITE LOCATION

The site of Power Plant is located about 15km northeast to Sahiwal, Punjab province, Pakistan. (30°43'10"north latitude,73°14'30"east longitude of Greenwich).

LOWER BARI DOAB CANAL (LBDC) is adjacent, to southeast of the site. The further southeast is the railway from Karachi to Lahore and National Highway-N5. Yusaf wala railway station is 4km southwest to the site.







2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – LOCATION AND LAND







2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – LOCATION AND LAND

SITE MAP



LAND

The land can be used for power plant is private owned land. The land owned by private department is about 450 ha (inside yellow line).

The project area comprises fertile agricultural lands, which is irrigated by 5R Yousafwala Distributary taking off from LBDC. LBDC runs from east to west about 600m south to the site. The Landform of the site is shown in Figure 3-1, 3-2.

The topography of site is flat. The average height above sea level is about 173.2m. Most of the site is farmland, and a small part is used for husbandry.





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - LOCATION AND LAND







2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



TECHNOLOGY, SIZE OF THE PLANT, NUMBER OF UNITS (Section 17.2)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – TECHNOLOGY, SIZE OF THE PLANT, NUMBER OF UNITS

Technology Selection and Design Standards

Technology Selection

Supercritical and Subcritical Technology

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

02. The efficiency of supercritical units is higher than that of the subcritical units. The heat rate of the subcritical units with the primary pressure of 173.8 bars is 2% lower than that of the supercritical units with the primary pressure of 242 bar.

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

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

FGD

05. Flue gas desulfurization (FGD): FGD shall be built together with the power generation units, and the limestone-gypsum wet FGD processing is adopted.




2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – TECHNOLOGY, SIZE OF THE PLANT, NUMBER OF UNITS

06. Limestone-gypsum wet FGD will be adopted in this project. The efficiency shall be not less than 90%.

Main Design Principles

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

2) Units: 2x660MW supercritical coal-fired wet cooling units; supercritical PC boilers

with condensing steam turbine generators;

Design Codes and Standards

Technical Code for Designing Fossil Fuel Power Plant (**GB 50660-2011**) Technical Code for General Plan Transportation Design of Fossil Fuel Power Plant (DL 5032-2005) Technical Code for Design of Civil Structure of Fossil-fired Power Plant (DL 5022-2012) Technical Code for Design of Waste Water Treatment of Fossil Fuel Power Plant (DL/T 5046-2006) Code for Hydraulic Design of Fossil Fuel Power Plant (DL/T 5339-2006)

POWER PLANT SCALE

07. The project is a 2 x 660MW power plant and shall be completed in one phase, and the next phase there will be built 2×1000 MW power plant.

Unit Capacity

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

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





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - TECHNOLOGY, SIZE OF THE PLANT, NUMBER OF UNITS

Primary Technical and Economic Data

Plant land occupation	: 51.06 lhm^2
Gross Power plant efficiency	: 42.11%
Rate of standard coal consumption for power generation (Gross)	: 291.65g/kW.h
Auxiliary power rate	: 5.1%
Number of staff of power plant	: 450
Annual power generating capacity	: 8976GWh





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



FUEL: TYPE, IMPORTED/INDIGENOUS, SUPPLIER, LOGISTICS, PIPELINE ETC (Section 17.3)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

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2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

FUEL

01. The coal consumption of two boilers will be $4.48 \times 106t/a$, coal sources for the power plant will be Indonesian and South Africa.

INDONESIA

02. Indonesia's major coal-producing areas are in Kalimantan Island. Indonesia is currently the world's No.1 steam coal exporting country. Indonesia's major coal companies: Banpu Group, KPC Mine, KIDECO Company, etc.

➢ Banpu Group:

03. Banpu Group has four wholly-owned coal mines in Indonesia, namely Indominco Mine, Jorong Mine, Trubaindo Mine and Kitadin Mine.

 \succ KPC Mine

04. KPC Mine is Indonesia's largest coal mine. It has special wharf with draft of 17.5m available for CAPE type vessels docking. KPC Mine covers an area of 900 km2.

KIDECO Company

05. KIDECO Company's main coal producing areas are in East Kalimantan, covering an area of 50,921 hectares, reserves: 1.442 billion tons, recoverable reserves: 651 million tons. KIDECO Company's coals are mainly sold to Asia, including Indonesia's consumption of about 30%, and the rest are exported to other countries.

SOUTH AFRICA

06. South Africa is the African continent's largest steam coal exporter. Currently, its volume of exports is 65 million tons, and more than 90 percent of the coal exported is used as steam coal.

07. Currently there are 52 coal mines in South Africa. Compared with other African countries, South Africa has good rail and port infrastructures. South Africa ranks No.6 in





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

anthracite reserves and also No.6 in coal production capacity in the world. Richards Bay, South Africa is the world's largest single coal export port, while South Africa is also the No.5 coal exporter in the world. South Africa has abundant coal reserves, accounting for about 7% of global coal reserves. These reserves are expected to support a continuous development of 30-50 years, while the application of clean coal technology can extend the useful life of these coal reserves.

08.	The analysis of raw coal and ash is	s shown in the follow	wing tabl	e .
	Item	Symbols	Unit	Design coal

Item	Symbols	Unit	Design coal	Check coal
Total moisture(on as received basis)	M _t	%	18.2	25.1
Inherent moisture (on air dried basis)	M _{ad}	%	11.53	10.04
Ash(on as received basis)	A _{ar}	%	8.15	9.28
Volatile matter(on dry ash-free basis)	V_{daf}	%	44.69	41.72
Carbon(on as received basis)	C _{ar}	%	55.14	49.90
Hydrogen(on as receiced basis)	H _{ar}	%	3.40	3.05
Nitrogen(on as reveived basis)	N _{ar}	%	0.92	0.88
Oxygen(on as received basis)	O _{ar}	%	13.79	11.45
Total sulfur(on as received basis)	S _{t,ar}	%	0.40	0.34
High heating value(on as received basis)	Q _{gr,v,ar}	MJ/kg	21.32	19.29
Low heating value(on as received basis)	Qnet, v, ar	MJ/kg	20.20	18.08
Hardgrove grindability	HGI	/	52	51
Impingement abrasion index	Ke	1	1.4	1.2
Ash fusion temperature/Deformation temperature	DT	×10 ³ °C	1.14	1.18
Ash fusion temperature/Softening temperature	ST	×10 ³ °C	1.17	1.21
Ash fusion temperature/Hemispherical temperature	HT	×10 ³ °C	1.19	1.22
Ash fusion temperature/Flow temperature	FT	×10 ³ °C	1.21	1.24

Page 2





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Item	Symbols	Unit	Design coal	Check coal
Silicon dioxide	SiO ₂	%	44.99	46.70
Aluminum trioxide	Al ₂ O ₃	%	19.11	24.10
Ferric trioxide	Fe ₂ O ₃	%	13.24	10.01
Calcium oxide	CaO	%	11.55	9.69
Magnesium oxide	MgO	%	1.20	1.07
Sodium oxide	Na ₂ O	%	0.42	0.39
Kalium oxide	K ₂ O	%	0.87	0.90
Titanium oxide	TiO ₂	%	0.52	0.64
Sulfur trioxide	SO ₃	%	7.45	5.75
Manganese oxide	MnO ₂	%	0.020	0.020
Chlorine in coal	Cl _{ar}	%	0.018	0.014
Free silicon dioxide in coal	SiO ₂ (F)	%	0.71	0.67
Fluorine in coal	F _{ar}	µg/g	79	64
Mercury in coal	Hg _{ar}	µg/g	0.17	0.13





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

	Specific resistance of ash					
Item	Symbols	Testing voltage (V)	Testing temperature (°C)	Specific resistance $(\Omega \cdot cm)$		
			Atmospheric temperature	4.10×10 ¹⁰		
			80	6.50×10 ¹¹		
Design Cool		500	100	2.00×10 ¹²		
Design Coal	РСА	500	120	2.20×10 ¹²		
			150	4.10×10 ¹¹		
			180	6.50×10 ¹⁰		
			Atmospheric temperature	1.80×10 ¹⁰		
			80	1.90×10 ¹¹		
Check Coal	ρςα	500	100	1.10×10 ¹²		
CHECK COAL			120	1.90×10 ¹²		
			150	3.90×10 ¹¹		
			180	6.30×10 ¹⁰		

Mode of coal transportation

09. Coal will be shipped to Karachi Port or Qasim Port by sea from oversea suppliers and transported to Yusaf Wala station in Sahiwal by Pakistan Railway, and then transported to the power plant by special railway line. More detail see refer to annex 1 section 3.4 Coal transportation

10. Coal will be shipped to Karachi Port or Qasim Port by sea from oversea suppliers and transported to Yusaf Wala station in Sahiwal by Pakistan Railway, and then transported to the power plant by special railway line.





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Conditions of transportation channels

Sea transportation

11. Coals will be shipped by the overseas suppliers (from Indonesia and South Africa) using dry bulk carrier.



Ship

12. Bulk carrier is generally classified by deadweight tonnage(dwt) into 4 size categories: Handysizer, handymax, Panamax, and Capesize. Bulk carriers of less than 35,000 dwt constitute the Handysize vessel category. Vessels with capacities ranging from 35,000 dwt to 60,000 dwt comprise the Handymax class. Bulk carriers in the





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

 $60,000t \sim 80,000$ dwt size class are termed Panamax vessels, which is the largest bulk carriers that can pass through the Panama Canal. The Ocean-going vessels extending 80,000 dwt fall into the Capesize class.

Classification of bulk carriers according to size is summarized in the following table:

				WORLD BULK AS (CARRER FLEI JF JANUARY 1,	ET (1) PROFILE 2013				
	¥	VERAGE DINE	NSIONS, SPEED			IN SERVICE			ON ORDER	
	LENGTH (Feel)	BEAN (Foot)	DRAFT (Feet)	SPEED (Knots)	Sdihs	DWT (000s)	Average DWT	SHIPS	DWT (000s)	Average DWT
				Handy	Size (10,000-29,	(Julo 884				
10,000-19,999	463.6	11.2	28.9	13.6	\$13	7,894	15,388	19	235	12,368
20,000-29,999	523	8,4	31.5	13.8	1,184	31,047	na	58	1,519	
				Handyn	nar (35,000-59,1	(1mp 66)				
30,000-39,999	599.8	92.2	34.1	14.1	0401	46,422	3,443	315	11,175	35,474
40,000-49,999	625.0	101.4	37.4	14.3	36 5	40,509	45.211	111	5,128	46,194
666765-000705	628.0	106.0	40.7	14.3	1,786	915,96	55,385	303	16,928	55,869
				Panan	19,000,00) xer	(IMD 88				
665'62-000'09	6181	106.3	41.3	14.2	1,490	108.360	72,725	304	21,616	71,104
				Capt SI	iza (80,000 dwt ;	ind over)				
665'66 - 000'08	757.6	117.5	46.6	14.3	176	67,145	88.527	356	30,024	84.338
100,000-119,000	833.0	142.4	47.6	14.3	90	11,963	112,262	ß	3,625	109.843
120.000-159,999	892.1	142.4	55.8	13.9	137	20.283	148,050		130	120,000
160.000 & over	971.2	154.2	29.7	14.6	1262	246,628	195,426	211	45,844	217,269
TOTALS	678.8	107.6	41.0	112	067'5	679,169	71,567	1,711	136,214	79.610
(*) Excludes vess	els confined to the Gr	teal Lakes					Source	r. Clarkson Rese	earch. The Bulk Ca	nier Register 2013.

Classification of Bulk Carriers according to Size





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Port in Coal Source Place

13. Coals from the South Africa can be loaded into the Capesize bulk carrier in Richards Bay. Coals from Indonesia can be loaded into the Capesize bulk carrier by using the offshore cranes or floating loading facilities. The coal port in Balikpapan can accommodate the Capesize bulk carrier. KPC can accommodate the Capesize bulk carrier. International bulk terminal (IBT, Adaro) can only accommodate the Panamax bulk carrier, but Adaro terminal can accommodate the Capesize bulk carrier through the offshore cranes.

Traveling Distance and Transportation Frequency

14. According to the annual consumption of the power plant, 4 ships will arrive at the port each month if the Capesize bulk carrier is used for transportation; 9 ships will arrive at the port each month if the Panamax bulk carrier is used. It will only need 11 days if starting from the Richards Bay of the South Africa; and it will need about 12 days if starting from Balikpapan of Indonesia.

15. From the above, the sea transportation capacity is guaranteed in accordance with the experience and current situation of the international trade and logistics for coals, but there is a risk of freight fluctuation. Currently, the freight by sea has been decreasing for years.

Port

16. The ports connecting with the Karachi \sim Lahore national railway in the south of Pakistan include the Karachi Port and Qasim Port; their channel depth is about 30m, and the port apron has sufficient water depth. Currently, transportation of imported coals in these two ports most vessels are self-unloading, and it need about 2 days to unload 45,000t coals by using self-equipped unloading equipment; At present, berth for coal is not provided with fixed mechanical unloading equipment, and mobile unloading equipment is usually used for coal bulk carrier. It needs about 4-5 days to unload the coals of a 45,000t vessel.





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Karachi Port

17. Karachi Port is the largest port in Pakistan, and the water depth alongside the port is 16m; it can accommodate vessels of 100,000t and above. There are 30 berths for coal, cement, petroleum, chemicals, containers, etc, in the port currently. Among them, four 60,000t coal berths have a throughput capacity of $7,000,000t \sim 8,000,000t$, and the annual actual coal throughput is about 4,000,000t. Karachi Port currently has about 18 ha of storage yard, and the storage yard area will be increased by 6 ha through reclaiming land from sea. At present, three 55000 dwt coal vessels can be unloaded at same time in Karachi Port.

18. In accordance with the development plan of Karachi Port, it is planned to reconstruct the existing 3 berths (No. 15, No. 16 and No. 17) to specialized coal unloading berths. After reconstruction, the specialized coal ports have a throughput capacity of 8,000,000t, and the unloading equipment in port will use the bridge grab ship unloader with an output of 1200t/h. It is planned to be completed and put into operation in 2016, and currently financing is in progress.





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.



Plane and Planning Diagram for the Karachi Port

- 19. The current capacity of Karachi Port is as follows:
 - Coal loading & unloading capacity 8,000,000t/a
 - Current loading & unloading of coals 4,000,000t/a
 - Storage yard 180,000m2
 - Increased storage yard (being reclaiming land from sea) 60,000m2
 - ✤ Available storage capacity 700,000t
 - Handling capacity of current Karachi Port 55,000t coal carrier (3 carriers can be handled at the same time)





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Qasim Port

20. Qasim Port, which is located about 20km in the east of the Karachi Port, is the second largest port of Pakistan; the port apron has a water depth of 10.5m, and it can accommodate 45, 000t ships; there are 7 berths currently in the port for coal, cement, petroleum, chemicals, containers, etc. Among them, the annual actual coal throughput of three 45,000t coal berths is about 2,500,000t, while the capacity is $4,000,000 \sim 5,000,000$. Qasim Port currently has about 4 ha of storage yard.

21. In accordance with the development plan of Qasim Port, PIBT (Pakistan International Bulk Terminal Co., Ltd) is constructing two 45,000t specialized coal unloading berths in the Qasim Port in BOT mode, and each berth has a throughput capacity of 8,000,000t. These berths will be completed and put into service in June 2016 according to the plan. In addition, one 75,000t specialized coal unloading port is proposed in the Qasim Port in BOT mode, and it will have a throughput capacity of 12,000,000~16,000,000t. It will be completed and put into service in 2017 according to the plan, and currently this project is in the funding phase.



PORT QASIM - LAYOUT PLAN

Plane and Planning Diagram for the Qasim Port





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

Current Capacity of Qasim Port

- Maximum handling capacity of 2-4 berths 5,000,000t/a draught 10.5m
- Loaded and unloaded coals since 2001 66 ships, 2,500,000t, largest ship 45,500t (a small amount loaded and unloaded coals since 2010)
- Storage yard 53 acre (currently, 10 acres are used for coal storage each acre can store 20,000t coals)
- Coal unloading facilities 4-5 days will be required if using the coal unloading bucket wheel machine/mobile cargo unloading facility

22. From the above, the existing berths as well as the conditions of coal unloading facilities, coal transfer and railway loading, etc cannot meet the transportation demands of coals required by this project. In order to meet the requirement of planning coal-fired plant in Pakistan, corresponding updating plan is made for the 2 ports, and the existing ports will be reconstructed to specialized coal port or 100,000t specialized coal ports will be constructed in coming years. The port loading and unloading equipment will use the bridge grab ship unloader with an output of 1200 t/h. After implementation of the plan, 6,000,000t coals can be conveyed to this project each year.

23. The sponsor has signed MOM about coal handling and unloading with the port management. Further agreement with more details about the reconstruction of coal berths, provision of additional coal conveying belt and railway loading facilities, etc should be signed with port management, port BOT operator and Pakistan Railways.

Railway

24. The railway from Karachi Port to Yusalf Wala railway station in Sahiwal is a double-line railway, with a total length of about 1100km, track gauge of 1676mm, 54kg/m steel rail, diesel locomotive traction, traction tonnage of 3200t~3500t, 40 marshaling sections of train (each section has a dead weight of about 20t and load of 60t) and effective length of 700m. The designed through capacity of this railway is 90 pairs/day, the current volume is 40 pairs/day and there is still a surplus capacity of 50 pairs/day. 50% section rail lines of the whole railway can meet the designed capacity. Currently, PAKISTAN RAILWAYS is making invitation for bid for the reconstruction project of section rail lines of the railway from Karachi Port to YUSAF WALA railway





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – FUEL TYPE, IMPORTED /INDEGENOUS, SUPPLIER, LOGISTICS, PIPELINES ETC.

station of Sahiwal, and the reconstruction will be started at the end of this year according to the plan. The railway after reconstruction can meet the coal transportation demand of 6-7 pairs/day of the power plant. PAKISTAN RAILWAYS has issued a commitment letter for transportation of the plant.

25. Yusaf Wala railway station in Sahiwal currently has 2 main tracks, 2 arrival-departure tracks and 1 goods line. In accordance with the site investigation, 1 arrival-departure track close to the station building is not put into service. The special railway line of power plant proposes to connect with the northeast throat of Yusaf Wala railway station. About 22km power plant special railway line will be constructed from the Yusaf Wala railway station to the power plant. A bridge with a span of 30m shall be constructed at the location crossing over the LBDC canal; single-slot coal unloading chute shall be arranged in the power plant to meet the coal unloading demands of half of a train (20 sections); the railway is the passing through type.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



EMISSION VALUES (SECTION 17.4)

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2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – EMISSION VALUES

Prevention & Control of Air Pollution

SO2 emissions will be minimized by use of WFGD with SO₂ removal efficiency of 80.0%.

Emissions of particulate matter will be minimized by use of electrostatic precipitator with dust removal efficiency of 99.70%.

According to EIA report, NOx emissions will be minimized by use of low NOx burners. A space will be reserved for SCR system in each boiler.

• According to EIA report, Flue gas from the boilers is emitted by one stack with preliminary height of 180m.

* The continuous emission monitoring system (CEMS) with SO₂, PM, HC, CO, NOx and mercury will be used to monitor the flue gas emission.

↔ Mercury emissions will be minimized by use of Electrostatic Precipitators (ESP) and Flue Gas Desulphurization (FGD) with mercury removal efficiency of 70%.

✤ Air pollutant emission are shown as under:

	AIR POLLUTANT EMISSION				
	Pollutant	Linit	coal rank		
	Tonutant	Omt	Design Coal	Check coal	
	Emission Concentration	mg/Nm ³	194.38	181.72	
	Pakistan standard <neqs></neqs>	mg/Nm ³	1700		
SO ₂	Pakistan standard <neqs> 1-Year Average Ground Level Increment to Ambient</neqs>	µg/Nm³	5	0	
	Discharge Amount	kg/h	842.62	800.22	
		t/d	18.54	17.60	
	Pakistan standard <neqs></neqs>	TPD	50)0	
	Emission Concentration	ma/NIm ³	31.69	39.22	
Smoke	Pakistan standard <neqs></neqs>	mg/mm	500		
	Discharge Amount	kg/h	137.40	172.72	
	Emission Concentration	mg/Nm ³	300.0	300.0	
	Pakistan standard <neqs></neqs>	mg/Nm ³	1200		
NO _X	Pakistan standard <neqs> Annual arithmetic mean of ambient air concentrations of nitrogen oxides (expressed as NO₂) should not exceed</neqs>	µg/Nm³	100		
	Discharge Amount	kg/h	1300.46	1321.04	

Page 1





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - EMISSION VALUES

	AIR POLLUTANT E	EMISSION		
		Unit	coal rank	
	Pollutant	Unit	Design Coal	Check coal
	Actual emission concentration		<10	<10
mercury	Acceptable emission concentration		1	0

Note: NO_X emission concentration on boiler exit is 300mg/Nm^3 .





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



COOLING WATER SOURCE (SECTION 17.5)

LEGAL CONSULTANT HAIDERMOTABNR

FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – COOLING WATER SOURCE, TUBE WELL, CANAL, DISTANCE FROM SOURCE

WATER SOURCE

The water consumption of the power plant is 2991m³/h, the yearly water consumption is 2034x104m3. The water source of this project is Lower Bari Doab Canal (LBDC) in the southeast of the power plant which will have one month shut down at January. Groundwater and raw water reservoir will be supplied to satisfy the power plant water consumption during the canal shut down period. The probability of water supply is 97%.

The landscape of LBDC





LBDC Canal landscape plan

Lower Bari Doab Canal (LBDC) running in the immediate vicinity of the proposed site is the





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – COOLING WATER SOURCE, TUBE WELL, CANAL, DISTANCE FROM SOURCE

major source of water for cooling and consumptive use. Irrigation Department of Punjab is the controlling authority for running and maintenance of the entire irrigation network. Design discharge of the LBDC is 244m3/s and the sanctioned discharge of LBDC is 190m3/s; however, it actually operates at less discharge. Near the site, the design bed width is 59.4m and bed level is 172.5m .As per data provided by the Irrigation Department, actual deliveries by the canal, during last 30 years, are as follows:

- ➢ Highest discharge 147.2 m3/s
- > Average discharge 121.8 m3/s
- ➢ Lowest ever 67.1m3/s

DISTANCE FROM CANAL

Annual water demand of the project: 20,340,000m3 from LBDC Canal about 600m away to south of the site, and groundwater sources are supplementary and alternate water.

Groundwater

According to the verification report of water source, the quaternary aquifer is mainly composed of unconsolidated sand, silt, silty clay. Furthermore, the maximum thickness of the aquifer is up to 300m within Bari Doab region.

Within Sahiwal and Okara area, groundwater is widely used for drinking, industry, agricultural irrigation and other areas. In addition, groundwater is the only source of living water, and there are no local laws that restrict the extraction of groundwater.

The current groundwater extraction depth is about 12m. According to historical data, the lowering speed of groundwater level is 0.3m/year.

According to the verification report of water source, the recommended values of permeability coefficient range between 16 and 50m/day, and the average value is 35m/day. The drilling of eight deep wells with flow of about 2.5 cubic feet per second within the plant area can meet half of the requirements of power plant for the water flow of 29.33 cubic feet per second (the other half of power plant water has to be taken from the surface water in a 1 million m3 reservoir). Two wells serve as standby wells, and one month of water flow is taken in every year. Groundwater can gradually return to normal levels.





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - COOLING WATER SOURCE, TUBE WELL, CANAL, DISTANCE FROM SOURCE

In order to avoid the adverse effect of saltwater intrusion that affects groundwater water quality, it is required to reasonably control the annual total extraction of groundwater and continuous extraction time.

Conclusion and Suggestions

The max water consumption of the power plant is 2991m3/h, the yearly water consumption is $2034 \times 104m3$.

The irrigation authorities sound agreeable on this arrangement verbally. A written consent has yet to be arranged but the canal is normally closed during the month of January for the purpose of cleaning and maintenance. During this period requirement of makeup water would be about 0.83 m3/s, which is requirement to be arranged by developing ground water resource underlying the project area or by constructing the regulating reservoir. Guarantee rate of water supply is 97%.

At the same time, it is suggested that the yearly maximum, minimum flow, the highest and lowest water level of LBDC canal and Ravi river including relief map cross vertical and horizontal section of river channel should be collected for detailed argument.

Hydrometeorology

The proposed project site is situated at a distance of 18 km east of Sahiwal city, Punjab, Pakistan. The project area is a part of the Indus Basin, which was formed by Indus River and its tributaries i.e. Jhelum, Chenab, Ravi and Sutlej. The project area falls in the Bari Doab, which is bounded by Ravi River on the north and Sutlej River on the south. Ravi River is located towards north of the project area at a distance of about 18 km and flows in south-western direction.

The project area comprises fertile agricultural lands, which is irrigated by 5R Yousafwala Distributary taking off from LBDC. LBDC runs from east to west about 600m south to the site. The Landform of the site is shown in Figure 4.6.1-1.

The site area is flat, and the elevation is about 173.2m (MSL).Considering Ravi river affluent Sluggish flood, the rivers characteristics, and terrain factors, the preliminary conclusion is





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – COOLING WATER SOURCE, TUBE WELL, CANAL, DISTANCE FROM SOURCE

that the flood level of site which return period is 100-year is 174.4m, the depth of submerge is 1.2m.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



INTERCONNECTION WITH NATIONAL GRID COMPANY (Section 17.6)

LEGAL CONSULTANT HAIDERMOTABNR

FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

INTERCONNECTION WITH NATIONAL GRID COMPANY, DISTANCE AND NAME OF NEAREST GRID, VOLTAGE LEVEL (SINGLE LINE DIAGRAM)

INTERCONNECTION SCHEME

1. The location of Sahiwal power plant is just near the existing Sahiwal (Yousafwala) – Lahore 500 kV single circuit line, about 9.5 km on the line route from Sahiwal substation. The following interconnection scheme has been proposed for 1320 MW Sahiwal CFPP keeping in view its generation capacity, its location and the existing/planned system network in the vicinity

- 2. Proposed Interconnection Scheme
 - A 500 kV D/C transmission line, approx. 0.5 km long on Drake conductor, for looping In/Out of proposed Sahiwal (Yousafwala) Lahore South S/C transmission line at Sahiwal CFPP.
 - Addition of 1x600 MVA, 500/220 kV Transformer at 500 kV Sahiwal (Yousafwala) substation.

For details, please refer to Grid Interconnection Study carried out by NTDC.

3. The power plant will be interconnected to the National Grid with two outgoing 500kV lines. The interconnection scheme has been approved by NTDC that to break the 500kV line between Lahore and Sahiwal, the broken points connect with the outgoing lines respectively. It is needed to build new lines 2×0.5 km. The conductor type is 4×400 mm², the maximum transmission capacity is about 2760MVA (25 °C). The interconnection scheme is shown in Figure #1.





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

INTERCONNECTION WITH NATIONAL GRID COMPANY, DISTANCE AND NAME OF NEAREST GRID, VOLTAGE LEVEL (SINGLE LINE DIAGRAM)



National Transmission and Despatch Company Limited (NTDCL)

I

I



Interconnection Study for Dispersal of Power from 1320 MW Coal-fired Power Plant at Sahiwal

(Report-1)

Planning (Power) Department 5th Floor, PIA Tower, Egerton Road, Lahore.

January 2014

Table of Contents

	Page No.
Executive Summary	i
1. Introduction	1
2. Proposed Interconnection Scheme	2
3. Study Assumptions and Criterion	3
3.1 Study Assumptions	3
3.2 Study Criterion	4
4. Load Flow Analysis	5
4.1 Peak Load January 2017	5
4.2 Off-peak Load January 2017	8
4.3 Peak Load Aug/Sep 2017	11
4.4 Comments on Proposed Interconnection Scheme	13
5. Conclusions	14
Figure #1: Geographical Diagram of Proposed Interconnection Schem	1e 15

Appendix-1: Load Flow Study Exhibits (30-pages)

Executive Summary

- Government of Punjab is planning to set up two coal-fired power plants, each of 660 MW capacity at Sahiwal with the expected CoD in December 2016. M/s SEPCOIII, China has been assigned the task of completing overall feasibility of the project. In this regard, Government of Punjab has approached Planning Power NTDC to carry out interconnection studies of the said power plant, located just near the existing 500 kV Sahiwal (Yousafwala) – Lahore 500 kV transmission line. M/s SEPCOIII has provided design data of 2x660 MW power plant at Sahiwal for the interconnection study.
- 2. This is Interconnection Study Report-1 in which the results of load flow studies have been presented for the connectivity of 1320 MW (2x660 MW) Sahiwal power plant with the National Grid. The load flow analysis has been carried out for various operating scenarios of winter and summer in order to evaluate adequacy of the proposed interconnection scheme for 1320 MW Sahiwal power plant in the light of NTDC Grid Code.
- 3. The proposed interconnection scheme for power dispersal of 1320 MW Sahiwal power plant to the National Grid is given as under:
 - A 500 kV D/C transmission line, approx. 0.5 km long on quad-bundled Drake conductor, for looping In/Out of existing Sahiwal (Yousafwala) – Lahore old (Lahore South) S/C transmission line at the proposed Sahiwal coal-fired power plant.
 - Addition of 1x600 MVA, 500/220 kV Transformer at 500 kV Sahiwal (Yousafwala) substation.
- 4. The proposed interconnection scheme has been studied/evaluated in detail and has been found reliable for dispersal of power from 1320 MW Sahiwal coal-fired power plant to the National Grid.
- 5. Short circuit and transient stability studies are under process and would be presented in Interconnection Report-2 (Final Report) very shortly.
- The comments of concerned departments of Government of Punjab and M/s SEPCOIII, China are welcome on this report and would be incorporated in the Interconnection Report-2.

1. Introduction

This is Interconnection Study Report-1 in which the results of load flow studies have been presented for the connectivity of 1320 MW (2x660MW) Sahiwal coal-fired power plant with the National Grid. The load flow analysis has been carried out for various operating scenarios of winter and summer in order to evaluate adequacy of the proposed interconnection scheme for 1320 MW Sahiwal power plant in the light of NTDC Grid Code. The interconnection study has been carried out on the request of Punjab Government. As per information provided by M/s SEPCOIII, China, the expected COD of said power plant is December 2016 and the location of the power plant is near Sahiwal, just adjacent to the existing Sahiwal (Yousafwala) – Lahore 500 kV single circuit transmission line.

2. Proposed Interconnection Scheme

The objective of the interconnection study is to propose the transmission arrangement for reliable dispersal of power from 1320 MW (2x660 MW) Sahiwal coal-fired power plant to the National Grid System under normal and single line contingency conditions. It is important to mention that at present, a new 500 kV substation (Lahore South) is under implementation and is expected to be completed within next three years. Lahore South would be at an approx. distance of 52 km from the existing Lahore (Old) 500kV substation towards Sahiwal.

The location of Sahiwal coal-fired power plant is near Sahiwal, just adjacent to the existing Sahiwal (Yousafwala) – Lahore Old 500 kV single circuit transmission line, about 9km away from Sahiwal substation along the line route.

The following interconnection scheme has been proposed for 2x660 MW Sahiwal power project keeping in view its generation capacity, its location and the existing/planned system network in the vicinity:

- A 500 kV D/C transmission line, approx. 0.5 km long on quad-bundled Drake conductor, for looping In/Out of existing Sahiwal (Yousafwala) Lahore old (Lahore South) S/C transmission line at the proposed Sahiwal coal-fired power plant.
- Addition of 1x600 MVA, 500/220 kV Transformer at 500 kV Sahiwal (Yousafwala) substation.

The geographical diagram showing above interconnection scheme for power dispersal of 1320 MW Sahiwal coal-fired power plant is attached as Figure #1.
3. Study Assumptions and Criteria

3.1 Study Assumptions

The load flow studies are based on the following assumptions:

- Latest load forecast.
- Latest generation expansion plan.
- Latest transmission expansion plans of NTDC and DISCOs.
- In the studies, interconnection transmission system has been assumed at 500kV & 220 kV voltage levels. However, line openings have been carried out in the 132 kV network underneath Sahiwal (Yousafwala) to avoid overloading of the lines, as per system requirements.
- The maximum net generation capacities of the existing/planned power plants in the Grid have been assumed in the studies. In addition, rehabilitation of generation capacity at Jamshoro, Guddu and Muzaffarhgarh power plants has been assumed in the studies.
- The planned Lahore South 500/220 kV substation with their associated transmission lines has also been assumed in the studies. At present, Lahore South 500 kV substation is under implementation and is expected to be completed within next 2-3 years. Lahore New 500 kV substation will be connected with the Grid by looping In/out of the existing Sahiwal Lahore 500kV single circuit line and the looping In/out of Lahore Gakkhar 500 kV single circuit line.
- As per information provided by M/s SEPCOIII, China, the data/information of the proposed Sahiwal power plant, pertaining to the subject study, is as under:

Generator Data:

- No. of generating units = 2
- Gross capacity of each unit = 660 MW, 825 MVA
- Net capacity of each unit = 603.9 MW
- Generator voltage = 22 kV

Generator Step-up Transformer Data:

- No. of transformers = 2
- Voltage rating of each transformer = $550/\sqrt{3} \pm 2x2.5\% / 22 \text{ kV}$
- Rating of each transformer = 3x280 MVA
- Percentage Impedance = 15% at main tap.
- No. of generators connected to each Transformer = 1

3.2 Study Criteria

I

The load flow studies have been carried out keeping in view of the following system operating criteria/limits in accordance with NTDC's Grid Code:

Voltage Limits:	±5% under normal and ±10% under contingency conditions.
	However, voltages at generation and/or substations may be
	kept upto +8% under normal operating conditions as per
	network configuration and/or system requirements.

Transmission Line100% of rating under normal and N-1 contingencyand Transformerconditions.Loading Limits:

4. Load Flow Analysis

The load flow analysis has been carried out with the proposed interconnection scheme for various operating scenarios for the months of January 2017 and Aug/Sep 2017 corresponding to the typical winter and summer seasons respectively. In this regard, necessary system scenarios of peak load conditions in January 2017 & Aug/Sep. 2017 and off-peak load condition of January 2017 have been simulated to analyze the impact of the proposed 1320 MW Sahiwal coal-fired power plant on the system network in its vicinity under normal and single line (N-1) contingency conditions.

The results of load flow studies for power dispersal of 1320 MW Sahiwal coal-fired power plant with the proposed Interconnection scheme are described as under:

4.1 Peak Load January 2017

Two scenarios have been simulated for this system condition, i.e., one with and the other without Lahore South 500 kV substation.

(a) With Lahore South 500/220 kV Substation

Load flow study for the peak load condition of January 2017 has been carried out with 1320 MW Sahiwal power plant and is attached as Exhibit #1. The 500 kV & 220 kV networks are operated interconnected, however, line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow
Sahiwal Power Plant - Sahiwal (Yousafwala) 500 kV S/C	120 MW
Sahiwal Power Plant - Lahore South 500 kV S/C	1088 MW
Multan – Sahiwal 500kV S/C	711 MW
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	825 MW

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #2-6. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
2	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
3	Sahiwal Power Plant – Lahore South 500 kV S/C out	-do-
4	Multan – Sahiwal 500 kV S/C out	-do-
5	Gatti – Multan 500 kV S/C out	-do-
6	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

(b) Without Lahore South 500/220 kV Substation

Load flow study for the peak load condition of January 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #7. The 500 kV & 220 kV networks are operated interconnected and 132 kV line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines, as are assumed in the scenario with Lahore South 500/220 kV Substation. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow	
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	277 MW	
Sahiwal Power Plant – Lahore Old 500 kV S/C	931 MW	
Multan – Sahiwal 500kV S/C	665 MW	
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	936 MW	

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #8-12. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
8	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
9	Sahiwal Power Plant – Lahore Old 500 kV S/C out	-do-
10	Multan – Sahiwal 500 kV S/C out	-do-
11	Gatti – Multan 500 kV S/C out	-do-
12	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

4.2 Off-peak Load January 2017

Two scenarios have been simulated for this system condition, i.e., one with and the other without Lahore South 500 kV substation.

(a) With Lahore South 500/220 kV Substation

Load flow study for the off-peak load condition of January 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #13. The 500kV & 220 kV networks are operated interconnected, however, line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow 9 MW	
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C		
Sahiwal Power Plant Lahore South 500 kV S/C	1217 MW	
Multan – Sahiwal 500kV S/C	715 MW	
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	700 MW	

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #14-18. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
14	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
15	Sahiwal Power Plant – Lahore South 500 kV S/C out	-do-
16	Multan – Sahiwal 500 kV S/C out	-do-
17	Gatti – Multan 500 kV S/C out	-do-
18	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

(b) <u>Without Lahore South 500/220 kV Substation</u>

Load flow study for the off-peak load condition of January 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #19. The 500 kV & 220 kV networks are operated interconnected and 132 kV line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines, as are assumed in the scenario with Lahore South 500/220 kV Substation. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow	
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	154 MW	
Sahiwal Power Plant – Lahore Old 500 kV S/C	1054 MW	
Multan – Sahiwal 500kV S/C	661 MW	
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	810 MW	

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #20-24. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
20	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
21	Sahiwal Power Plant – Lahore Old 500 kV S/C out	-do-
22	Multan – Sahiwal 500 kV S/C out	-do-
23	Gatti – Multan 500 kV S/C out	-do-
24	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

4.3 Peak Load Aug/Sep 2017

Load flow study for the peak load condition of Aug/Sep 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #25. In this scenario, it is assumed that Lahore South 500 kV substation would have been commissioned by that time. The 500 kV & 220 kV networks are operated interconnected, however, line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow	
Sahiwal Power Plant - Sahiwal (Yousafwala) 500 kV S/C	837 MW	
Sahiwal Power Plant – Lahore South 500 kV S/C	371 MW	
Multan – Sahiwal 500kV S/C	572 MW	
3x600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	1131 MW	

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #26-30. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
26	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
27	Sahiwal Power Plant – Lahore South 500 kV S/C out	-do-
28	Multan – Sahiwal 500 kV S/C out	-do-
29	Gatti – Multan 500 kV S/C out	-do-
30	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

4.4 Comments on Proposed Interconnection Scheme

As per load flow study results, the proposed interconnection scheme has been found as a reliable transmission arrangement for power dispersal of the 1320 MW Sahiwal coal-fired power plant to the National Grid System under normal and single line contingency conditions.

5. Conclusions

- (a) On the basis of load flow analysis, the following interconnection scheme has been proposed for reliable dispersal of power from 1320 MW Sahiwal coal-fired power plant to the National Grid System under normal and single line contingency conditions:
 - A 500 kV D/C transmission line, approx. 0.5 km long on quadbundled Drake conductor, for looping In/Out of existing Sahiwal (Yousafwala) – Lahore old (Lahore South) S/C transmission line at the proposed Sahiwal coal-fired power plant.
 - Addition of 1x600 MVA, 500/220 kV Transformer at 500 kV Sahiwal (Yousafwala) substation.
- (b) Short circuit and transient stability studies are under process and would be presented in Interconnection Report-2 (Final Report) very shortly.
- (c) The comments of concerned departments of Government of Punjab and M/s SEPCOIII, China are welcome on this report and would be incorporated in the Interconnection Report-2.



INTERCONNECTION SCHEME FOR POWER DISPERSAL OF 2x660 MW (1320 MW) COAL POWER PLANTS AT SAHIWAL







2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

ESSA (Environmental And Social Soundness Assessment)

An Environmental Management Plan (EMP) has been developed as part of the EIA report which provides a detailed mitigation matrix that covers impacts, mitigation measures roles and responsibilities and timings to avoid, minimize or mitigate the adverse impacts and justify the friendly nature of the power plant Project.

The Environmental Impact Assessment Report is separately attached.





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

ESSA (ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT)

8.1.3 Operation Phase

• Impacts on ambient air quality and noise due to plant operations such as coal combustion, typical air emissions will include SOx, NOx, CO, CO2, Volatile Organic Compounds (VOC's), Particulate Matter (PM) and Mercury. Noise emissions from the power plant will include noise from coal delivery and handling, operation of the boilers (steam blowing and purging). These impacts should be mitigated by the use of control technologies such as FGDs for SOx, ESPs for PM and Low NOx burners for NOx with future provisions for SCR and FGMC. Noise monitoring should be regularly done to ensure that they are within NEQS limits;

- Impacts of security situation can be mitigated by installation of CCTVs and other security measures;
- Impact on Groundwater quality due to improper disposal of wastewater produced at the power plant should be mitigated by channelizing the treatment of wastewater. The wastewater generated from the power plant will be discharged after the proper treatment for different types of wastewater.
- Impact on Drinking water quality due to coal ash storage and disposal should be mitigated by proper storage of the coal ash according to standard operating procedures such as ensuring that the disposal area is properly lined and contained to prevent leaks;
- Impact on surface water bodies due to improper handling and disposal of many chemicals being used at the power plant should be mitigated by using drums and storage containers that are tight and do not leak as well as ensuring that the staff is trained to deal and contain accidental spills;
- Impact on Human health due to improper disposal of sanitary waste from residential colony and solid waste in the form of coal, bottom ash, fly ash etc. should be mitigated by providing firefighting plan in case coal stocks catch fire, as well as a proper solid waste management plan to deal with collection and disposal of waste: and
- Impacts on Socio-economic aspects such as gender issues due to outside labor at the power plant/privacy issues, impacts of noise and air pollutants on local population etc. should be mitigated by continuous monitoring to ensure that emissions are not exceeding NEQS limits and the contractor should make an effort to follow the local norms and be culturally sensitive to the local population.





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

ESSA (ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT)

• Disruption of Irrigation water flow in Canal tributaries and water courses should be mitigated by the Punjab Irrigation Department by providing new irrigation channels 8.1.2 Construction Phase

• Impact of Soil erosion as a result of improper runoff from construction activities should be mitigated by good engineering practices such as mulching and compaction;

• Contamination of soil by toxic/ fuel based/ chemical materials by improper handling should be mitigated by appropriate storing of the chemicals in drums and necessary precautions taken by the contractor's staff;

• Loss of vegetation cover due to removal of trees, shrubs, and fruit plants etc. should be mitigated by planting additional trees in appropriate and suitable areas around the proposed power plant which will also act as a noise barrier.

• Aesthetic value of the area should be improved by placing vegetative barriers around the proposed power plant site and developing green areas in the Project Area as well as in the vicinity of the proposed Project site;

• Degraded quality of irrigation water and surface water due to contamination (if any) which should be mitigated by containing chemical and oil spills directly into open drains and from preventing untreated wastewater and sewage to flow towards the irrigation channels by channeling it towards septic tanks and soakage pits;

• Impacts on ambient air and noise quality due to gaseous/fugitive dust emissions and movement of vehicles, vibration by machinery/equipment etc. should be mitigated by fine tuning of the vehicles, sprinkling water on the soil to prevent dust from rising, and by adjusting timing of construction activities so that there is no excessive noise during the night;

• Impacts on downstream water users due to wastewater discharge should be mitigated by the treatment of wastewater to meet NEQS limits before it is discharged;

• Increase in solid waste generation should be mitigated by adopting a solid waste management plan for the collection and disposal of all types of wastes; and

• Impacts on Socio-economic aspects should be mitigated by ensuring that cultural sensitivity should be understood by the contractor and good relationships are maintained between the locals and the power plant staff.





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

ESSA (ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT)

- The land required for Project construction will be transferred from Livestock and Dairy Development Department and only small piece of land 19 hectares (50 acres) will be privately acquired. Land acquisition will be mitigated by proper compensation as per the LAA,1894;
- In order to mitigate this temporary impact compensation (temporary and permanent) should be given to the affectees;





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

ESSA (ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT)

incorporated in EIA through Change Management Plan (CMP) suggested in Environmental Management Plan (EMP).

7. The major positive impacts of the Project include the following:

• Electricity Generation: Given that Pakistan currently faces a shortfall of about 4,000 to 6,000 MW per day, the generation capacity of this power plant will help towards meeting a portion of the shortfall. The generation of electricity will not only help the industrial sector and its outputs but will also help to raise the standard of living as it will reduce load shedding;

• Employment Opportunities: As per estimate provided by SEPCO III, the peak number of workers required will be about 4,000 during the construction phase and about 250 during the operation phase. Other job opportunities will include staff required for the loading and unloading of coal from the port and at destination, as well as staff working during the planning and design phase;

• Increase in Businesses: With the influx of labourers for the proposed Project, there will be more opportunities for small scale business;

• Increased Accessibility: upgradation of railway track and roads in the area will result in improved accessibility;

• Establishment of Residential Colony: Basic amenities such as school for children, hospitals/health clinics, local shops provided in residential colony will also benefit the locals; and

• Other indirect benefits like improvement in railway infrastructure increase in land prices of the area, general economic and social uplift of the Project surroundings and overall country etc.

8. The major impacts foreseen and their mitigation include:

8.1.1 Pre-Construction Phase





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

ESSA (ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT)

- 1. The proposed Project is essentially a coal fired power plant having a gross capacity of 1,320 MW produced by the use of supercritical boilers technology about 1.5 Km. The Power Plant has a capacity of producing 1,320 MW of electricity. The Plant will operate on imported coal to be transported from Karachi through railway. This power plant site primarily falls within the area of Chak No. 75/5-R and is located on a single track road at a distance of 1-2 Km from Qadirabad on left hand side of main dual track of National Highway (N5) from Sahiwal to Lahore. Dual main railway track also exists near the Project site. There is no issue of water availability as LBDC is passing near the site. The evacuation of power is proposed by means of 500 kV double circuit Transmission Line(s), having length of approximately 1.5 Km to link to the nearest 500 kV Grid Station in Yousafwala.
- 2. Different site options for the Power Plant were appraised and final site selection (Site "C" near Yousafwala) was made considering the key evaluation criteria such as land acquisition, fuel transportation, power evacuation, water supply sources in order to meet the fast track Project time schedule.
- 3. The total Project Area is 258.5 hectares (639 acres). This whole area is Government owned (Punjab Livestock department and Seman Production) land except 19 hectares (50 acres) of private land to be acquired for the approach rail track from main line to Project site and water channel from LBDC or its minor.
- 4. The Project will have an annual coal consumption of up to 6 million metric tons per year (MTPY). This will most likely to be imported from Indonesia, Australia or South Africa and transported by sea. Coal will be unloaded at Karachi Port and transportation from Karachi to Sahiwal will be through railway locomotives i.e. cargo bogeys. The Coal fired Power Plant Project is estimated to be completed and commissioned within 48 months.
- 5. As per the recommended Coal analysis in feasibility study for Coal Fired Power Plant near Sahiwal, the sulphur and ash content in coal should not exceed 0.66% AR and 5.29% respectively.
- 6. The total water requirement at the plant will be 0.13 m3/sec (4.7 cusecs) which includes both water for the power plant operations as well as miscellaneous uses such as residential areas etc. with IDDC. In case, the selection of cooling system is changed from indirect dry air cooling system to water cooling system, related impacts will be reassessed and changes will be

- xiii. The proponent shall plant at least 30000 trees of minimum height 6-7 feet especially of indigenous species in and around the project area on available space in consultation with District Officer (Environment), within six months. The Proponent will also make necessary arrangements for the maintenance and protection of these trees.
- xiv. The proponent shall appoint an Environmental Manager and shall convey the name of the Environmental Manager (having at least qualification of BS Environmental Sciences along with his complete Mailing Address and Phone Numbers).
- xv. The proponent shall take effective measures for safe transportation of Fuel.
- xvi. The proponent shall install on line Air Pollution Monitoring Analyzers for major pollutants like particulate matter, CO, SO₂, NO₃, HC and Mercury.

5. The proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.

6. The proponent shall be liable for compliance of Sections 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the installation/construction phase of the project. The proponent will obtain approval for operation of the Project in accordance with Section 13(2)(b) and Section 18 of the IEE/EIA Regulations, 2000.

- 8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.
- 9. This approval shall be treated as null and void if all or any of the conditions mentioned above, is/are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force and is subjudice to legal proceedings in any legal fora / court.
- 10. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Section 16 of IEE / EIA Regulations, 2000.0.4

(AMEN HANIF) ASSISTANT DIRECTOR (EIA) for Director General, EPA, Punjab Ph: # (042)99232228

NO. & DATE EVEN.

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A copy is forwarded for information to:

The District Officer (Environment), Sahiwal w.r.t. his letter No. 119/DOE/SWI dated 08.04.2014. He is requested to ensure compliance of the above-mentioned conditions measures under intimation to this office.

(AMEN HANIF) ASSISTANT DIRECTOR (EIA) for Director General, EPA, Punjab

Attachment 3

]	
		National Hockey Stadium, Fernaceur Road, Labore
		NO. DD (ELAVEPA/E-20(ELA)/2905/2014/
na se K		Dated: 28 / 05 / 2014
То		
	27 1	
	**	The Managing Director,
		Energy Department
		1 st Floor, Central Design Building,
		Irrigation Secretariat, Old Anarkali,
CL.		
Subj	ect	DECISION OF EPA PUNJAB REGARDING CONSTRUCTION OF 2 X
		(Under Section 12 of the PEP Act 1997 (amended 2012) and UE 2015 ANIWAL
		2000)
1.	Descr	iption of Project: Construction of 2 x 660 MW Coal Fired Power Plant
· ·	Locati	on of Project: The project site is located at Chak No. 75/5-R,
3.	Date c	of submission of application: 01.04:2014
4.		After review of the Environmental Impact Assessment (FIA) Report Site Incounting
Repo	rt of Di	strict Officer (Environment) and other documents the Environmental Destation
Punja	ab has de	cided to accord its approval for the construction of the above mentioned metioned
the e	nvironm	ental issues subject to the following conditions:
	J.	Standards (NEQS).
	11.	Mitigation measures suggested in the EIA Report and Environmental Management Plan shall be strictly adhered to minimize any negative impacts on soil, groundwater, air and biological resources of the project area
	lii.	Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis
	iv.	The proponent shall install pollution abatement equipment/treatment plant i.e. Electrostatic Precipitator, cyclone & fabric filters etc. in compatible with NEOS.
	ν.	The proponent shall also install Mcrcury Control System best available in the world as per requirement of Minamata Convention ratified by Pakistan in October 2013.
	vi.	The proponent shall install waste water treatment plant and shall dispose of wastewater after proper treatment in conformity with the NEOS
1 - - 		
	viî.	Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environment friendly way at a suitable disposal facility.
	vii. viii.	Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environment friendly way at a suitable disposal facility. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system
n	vii. viii. ix.	Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environment friendly way at a suitable disposal facility. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system. The proponent shall provide proper firefighting arrangements.
	vii. viii. ix. x.	Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environment friendly way at a suitable disposal facility. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system. The proponent shall provide proper firefighting arrangements. The proponent shall take measures for proper storage of fuel.
	vii. viii. ix. x. xi.	Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environment friendly way at a suitable disposal facility. The proponent shall ensure that strict and efficient health and safety measures are in place for protection of workers backed by a comprehensive emergency response system. The proponent shall provide proper firefighting arrangements. The proponent shall take measures for proper storage of fuel. At least 90% unskilled and to the extent possible skilled jobs shall be given to locals after providing them proper training.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



ESSA (ENVIRONMENTAL AND SOCIAL SOUNDNESS ASSESSMENT) (Section 17.10)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - PROJECT COMMENCEMENT AND COMPLETION SCHEDULE WITH MILESTONES

SR. NO.	MILESTONES	COMPLETION
		SCHEDULE
01.	Start of construction of pile foundations for main power house	April 20, 2015
02.	Start of excavation of main power house foundation	June 1, 2015
03.	First concrete of main power house foundation	June 30, 2015
04.	Enclosure of main power house	May 15, 2016
05.	Outer cylinder of chimney built to top	August 15, 2016
06.	Back-energization	March 10, 2017
07.	Qualified demineralized water available	March 31, 2017
08.	Chemical cleaning of Unit 1 boiler completed	July 31, 2017
09.	Purge of Unit 1 boiler completed	August 31, 2017
10.	Chemical cleaning of Unit 2 boiler completed	August 31, 2017
11.	purge Of Unit 2 boiler completed	September 30, 2017
12.	Unit 1 COD	November 30, 2017
13.	Unit 2 COD	December 31, 2017





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



PROJECT COMMENCEMENT AND COMPLETION SCHEDULE WITH MILESTONE (Section 17.9)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PROJECT COST, INFORMATION REGARDING SOURCES AND AMOUNTS OF EQUITY AND DEBT

Project cost

General Assumptions for Cost Estimate

The following assumptions apply to the cost estimate for the development of power generation facilities using a pulverized coal boiler, located in Sahiwal.

The planned capacity of this project is 2×660MW. Two supercritical coal-fired condensing power generation units will be constructed.

The total cost the project will be 1782 millions of US \$..

Sources and amounts of equity and debt

Equity : Huaneng Shandong Power Generation Co., Ltd and Shandong Ruyi Technology Group Co., Ltd is the sponsors will inject 20% of the total cost, total will inject 356.4 millions of US \$; the remain of 80% of the total cost , that means 1425.6 millions of US \$ will get from Chinese bank ICBC.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



SAFETY PLANS, EMERGENCY PLANS (SECTION 17.11)

LEGAL CONSULTANT HAIDERMOTABNR

FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants







2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SAFETY PLANS, EMERGENCY PLANS

Guiding Ideology:

1. For the purpose of earnestly implementing safety laws and regulations of Pakistani Government and safety production work plan of Huaneng Group, this Safety and Contingency Program is made to ensure safety during construction and production period of Sahiwal power project. This program is committed to the pre-construction planning of this project, in order to achieve the desired effect and ensure personal and equipment accidents do not occur.

Safety Goals

- 1. No human casualty accident;
- 2. Large mechanical equipment damage does not occur;
- 3. Large fire accident does not occur;
- 4. Large traffic accident does not occur;
- 5. Building collapse accident does not occur;
- 6. Widespread infectious disease and food poisoning does not occur;
- 7. Larger environmental pollution accident does not occur;
- 8. Occupational disease does not occur.

Safety Plans and Measures

(A) In process of construction

1. Security and Protection Plan:

During construction period, the power plant project department apply to local government for armed police to strengthen the security on construction site, with 24-hour on-site protection. application of armed police. If necessary, apply for armed military police to ensure the safety of personnel and equipment during construction.

2. Personnel Safety Plan:

(1) All staff must go through safety training and education before they go to work in Pakistan, in order to understand Pakistan's national conditions and risk culture, local security situation,





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SAFETY PLANS, EMERGENCY PLANS

general knowledge in laws and self-salvage measures to manage dangers, engaging in improving security awareness and self-protection capabilities.

(2) Project company and the general construction contractor purchase insurances such as overseas personal accidental injury insurance, enhancing anti-risk capabilities.

3. Construction Safety Plan

(1) Organizing and establishing Production Safety Committee participated by general construction contractor and project supervisor, which should carry out work on a regular basis.

(2) General construction contractor is responsible for the overall preparation of construction design, which will be implemented after reviewed by the supervision unit and approved by the director of the power plant project.

(3) Establishing and improving all kinds of safety management system with strict enforcement.

NO.	Name of Management System
1	external communication system
2	risk pre-control system
3	duty system
4	ask for leave system
5	site security system
6	regular and emergency report system
7	personal accident insurance system
8	security system
9	security clearance system
10	safety education system

(B) During running and production period of power plant

1. Implementing production safety and fire control regulations of Government of Pakistan, enhancing ideas, knowledge, skills, education of security, and strengthening labor discipline.





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SAFETY PLANS, EMERGENCY PLANS

2. Establishing and improving safety management organization and building a three-stage safety net, with clear lines of responsibility for safe production.

3. Strengthening production safety management by objectives and developing safe production goals down to every level.

4. Earnestly implementing safety production responsibility system, and strengthening supervision and management in the safety production process.

5. Establishing and improving safety production management system, and the power plant safety procedure and system list is as follows:

NO.	Name of Standards
1	Safety equipment management standard
2	Safety production evaluation management standard
3	violation of rules handling standards
4	Accident investigation standard
5	occupational hazard management standard
6	traffic safety management standard
7	provisional power management standard
8	safety production training management standard
9	outsourcing project safety management standard
10	dangerous chemicals management standard
11	contingency management standard
12	staff health management standard
13	safety production check management standard
14	fire control management standard

Contingency Plans

2. On the basis of risk analysis, the power plant will establish and improve the following contingency plans and put emphasis on emergency drilling. The purpose is to provide




2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SAFETY PLANS, EMERGENCY PLANS

necessary guidance on how to take immediate action to protect personal and property safety in case of any accident or incident.

No.	name of contingency plan
1	flood prevention contingency plan
2	fire and explosion contingency plan
3	dangerous chemicals accident contingency plan
4	heatstroke prevention contingency plan
5	traffic accident contingency plan
6	war and disturbance contingency plan
7	kidnap contingency plan
8	crane accident contingency plan
9	personal injury accident contingency plan
10	communicable disease contingency plan
11	food poisoning accident contingency plan
12	personal emergency evacuation contingency plan





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



SYSTEM STUDIES (SECTION 17.12)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Charlered Accountants







2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

LOAD FLOW ANALYSIS

The load flow analysis has been carried out with the proposed interconnection scheme for various operating scenarios for the months of January 2017 and Aug/Sep 2017 corresponding to the typical winter and summer seasons respectively. In this regard, necessary system scenarios of peak load conditions in January 2017 & Aug/Sep. 2017 and off-peak load condition of January 2017 have been simulated to analyze the impact of the proposed 1320 MW Sahiwal coal-fired power plant on the system network in its vicinity under normal and single line (N-1) contingency conditions.

The results of load flow studies for power dispersal of 1320 MW Sahiwal coal-fired power plant with the proposed Interconnection scheme are described as under:

Peak Load January 2017

Two scenarios have been simulated for this system condition, i.e., one with and the other without Lahore South 500 kV substation.

With Lahore South 500/220 kV Substation

Load flow study for the peak load condition of January 2017 has been carried out with 1320 MW Sahiwal power plant and is attached as Exhibit #1. The 500 kV & 220 kV networks are operated interconnected, however, line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	120 MW
Sahiwal Power Plant – Lahore South 500 kV S/C	1088 MW
Multan – Sahiwal 500kV S/C	711 MW
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	825 MW





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

The study results for the normal and N-1 contingency conditions are described as under: Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
2	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
3	Sahiwal Power Plant – Lahore South 500 kV S/C out	-do-
4	Multan – Sahiwal 500 kV S/C out	-do-
5	Gatti – Multan 500 kV S/C out	-do-
6	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

Without Lahore South 500/220 kV Substation

Load flow study for the peak load condition of January 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #7. The 500 kV & 220 kV





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

networks are operated interconnected and 132 kV line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines, as are assumed in the scenario with Lahore South 500/220 kV Substation. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	277 MW
Sahiwal Power Plant – Lahore Old 500 kV S/C	931 MW
Multan – Sahiwal 500kV S/C	665 MW
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	936 MW

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #8-12. The results of contingency studies have been summarized as under:





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

Exhibit #	Contingency Conditions	Remarks
8	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
9	Sahiwal Power Plant – Lahore Old 500 kV S/C out	-do-
10	Multan – Sahiwal 500 kV S/C out	-do-
11	Gatti – Multan 500 kV S/C out	-do-
12	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

Off-peak Load January 2017

Two scenarios have been simulated for this system condition, i.e., one with and the other without Lahore South 500 kV substation.

With Lahore South 500/220 kV Substation

Load flow study for the off-peak load condition of January 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #13. The 500kV & 220 kV networks are operated interconnected, however, line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

Transmission Line/Transformer	Power Flow
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	9 MW
Sahiwal Power Plant – Lahore South 500 kV S/C	1217 MW
Multan – Sahiwal 500kV S/C	715 MW
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	700 MW

The study results for the normal and N-1 contingency conditions are described as under: Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are The results of contingency studies have been summarized as under:





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

Exhibit #	Contingency Conditions	Remarks
14	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
15	Sahiwal Power Plant – Lahore South 500 kV S/C out	-do-
16	Multan – Sahiwal 500 kV S/C out	-do-
17	Gatti – Multan 500 kV S/C out	-do-
18	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

Without Lahore South 500/220 kV Substation

Load flow study for the off-peak load condition of January 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #19. The 500 kV & 220 kV networks are operated interconnected and 132 kV line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines, as are assumed in the scenario with Lahore South 500/220 kV Substation. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	154 MW
Sahiwal Power Plant – Lahore Old 500 kV S/C	1054 MW
Multan – Sahiwal 500kV S/C	661 MW
3 x 600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	810 MW





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of proposed 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #20-24. The results of contingency studies have been summarized as under:

Exhibit #	Contingency Conditions	Remarks
20	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
21	Sahiwal Power Plant – Lahore Old 500 kV S/C out	-do-
22	Multan – Sahiwal 500 kV S/C out	-do-
23	Gatti – Multan 500 kV S/C out	-do-
24	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

Peak Load Aug/Sep 2017

Load flow study for the peak load condition of Aug/Sep 2017 has been carried out with 1320 MW Sahiwal coal-fired power plant and is attached as Exhibit #25. In this scenario, it is assumed that Lahore South 500 kV substation would have been commissioned by that time. The 500 kV & 220 kV networks are operated interconnected, however, line openings have been carried out on 132 kV network underneath Sahiwal (Yousafwala) substation to avoid overloading of the 132 kV lines. As per load flow study, the power flows on the circuits emanating from subject power plant and in their vicinity are as under:

Transmission Line/Transformer	Power Flow
Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C	837 MW
Sahiwal Power Plant – Lahore South 500 kV S/C	371 MW
Multan – Sahiwal 500kV S/C	572 MW
3x600 MVA, 500/220 kV Transformers at Sahiwal (Yousafwala)	1131 MW

The study results for the normal and N-1 contingency conditions are described as under:

Normal System Conditions

As per load flow study, the power flows on transmission lines and transformers in the vicinity of proposed Sahiwal power plant are well within their capacities. In general, the study depicts that the voltage profile of the system is within limits and there would be no transmission system constraints in the flow of power from the proposed 1320 MW Sahiwal coal-fired power plant to the system under normal operating condition.

N-1 Contingency Analysis

The load flow studies have also been carried out for single line contingency (N-1) analysis in the vicinity of 1320 MW Sahiwal coal-fired power plant and are attached as Exhibit #26-30. The results of contingency studies have been summarized as under:





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

Exhibit #	Contingency Conditions	Remarks
26	Sahiwal Power Plant – Sahiwal (Yousafwala) 500 kV S/C out	Power flows on the other transmission lines and transformers as well as the voltage profile of the system remain within limits.
27	Sahiwal Power Plant – Lahore South 500 kV S/C out	-do-
28	Multan – Sahiwal 500 kV S/C out	-do-
29	Gatti – Multan 500 kV S/C out	-do-
30	1 x 600 MVA, 500/220 kV Transformer at Sahiwal (Yousafwala) out	-do-

Comments on Proposed Interconnection Scheme

As per load flow study results, the proposed interconnection scheme has been found as a reliable transmission arrangement for power dispersal of the 1320 MW Sahiwal coal-fired power plant to the National Grid System under normal and single line contingency conditions.

Conclusions

On the basis of load flow analysis, the following interconnection scheme has been proposed for reliable dispersal of power from 1320 MW Sahiwal coal-fired power plant to the National Grid System under normal and single line contingency conditions:

A 500 kV D/C transmission line, approx. 0.5 km long on quadbundled Drake conductor, for looping In/Out of existing Sahiwal (Yousafwala) usafwala)) fwala) looping In/Out of existing ng on quadbundled DrSahiwal coal-fired power plant.

Addition of 1x600 MVA, 500/220 kV Transformer at 500 kV Sahiwal (Yousafwala)





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - SYSTEM STUDIES: LOAD FLOW, SHORT CIRCUIT, STABILITY, RELIABILITY

substation.

Short circuit and transient stability studies are under process and would be presented in Interconnection Report-2 (Final Report) very shortly.

The comments of concerned departments of Government of Punjab and M/s SEPCOIII, China are welcome on this report and would be incorporated in the Interconnection Report-2.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



PLANT CHARACTERISTICS (SECTION 17.13)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

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2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PLANT CHARACTERISTICS

1 Generator

Generator Cooling Method is water-hydrogen-hydrogen. Excitation type is static excitation. The generator rated output is 660MW, and rated voltage is 22kV.The generator rated power factor is 0.85(Lagging). The generator should be capable of providing 0.95 underexcited power factor at rated MW.

Туре :	QFSN-660-2
Rated power:	660MW
Rated power factor:	0.85 (lagging)
Rated voltage:	22kV
Rated speed:	3000r/min
Frequency:	50Hz
Phase:	3
Pole:	2
Stator winding connection:	YY
Cooling type:	Water-Hydrogen-Hydrogen
Excitation:	Statistic excitation

2 Excitation

Generator excitation source which derived from the generator terminal will be step-down by excitation transformer before rectified by thyristor, after being rectified to DC, it will be introduced to excitation winding through demagnetizing switch, there are no rotating parts in the excitation device.

3 Outdoor substation

500kV AIS would be adopted for this project. One and a half breaker scheme is adopted for the design of 500kV switchyard. The step-up transformers connect to 500kV switchyard by overhead lines, and there are two outgoing lines. The start-up/stand-by transformer connects to 500kV main bus.

1





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PLANT CHARACTERISTICS

4 System Dispatching Automation

4.1 Tele-control equipment

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

4.2 Tariff Metering System

Tariff metering will be provided at following points.

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

Check metering will be provided at following points.

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

•High voltage side of the step-up Transformer (one main meter meter).

•Exit terminal of generator (one main meter meter).

•The high voltage side of Unit Transformer (one main meter meter).

•The high voltage side of Excitation Transformer (one main meter meter).

4.3 Relay Protection of switchyard

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

4.4 Communication with the Grid

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

5 Dispatch Automation

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





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PLANT CHARACTERISTICS

temporarily.

5.1 Dispatching Automation System

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

5.2 Transmission Mode of Telecontrol Information and Channel

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

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

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

5.3 Telecontrol Information

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

Tele-measurement

-Generator exit: Active power, Reactive power, current, voltage;

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

-500kV bus voltage, frequency;

Tele-signal

-Whole plant fault signal;

-Dispatched CB position signal;

-Dispatched disconnector and grounding disconnector position signal;





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PLANT CHARACTERISTICS

-Neutral grounding disconnector position signal of Generator Transformer;

-Tap position signal of Generator Transformer;

- -Main protection action signal of generator and Generator Transformer;
- -Main protection action signal of High voltage auxiliary power standby power transformer and Startup-standby transformer;

-Main protection action signal of 500kV line, CB and bus;

5.4 Telecontrol Equipment

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

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

5.5 The Request of Power Energy Tariff Point Setting

Power energy tariff point setting as follows:

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

0.2S.

Power energy check point setting as follows:

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

-Generator exit, main meter which precision would be 0.2.

-The high voltage side of Unit Transformer, main meter which precision would





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PLANT CHARACTERISTICS

be 0.2.

-The high voltage side of Excitation Transformer, main meter which precision would be 0.2.

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

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

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

6 **Project Loading**

a. The Project load changing rate is the steady rate at which the load can be changed. Allowable load change rate of the Unit:

The Unit lifetime and performance will not be reduced when load change rate is less than 4%MCR per minute in the range of 40% $\sim 100^{\circ}$ / \odot MCR. The Unit can bear the following load change rate without affecting its stable operation:

-From50%~ 100%MCR	5%MCR per minute
-From30%~ 50%MCR	3%MCR per minute
-Under30%MCR	2%MCR per minute
-Load Step	10%MCR per

minute





2 x 660 MW Imported Coal Based IPP project at Sahiwal, Punjab, Pakistan

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

PLANT CHARACTERISTICS

- b. Unit load percentage in this Schedule refers to the load at the Generator terminals as a percentage of gross capacity of the respective unit.
- c. It could be operated within the voltage range of \pm 5% at the 500kV high voltage system. The voltage regulator shall be adjustable in the range of 2.5% of generated rated voltage.
- d. The units can operate with the frequency range given in the table below:

Frequency Range (Hz)	Time Limitation (second)
51.0 ~51.5	>30
48.5 ~50.5	Continuous
48.5 ~48	>300
48.0 ~47.5	>60

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





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



CONTROL, METERING, INSTRUMENTATION AND PROTECTION (Section 17.14)

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2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

Project description

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

Abbreviations

- BOP: Balance of Plant
- BPC: Turbine Bypass Control
- BFPT: Boiler Feed Pump Turbine
- CCR: Central Control Room
- CEMS: Continuous Emission Monitoring System
- CCTV; Close Circuit Television
- DCS: Distributed Control System
- DEH: Digital Electro Hydraulic
- DAS: Data Acquisition System
- ESP: Electrostatic Precipitator
- ESR: Engineer station room
- ETS: Emergency Trip System
- ECS: electric control system
- EER: Electronic Equipment Room
- FSSS: Furnace Safeguard Supervisory System
- FSS: Furnace safety system
- FGD: Flue Gas desulfurization
- HVAC: Heating & Ventilation and Air Conditioning
- I/O: Input / Output
- LVS: Large Video Screen
- LCR: Local Control Room
- MEH: BFPT micro-electro-hydraulic control system
- METS: BFPT micro-emergency trip system
- MTSI: BFPT micro-supervisory instrument
- MCS: Modulating Control System
- NCS: Networked control system
- PLC: Programmable Logic Controller
- SBC: Soot Blower Control





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

- SCS: Sequence Control System
- SOE: Sequence of Event Recorder
- TSI: Turbine Supervisory Instruments System
- VMS: Vibration Monitoring System

Centralized Control and Automation Level

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

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

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

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

5) Flue gas desulfurization (FGD) will be controled and monitored in BOP DCS. Local EER of FGD area will be provided and local operation station of FGD and Ash handling will be conbined.

I&C Automation Configuration

1) DCS is the main control system of each unit. In addition to DCS, there are DEH, ETS,





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

TSI, BFPT MEH, BFPT METS, BFPT MTSI, boiler tube leakage monitoring system, VMS, BOP control network.

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

Unit monitoring control system mainly includes:

(1) Unit DCS. The main functions of DCS include: DAS, MCS, FSSS, SCS, Generator-transformer, ECMS, SBC, bottom ash removal system, and BPC, circulating water pump house are included in the unit DCS, Auxiliary power for common parts of two units, fuel pump control and other common system are included in the common network of two units. Monitoring and control of the common network can be achieved in operator station of each unit, but the operation can put in effect only in the operator station of one unit, while the other one will be blocked at the same time. FSS will adopt functional safety type system, fulfill the requirement of safety integrity level 3 (SIL3).

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

(3) DEH Control System and ETS will be provided by turbine manufacture. Hardware consistent with unit DCS will be adopted as far as possible. ETS will adopt functional safety type system, fulfill the requirement of safety integrity level 3 (SIL3).

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

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

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





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

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

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

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

(10)Each unit is provided with one set of a boiler tube leakage monitoring system.

(11)Continuous Emission Monitoring System (CEMS):In this project, to monitor the concentrations of gas emission and dust a suit of flue gas analyzing system will be provided for two units. The supervised parameters include SO2, NOx, CO, PM. and Hg. And the measurement signals will be sent to DCS.

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

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

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





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

CCR and EER

1) The CCR will be arranged in central control building. DCS operator stations, LVS, shift supervisor station and fire alarm panel, BOP DCS operator station, emergency trip push-buttons, Furnace flame TV, will be laid in CCR. CCR headroom will be about 3.6 m. Engineering stations will be placed in ESR. Unit DCS, DEH, ETS and TSI cabinets etc. will be laid in EER, which will be located near the respective unit. ESR and EER will also be arranged in the central control building. Detailed equipment arrangement drawing will be submitted during basic design stage.

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

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

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

4 Information and Security Monitoring System

Information and security monitoring system includesCCTV, Anti-intrusion Security System, Fire detection and alarm system, supervisory information system.

CCTV

CCTV will be installed for the project. The system includes 170 monitoring points (coal handling system is excluded). The CCTV subsystem will be placed at the following areas: turbine house subsystem, central control building subsystem, BOP subsystem, security subsystem. All cabinets for these areas will be placed at local EER.

Anti-intrusion Security System

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

Fire detection and alarm system

A fire detection and alarm system will be set for the project. The system will be designed





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

following Chinese fire code, and local related design specifications will be taken as reference. Fire detection and fire alarm zone comprises main power house zone, BOP zone, and non-plant area.

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

Supervisory Information System and Management Information System

The network of Supervisory Information System and Management Information System will be conbined.

Configuration of main monitoring and control equipment

1) Unit DCS will adopt international brand product, BOP DCS will adopt home made product.

2) Main I&C equipment

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

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

(3) Critical analyzers will adopt internationally recognized brands.

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

Actuator

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





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - CONTROL METERING, INSTRUMENTATION AND PROTECTION

I&C Laboratory

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





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



TRAINING AND DEVELOPMENT (SECTION 17.15)

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2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – TRAINING AND DEVELOPMENT

TRAINING AND DEVELOPMENT

01. Personnel prepared for Power Plant production must go through safety education and job skills training, and obtain relevant certificate before taking a post. The plant develops training program to ensure trained personnel conforms with production work requirements. The training program should be strictly enforced to make sure the training is effectively implemented.

Training Participants

02. Operating Personnel including those responsible for centralized control, chemical, fuel, and ash removing

03. Production Manager including those responsible for safety, production, and technical management

04. Maintenance Personnel including those responsible for maintenance and test of mechanical, electrical, furnace, chemical, fuel, ash removing and other equipment

Training Requirements

05. Power plant formulates detailed rules for implementation of training and on-the-job training programs, making clear trainees, training content, training methods, training objectives, and compiling training materials more targeted to training requirements.

06. Adhering to the orientation of training operating personnel into all-round operator on centralized control duty, and production management, repair and maintenance personnel into versatile specialists.

Operating Personnel

07. Familiar with structure, performance, theory and operational requirements of field equipment for 600MW unit; mastering operating adjustments, fault and accident handling of equipment; mastering daily operation maintenance skills; familiar with the power grid dispatching rules and regulations; familiar with the requirements of environmental protection and fire control provisions, to meet the post requirements.





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – TRAINING AND DEVELOPMENT

Major Posts for Operation

08. Having certain basic theoretical knowledge on equipment operation, parameter adjustment and abnormal situation analysis, with operation skills and practical experience in managing large units. The above-mentioned personnel will be recruited mainly from those people with operation experience in Pakistan, and new graduates from Pakistani universities will also be considered.

General Operating Personnel

09. General operating personnel will focus primarily on recruiting professionals with operating experience and a strong sense of responsibility, and outstanding new college graduates will also be considered.

Production Managers

10. Knowing well the laws and regulations on power generation and safety management enacted by Pakistani government and Huaneng Group; familiar with power plant production process, mastering the structure, performance, principle of major equipment of supercritical unit, familiar with operation, maintenance and testing standards of equipment; proficiency in management knowledge and skills on professional technology which is required to be qualified for this position. Production managers will mainly be recruited from power plants of Huaneng Group based in China.

Leaders in charge of production in relevant departments

11. Knowing well the system condition and production scheduling relations internal each system within the scope of management; understanding the main structure, main parameters, operating characteristics and maintenance process of major equipment of supercritical unit; understanding the key links for safety production and key indicators affecting economic benefits.

Specialist of power plant operation

12. Doing research and proposing solutions for production and technical problems occurred in the process of design, manufacturing, installation and commissioning. The main task





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - TRAINING AND DEVELOPMENT

during production preparation period is to organize and compile the professional code and system diagram, and to develop technical standards and technical measures and put them into practice under supervision.

Maintenance Personnel

13. The main source of maintenance personnel will be recruited from professionals with maintenance experience in Pakistan, and outstanding new college graduates will also be considered.

Compilation and selection of training materials

14. To collect relevant materials from power plants of same type units based in China; to collect technical information on drawings, materials, brochures, etc. from equipment manufacturers; to collect technical information from designing institution; to collect national and industrial standards, regulations, guidelines, etc.

15. The technical management personnel for production preparation compile boiler, turbine, electrical, auxiliary equipment, thermal and other training materials based on different specialties, and give lectures combined with the actual condition of power plant.

16. Professional engineers take pictures of structure, installation process and requirements of main equipment according to the progress of equipment installation, after editing will be served as contents of training materials for future maintenance personnel.

Training method and approach

17. Training for centralized control operator (including technical management staff)

Theoretical training

18. The four-month training starts from February 2016 to May 2016, taught by university teachers. Organizing operating personnel specifically to learn the basic professional-related theoretical knowledge, especially focusing on improving the level of professional theory on turbine, boiler, electrical and instrument control of centralized control operating personnel; organizing the learning of relevant training materials so as to be familiar with technical




2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – TRAINING AND DEVELOPMENT

specifications and system design of supercritical unit; Mastering equipment principle and basic structure; Strengthening safety training and proficiency in safe work practices, fire control procedures and on site first-aid and other related knowledge, to ensure the safe and successful test run and production of the two units

Hands-on training with the same type of unit

19. From June 2016 to May 2017, the plant will organize operating personnel to be trained with regular classes in the same type power plant in China for 12 months, which is a comprehensive study of the technical specifications, operating characteristics, equipment works and system processes of the three major generators as well as start and stop operating essentials of the main and auxiliary equipment. Meanwhile, trainees should also pay attention to learning, absorbing and using the advanced management concepts and methods of the power plant.

Simulator Training

20. From June 2017 to July 2017, the plant will arrange centralized control operating personnel to Huaneng Simulation Center for two-month simulator training. This training is a comprehensive simulation of the actual production so that operating personnel will be familiar with start-stop operation, system stops, running adjustment and typical incident handling of the unit under various conditions, being well prepared for trial operation step-by-step and full start of the unit.

On-site training

21. From July 2017, the operating personnel enter the plant to get familiar with the equipment and systems. They will participate in commissioning and test run of field equipment.

Training by Equipment Manufacturers

22. In October 2017, some operating personnel of major post will be sent to equipment manufacturers to learn FSSS, DEH, DCS and other control systems, operation methods and using principles and so on.





2 x 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III - TRAINING AND DEVELOPMENT

23. At least one month before commissioning the unit, operating staff will take pre-job tests to determine posts and responsibilities.

Production manager training

24. Production manager will mainly adopt independent study, appropriately combined with theory, units of same type, manufacturers, on-site training; the training of operation specialist can be arranged together with the training of operating personnel and maintenance. Maintenance staff training

Theoretical training

25. The plant will organize theoretical training of professional knowledge, focusing on electrical technology, desulphulrization technology, turbine technology, boiler technology, etc. The theoretical training for maintenance personnel and operating personnel will be combined.

Hands-on training with the unit of same type.

26. The plant will organize maintenance personnel to practice in the same type power plant.

Designing and manufacturing unit training

27. The plant will organize maintenance personnel to designing institute and three major equipment manufacturers for learning and training.

On-site installation and commissioning training

28. Maintenance personnel follow construction units to participate in the entire process during infrastructure construction including on-site installation and quality inspection, commissioning, defect elimination, and are also involved in factory inspection and construction inspection of equipment, step-by-step commissioning and the full start of unit as a whole.

29. Training of operating personnel for auxiliary equipment operation (ash removing, chemical, fuel and transportation professional)





2 X 660 MW IMPORTED COAL BASED IPP PROJECT AT SAHIWAL, PUNJAB, PAKISTAN

APPLICATION FOR GENERATION LICENSE UNDER NEPRA (APPLICATION & MODIFICATION PROCEDURE) LICENSING REGULATIONS, 1999

SCHEDULE III – TRAINING AND DEVELOPMENT

Theoretical training period

30. From February 2016 to May 2016, auxiliary equipment operator will receive theoretical training.

- February 2016 to March 2016, theoretical training for chemical professionals of auxiliary equipment operators.
- April 2016 to May 2016, theoretical training for ash removing and fuel operating personnel.

Training and internship in power plant of same type

31. June 2016 - December 2016, auxiliary equipment operating personnel will be trained with regular class in the same type power plant in China.

Entering on-site practical training

In January 2017, all auxiliary equipment personnel enter the production site to begin a comprehensive study of equipment principle, system layout, commissioning operation, etc, while participating in commissioning inspection and operation of equipment.





2 x 660 MW COAL FIRED POWER PLANT AT SAHIWAL, PAKISTAN APPLICATION FOR GENERATION LICENSE UNDER NEPRA LICENSING (APPLICATION & MODIFICATION PROCEDURE) REGULATIONS, 1999



FEASIBILITY REPORT (SECTION 17.16)

LEGAL CONSULTANT HAIDERMOTABNR FINANCIAL CONSULTANT

RIAZ AHMAD & COMPANY Chartered Accountants



Feasibility Study Report For Huaneng Shandong Ruyi Sahiwal 2×660MW Coal-fired Power Project

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Sep, 2014, Jinan

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Contents

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Chapter 1 Executive Summary 1
1.1 Background 1
1.2 Investment mode
1.3 Scope of study
1.4 Project overview
Chapter 2 Power System5
2.1 Status of the Power System
2.2 Necessity of Construction
2.3 Connection with the Power networks
2.4 Main Electrical Connection 11
2.5 Plant Communication System11
2.5.1 Telephone System
2.5.2 Dedicated Automatic Dispatching Exchanger
2.5.3 Public Address system(PA system)11
2.5.4 Digital Walkie-talkie Radio system
2.5.5 -48V DC Communication Power Supply System
2.5.6 Communication Room and Other Rooms Used for Communication 12
2.6 Telecommunication System
Chapter 3 Fuel supply 13
3.1 Coal sources
3.2 The analysis of raw coal 14
3.3 Raw coal consumption 16
3.4 Coal transportation 17
Chapter 4 Site conditions
4.1 Technical Conditions of the Area25
4.2 Transportation
4.3 Heavy equipment transportation

4.4	Engineering geological condition
4.5	Water Source
4.6	Hydrometeorology
4.7	Ash yard42
Chapter 5	5 Engineering Envisage 44
5.2	Installation scheme
5.3	Main equipment specifications50
5.4	Thermodynamic system
5.5	Boiler Combustion and pulverized coal preparation System
5.6	Coal handling system
5.7	Ash handling system60
5.8	FGD and DeNOx system
5.9	Chemical water treatment system
5.10	Electrical72
5.12	Arrangement of main power house83
5.13	Architectural structure
5.14	Water Supply and Drainage System91
5.15	Ash yard design
5.16	Fire Protection System 100
5.17	HVAC 101
Chapter 6	Environmental Protection
6.1	Environmental Standard
6.2	Flue Gas Pollution Control
6.3	Contamination control of wastewater、ash、fine breeze and noise 109
Chapter 7	Staffing of power plant
7.1	Production personnel110
7.2	Managerial personnel 8 persons
Chapter 8	Project implementation conditions and construction period
8.1	Project implementation conditions111
8.2	Envision of construction organization 112

I

8.3 Envision of Construction progress	114
Chapter 9 Risk Analysis	115
Chapter 10 Cost Estimate and Economic Analysis	119
Chapter 11 Conclusion, Pending Issues and Advice	
11.1 Conclusion	119
11.2 Pending Issues and Advice	120

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Attachments

Attachment 1: Letter of Intent for Tender Awarded

Attachment 2: Memorandum of Understanding(MOU) with PPDB

Attachment 3: Approval Documents for Environmental Impact Assessmsent

Attachment 4: Land Purchase Agreement

Attachment 5: MOU of Inter-connection System With NTDCL

Attachment 6: Letter of comfort for Railway transportation

Attachment 7: The Transportation Plan

Attachment 8: Agreement of Application for Water Intake And Discharge

Attachment 9: Water Rate Enhancing Notification

Attachment 10: Drainage Charges Enhancing Notification

Attachment 11: Letter of Coal Supply

Attachment 12:Special Report on Generator Power Factor Selection

List of attached drawings

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S.N.	Drawing No.	Description
1	37-FA16161K-Z-01	Overall plot plant
2	37-FA16161K-Z-02	General layout
3	37-FA16161K-J-01	Principle thermal dynamic system diagram
4	37-FA16161K-J-02	Coal pulverizing system diagram
5	37-FA16161K-J-03	Air and flue gas system diagram
6	37-FA16161K-J-04	General arrangement of main power building
7	37-FA16161K-J-05	Section arrangement of main power building
8	37-FA16161K-P10-01	FGD process flow diagram
9	37-FA16161K-M-01	Flow diagram of coal handling system
10	37-FA16161K-C-01	Bottom ash handling system
11	37-FA16161K-C-02	Compressed air system
12	37-FA16161K-C-03	Fly ash handling system
13	37-FA16161K-H-01	Demineralized water treatment system principle diagram
14	37-FA16161K-H-02	Condensate water polishing treatment system principle drawing
15	37-FA16161K-H-03	Waste water treatment system principle diagram
16	37-FA16161K-D-01	Main circuit single line diagram
17	37-FA16161K-S01-01	Flow diagram of water supply
18	37-FA16161K-S01-02	Water balance diagram
19	37-FA16161K-K-01	I&C overview diagram
20	37-FA16161K-K-02	BOP network overview diagram

Chapter 1 Executive Summary

1.1 Background

Electricity is indispensable for socio-economic development of the country. Pakistan faces acute shortage of electricity. More than 33% of national power generation is through oil which is costly and has resulted in expensive energy mix. This phenomenon, along with subsidies, inefficiencies and leakages in the power sector has precipitated inter-corporate circular debt. High cost of power generation results in a consumer end tariff which is un-affordable for the majority of consumers. This has adverse implications for competitiveness and national production. Government of Pakistan (GoP) promulgated National Power Policy, 2013 to foster fast track development of electricity generation. The policy also provides guidelines for generating electricity from affordable energy resources. Power generation firing coal has also been emphasized in the Policy as this would re-balance the energy mix. All the federating units are expected to fast track energy projects in line with this Policy.

Punjab is the major load center of the country and consumes about 68% of entire national grid fed electricity. Protracted load-shedding has crippled civic life, agricultural production, industrial output and commercial activities in Punjab. The power deficit has hampered economic growth in Punjab leading to poverty and fewer economic opportunities.

Punjab is deficient in energy resources. Oil is expensive while gas is scarce. The hydro and wind power generation potential in Punjab is limited. Solar power generation can usefully augment off-grid solutions and can also be connected to grid. It does not, however, provide base load which is critical to the stability of the grid. Punjab has coal reserves which can potentially be used for power generation.

Due to high sulphur and ash contents in Punjab's coal, the choice of technology is limited. Efforts are being made to harness the potential of this reserve.

This could, however, take some time. Therefore, alternate source(s) of coal need to be tapped. The coal available in Balochistan is quite suitable for power generation.

-1-

However, the regularity and reliability of supply is not assured. The development of Thar coal is also likely to take some time. It is, thus, obvious that Punjab has to rely on imported coal to meet its growing power requirement through base load generation of electricity. The energy economics of imported coal have to be viewed in comparison to RFO/LNG to satisfy immediate needs on short and mid-term basis. Inland transportation of coal is an additional cost which more or less is offset by cost of transmission of electricity, if power generation facility is installed at coast.

More than 40% of electricity generation in the world is coal fueled. Whereas, in Pakistan less than 1% present power is produced from coal. Coal is and will remain, by necessity, a key component in the world electricity generation portfolio in foreseeable future. Coal price has

remained generally stable as compared to oil and gas. Punjab's

Initiative for Development of Coal Fired Power Projects 2014 provides a framework for establishment of sizeable power plants in Punjab. This initiative is essential for rapid and sustainable economic & social development. This document while highlighting key challenges, setting major goals, summarizing policy principles and strategy will provide a broad outline for the fast track development of coal fired power plants in Punjab.

To supply more electricity to ease the electricity shortage, adjust and optimize the energy supply structure, according to the Pakistani government's 2013 National Energy Policy, the Punjab provincial government developed a "3-5 year power development plan" where 6000MW (total installed capacity) coal-fired thermal power generating units shall be built through private or public investment. Invitation to bids for six power generation projects for international power investors were planned.

Among them, Sahiwal 2×660MW coal-fired power plant has finished some preliminary works under the government leadership, Punjab provincial government has organized and carried out preliminary works including preliminary feasibility study, site selection, environmental assessment, geological surveying, inter-connection systems and transportation and positioned this plant as rapid construction project while always seeking powerful and experienced partners. In February 2014, Huaneng Shandong Power Generation Co., Ltd. (Huaneng Shandong) and Shandong Ruyi Science & Technology Group Co., Ltd. (Shandong Ruyi Group) participated in the bidding activity of Punjab power project as a consortium and its technical strength and project implementation capacity shown in bidding process were fully recognized by Punjab provincial government. On May 21st, Punjab government officially awarded Letter of Intent (LOI) for Sahiwal 2×660MW coal-fired power plant project to Huaneng Shandong and Shandong Ruyi consortium.

1.2 Investment mode

Sahiwal 2×660MW coal-fired power plant shall be built in form of joint venture, and each shareholder's shares are as follows:

Huaneng Shandong Power Generation Co., Ltd. 51%

Shandong Ruyi Science & Technology Group Co., Ltd.
49%

Main equipment and auxiliary equipment of the 2×660 MW power generation units shall be imported from China.

1.3 Scope of study

In this stage, the scope of study mainly includes:

Feasibility study on all main systems and auxiliary systems and layout of 2×660MW power plant; lay emphasis on the study of the external conditions for building power plant including main equipment selection, fuel supply, water source, ash yard, environmental protection, meteorology, engineering geology, transportation, inter-connection systems, etc; and propose the scenario for each process system, implementation conditions and schedule of the project, as well as investment estimation and economic analysis of the project.

1.4 Project overview

1.4.1 Scale of project

Planned project capacity: 2×660 MW+ 2×1000 MW. In this phase, 2×660 MW supercritical coal-fired units will be built, #1 unit is planned to be put into operation on December 31 2016, and #2 unit on June 30 2017.

1.4.2 Construction conditions and principles

The following construction conditions are established as per requirements of IPP project and the sponsors on the basis of full investigation and analysis.

-3-

(1) Plant site

The project site: about 15km away in northeast of Sahiwal city of Punjab province. Available land on the site consists of two parts, the government land of about 240 hectares and private land of about 450 hectares.

(2) Coal source and fuel coal transport

Coal will be procured from Indonesia and South Africa.

Annual coal consumption of the project: 448×10^{4} t; as the project site is far away from the coal sources, all coal required shall be shipped by sea transportation and railway transportation. Transport corridors: Coal shall be shipped from Indonesia and South Africa to Karachi Port and Qasim Port \rightarrow unload for railway transportation \rightarrow Sahiwal's Yusaf wala station via Pakistan Railways (Karachi--Lahore) \rightarrow to the site via special railway line for power plant; total rail transport mileage: about 1,100km. The special railway line will link with Sahiwal's Yusaf wala station of Pakistan Railways (Karachi--Lahore), and the total length of the special railway line is about 8km.

(3) Water source

Annual water demand of the project: 20,340,000m³ from LBDC Canal about 600m away to south of the site, and groundwater sources are supplementary and alternate water.

(4) Site

The site is located in a relatively stable area suitable for building of large-scale projects.

Basic seismic intensity of the district: 7.

Foundation treatment will be necessary for the site. Pile foundation will be used for main power building, chimney, boiler, turbine foundation and other important buildings (structures) of the plant.

(5)Equipment selection

China-produced 660MW supercritical coal-fired condensing power generation units shall be used.

(6) Inter-connection system

In this project, 2×660MW class units will be connected to the new 500kV substation

-4-

of the plant via double-coil step-up main transformer; number of 500kV circuits: 2; the 500kV Lahore-Sahiwal line will be available for the connection.

(7) Ash handling and ash yard

Dry pneumatic ash handling and mechanical slag handling will be used; special vehicles will be used to transport the ash and slag to ash yard for compaction and piling.

(8) Thermal system

Except auxiliary steam system which uses common header system, all other systems shall use unit system.

(9) FGD facilities will be built together with the power generation units.

(10) I&C

This project uses centralized control of boiler, mechanical equipment, electrical equipment, grid and auxiliary equipment; one centralized control room shall be set for two units. Boiler, turbine and I&C devices are arranged in a decentralized way; main plant control uses Decentralized Control System (DCS), and auxiliary plant uses PLC control.

(11) Annual equivalent full load hours of the units: assumed to be 6800 hours.

Chapter 2 Power System

2.1 Status of the Power System

2.1.1 Outline

Pakistan has been facing substantial electricity shortage and the province of Punjab is no exception. Punjab, with a population of 93 million, is the largest province of Pakistan and contributes 60% of the GDP. It has a large industrial base with more than 48,000 industrial companies. There is a growing un-met demand of energy.

With deepening energy crisis over the last few years and growing gap between the demand and the supply, the Punjab province has also decided to look for ways and means to assist the Federal Government in its efforts to address the challenge of growing energy shortages. The Government of the Punjab has now taken major steps to open up the coal sector for power generation. The strategy aims at dramatically

-5-

increasing coal use with import-based and local coal.

In Punjab, at present, there is a demand-supply gap of about 4000 MW which is increasing at a rate of 6% per annum. Punjab with 68% of the consumption of generated power and gas is worst affected and has to endure both power and gas load shedding with adverse social and economic consequences.

Based on the new policy, the provinces are now vested with full authority to develop power projects of any capacity through public or private sector and establish required regulatory framework. In view of lingering energy crisis and opportunity provided by the new enabling framework, the Government of the Punjab decided to play a pro-active role in the energy sector.

2.1.2 Power Development in Pakistan

Considering the strong correlation between economic growth and energy demand growth, there is an imperative need for sustained increases in energy supply not only to sustain the growth momentum but to protect the economy from disruptions caused by energy deficits reflected in demand management, popularly known as load shedding.

The demand and supply of electricity was balanced in 1997 with the commissioning of private sector Independent Power Projects (IPPs) established under the Private Power Policy, 1994. Generation capacity has increased since 1997, and it was expected that demand and supply would remain in equilibrium by 2020. However, faster economic activity, rising disposable income, higher availability of consumer finance, double-digit growth of large-scale manufacturing, and higher agricultural production have all resulted in higher demand for power. From June 2005 to the end of 2013, there is big supply-demand gap as peak demand growth approached 4.7% per mean year during 2000 to 2013.

A yawning supply-demand gap is up to 4,200 MW, where the demand for electricity far outstrips the current generation capacity leading to gaps. The supply-demand gap has continuously grown over the past 5 years until reaching the existing levels. Such an enormous gap has led to load-shedding of several hours across the country.

The state grid of Pakistan is composed by National Transmission and Dispatch Company Limited (NTDC) grid and K-Electric grid. K-Electric, which achieved

-6-

privatization in 2005, is now responsible for power generation, transmission and distribution of Karachi as well as Uthal Sindh and Balochistan Bela.

NTDC undertakes the power transmission and distribution of Punjab, which was founded on November 6, 1998 and operated on December 24,1998. NTDC is responsible for operation and maintenance of all the power facility within its jurisdiction including twelve 500kV substations, twenty-nine 220kV substations, 5077km 500kV transmission line and 7359km 500kV transmission line.

Nine distribution companies are:

- (1) Lahore company (LESCO)
- (2) Gujranwala company (GEPCO)
- (3) Faisalabad company (FESCO)
- (4) Islamabad company (IESCO)
- (5) Multan compony (MEPCO)
- (6) PESCO
- (7) Hyderabad compony (HESCO)
- (8) Quetta compony (QESCO)
- (9) Taxila company (TESCO)

The total installed capacity by June, 2013 is indicated in the following table.

Table 2.1-1	Total Installed	Capacity	(MW, by	y June,	2013)	
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Category	Installed Capacity	Percentage
Hydel WAPDA	6572	32.4%
Gencos	4829	23.2%
Thermal IPP	8294	39.8%
Hydel IPP	195	0.9%
Nuclear	665	3.2%
Wind	106	0.5%
Total	20841	100%

Highly expensive generation of electricity due to an increased dependence on expensive thermal fuel sources (44% of total generation) such as RFO (Residual fuel oil), HSD (High speed Diesel) and Mixed. Dependence on such expensive fuel sources has forced Pakistan to create electricity at rates that are not affordable to the nation and its populace. A terribly inefficient power transmission and distribution system increases cost, which currently records losses of 23-25% due to poor infrastructure, mismanagement, and theft of electricity.



-9-

2.1.3 Power Balance

According to the data provided by NTDC (National Transmission and Dispatch Company Ltd .Pakistan), by Apr. 2013, the total installation capacity is 20,841MW. Due to delivery loss and lack of gas and oil, the actual operating capacity was about 14,600MW, the peak load was about 18,800MW, therefore, the gap between demand and supply was about 4,200MW. Table 2.1-2 below shows the balance of demand and supply from 2003 to 2012, Table 2.1-3 shows the forecast of demand and supply from 2013 to 2019. The gap between demand and supply will be 2496MW in 2017.

Table 2.1-2 Power Balance of Demand and Supply from 2003 to 2012

(MW)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Demand	11598	12595	13847	15838	17398	17852	18467	18521	18940	18827
Supply	13166	13816	13796	14085	14092	13912	13445	14451	14465	14600

Table 2.1-3

Forecast of Demand from 2013 to 2019

(MW)

	2013	2014	2015	2016	2017	2018	2019
Demand	22140	23242	24361	25521	26755	28058	29423
Supply	17574	19155	18534	20304	24259	26588	29895

Note: Source from NTDC

2.2 Necessity of Construction

In order to mitigate power shortage, the Punjab government has encouraged the private and public sector to develop power projects. Huaneng Shandong and Shandong Ruyi Group want to build the 2×660 MW coal-fired power plant, which is assumed to be put into operation in 2017 to meet the increasing electricity demands of Punjab system and increase the power distribution reliability.

2.3 Connection with the power networks

According to the size of the power plant, single unit capacity and its service area, this project is assumed to be connected with the power network with 500 kV transmission lines and its connection scheme is as follows:

-10-

The 2×660 MW units will be connected with the new 500kV substation through two-winding transformer, and 2 outgoing lines(4×400mm²) are needed to connected with the new substation. It is recommended to break the 500kV line between Lahore and Sahiwal and connect with the outgoing lines. (Note: The connection has been approved by NTDC)

2.4 Main Electrical Connection

The 500kV substation of the plant is in a one and a half breaker configuration.

2.5 Plant Communication System

Plant communication system contains Private Automatic Branch Exchanger (PABX), Dedicated Automatic Dispatching Exchanger (DADX), Public Address system, Digital Walkie-talkie Radio system and 48V DC power supply system.

2.5.1 Telephone System

One new PABX with 500 extensions will be provided for plant telephone system. And it can be expanded to 1000 extensions by adding matchable cards. The telephone network will cover the whole plant area. PABX can be trunked with PSTN(Public Service Telephone Network) by trunk lines so that persons in the plant can call outside parties. The final interface type of trunking to be used shall be determined by Owner/Employer. PABX is powered by 48V DC power supply.

At the same time, one Main Distribution Frame (MDF) cabinet is provided. And its capacity is 1200 pairs. Accordingly, communication cables, ducts, junction boxes, phone socket etc will be provided.

2.5.2 Dedicated Automatic Dispatching Exchanger

One Dedicated Automatic Dispatching Exchanger(DADX) is provided. Its preliminary capacity is 96 extensions. It will be dedicatedly used for production dispatching in the whole power plant. DADX contains one main station, one PC maintenance server, some dispatching consoles and indoor or outdoor user terminals which can be common phones, industrial stations with amplifier and/or loudspeaker etc. DADX is powered by 48V DC circuits.

2.5.3 Public Address system(PA system)

One Public Address system will be provided and can offer 50 industrial phone

-11 -

stations with loudspeaker. It is dedicatedly used for coal handling system. The CHP Control Room will be laid with one desktop control station. Every sub-control room in the coal handling area will be laid with one desktop station. Industrial phone stations will be installed indoor or outdoor. The type of every industrial phone station to be used is decided by its working environment. It may be waterproof, explosion-resistant, noise-resistant and so on. According to the different areas of the power plant, the phone stations can be divided into different groups. Every desktop control station will control one or more phone station groups. The industrial phone stations in one group are interconnected by multi-conductor cables. The system will be connected with PABX and DADX by trunking lines. The main station of PA system is powered by plant UPS power supply.

2.5.4 Digital Walkie-talkie Radio system

36 walkie-talkie radio sets will be provided. Every radio set will work at UHF band and has not less than 8 channels. The communication distance will be not less than 5km. But Employer shall be responsible to get the use license for the frequency from the local government radio management committee. The working frequency scope can be between 300MHz to 480MHz. Walkie-talkie radio sets are used by persons responsible for patrolling and maintenance in the plant area.

2.5.5 -48V DC Communication Power Supply System

Such a system includes two separate high-frequency switch power supplies and two separate groups of lead-acid batteries. The capacity of each high-frequency switch power supply is 48V/200A, and the capacity of each group of batteries is 48V/500Ah.The capacity of every cell battery is 2V/500Ah.Each group of batteries consists of 24 cell batteries. One high-frequency switch power supply charges one battery group. So that two separate communication power supply systems are set up. Each high-frequency switch power supply is input two separate 380V AC, three phases circuits. These two circuits shall come from different busbars of the plant power supplies. The capacity of each circuit is not less than 15kVA.

2.5.6 Communication Room and Other Rooms Used for CommunicationOne Communication Room is prepared inside the Network Control Building. All the

-12-

cabinets used to install all communication equipments are laid in the Communication Room. Beside the Communication Room, one communication battery room is provided and to be specially used to lay the two groups of communication batteries. All the equipments in the whole plant will be installed in the Communication Room with cabinets. They are PABX, DADX, Main Distribution Frame (MDF),PLCC terminals or optical communication equipments, -48V DC Communication Power Supply Systems etc. Public Address system will be installed in CHP COMPLEX BUILDING and be powered by UPS circuits.

At the same time, one communication keep-watching room and one communication instruments & meters room are provided. The PC maintenance servers of all communication systems and operator console of PABX will be laid in the communication keep-watching room. The communication persons working for patrolling and maintenance of plant communication will also work here. The instruments & meters room is used to deposit communication tools, instruments, meters, spare parts of communication equipments and so on.

2.6 Telecommunication System

The Telecommunication System is designed by NTDC. The style and parameter of the communication equipments installed in the power plant will be matched with the requirement of NTDC. The Sponsor is only responsible for the system within the power plant fence wall.

Chapter 3 Fuel supply

3.1 Coal sources

The coal consumption of two boilers will be 4.48×10⁶t/a, coal sources for the power plant will be Indonesian and South Africa.

3.1.1 Indonesia

Indonesia's major coal-producing areas are in Kalimantan Island. Indonesia is currently the world's No.1 steam coal exporting country.

Indonesia's major coal companies: Banpu Group, KPC Mine, KIDECO Company,

-13-

etc.

(1) Banpu Group: Banpu Group has four wholly-owned coal mines in Indonesia, namely Indominco Mine, Jorong Mine, Trubaindo Mine and Kitadin Mine.

(2) KPC Mine: KPC Mine is Indonesia's largest coal mine. It has special wharf with draft of 17.5m available for CAPE type vessels docking. KPC Mine covers an area of 900 km².

(3) KIDECO Company:

KIDECO Company's main coal producing areas are in East Kalimantan, covering an area of 50,921 hectares, reserves: 1.442 billion tons, recoverable reserves: 651 million tons. KIDECO Company's coals are mainly sold to Asia, including Indonesia's consumption of about 30%, and the rest are exported to other countries.

3.1.2 South Africa

South Africa is the African continent's largest steam coal exporter. Currently, its volume of exports is 65 million tons, and more than 90 percent of the coal exported is used as steam coal.

Currently there are 52 coal mines in South Africa. Compared with other African countries, South Africa has good rail and port infrastructures. South Africa ranks No.6 in anthracite reserves and also No.6 in coal production capacity in the world. Richards Bay, South Africa is the world's largest single coal export port, while South Africa is also the No.5 coal exporter in the world. South Africa has abundant coal reserves, accounting for about 7% of global coal reserves. These reserves are expected to support a continuous development of 30-50 years, while the application of clean coal technology can extend the useful life of these coal reserves.

3.1.3 Conclusion

The above-mentioned proposed reserves, produced quantity and export situation of coal source countries can meet the needs of the project. SPV has already signed the CSA (coal supply agreement) with Fuel supply company of Huaneng Group to ensure the long-term reliable supply of coal for the project.

3.2 The analysis of raw coal

The raw coal for this project will be imported from South Africa and Indonesia.

-14-

South Africa Coal and Indonesia Coal will be blended for the Design Coal and Check Coal. The analysis of raw coal and ash is shown in the following table.

Item	Symbols	Unit	Design coal	Check coal
Total moisture (on as received basis)	Mt	%	18.2	25.1
Inherent moisture (on air dried basis)	M _{ad}	%	11.53	10.04
Ash (on as received basis)	A _{ar}	%	8.15	9.28
Volatile matter (on dry ash-free basis)	V_{daf}	%	44.69	41.72
Carbon (on as received basis)	C _{ar}	%	55.14	49.90
Hydrogen (on as received basis)	H _{ar}	%	3.40	3.05
Nitrogen (on as received basis)	N _{ar}	%	0.92	0.88
Oxygen (on as received basis)	O _{ar}	%	13.79	11.45
Total sulfur (on as received basis)	S _{t,ar}	%	0.40	0.34
High heating value(on as received basis)	Q _{gr,v,ar}	MJ/kg	21.32	19.29
Low heating value(on as received basis)	Q _{net,v,ar}	MJ/kg	20.20	18.08
Hardgrove grindability	HGI	/	52	51
Impingement abrasion index	Ke	1	1.4	1.2
Ash fusion temperature/Deformation temperature	DT	×10 ³ ℃	1.14	1.18
Ash fusion temperature/Softening temperature	ST	×10 ³ ℃	1.17	1.21
Ash fusion temperature/Hemispherical temperature	НТ	×10 ³ ℃	1.19	1.22
Ash fusion temperature/Flow temperature	FT	×10 ³ ℃	1.21	1.24
Silicon dioxide	SiO ₂	%	44.99	46.70
Aluminum trioxide	AI_2O_3	%	19.11	24.10
Ferric trioxide	Fe ₂ O ₃	%	13.24	10.01
Calcium oxide	CaO	%	11.55	9.69
Magnesium oxide	MgO	%	1.20	1.07
Sodium oxide	Na ₂ O	%	0.42	0.39
Kalium oxide	K ₂ O	%	0.87	0.90

-15-

Item	Symbols	Unit	Design coal	Check coal
Titanium oxide	TiO ₂	%	0.52	0.64
Sulfur trioxide	SO ₃	%	7.45	5.75
Manganese oxide	MnO ₂	%	0.020	0.020
Chlorine in coal	CI _{ar}	%	0.018	0.014
Free silicon dioxide in coal	SiO ₂ (F)	%	0.71	0.67
Fluorine in coal	F _{ar}	hð\ð	79	64
Mercury in coal	Hg _{ar}	µg/g	0.17	0.13

			Specific	resistance of ash	
	Item	Symbols	Testing voltage (V)	Testing temperature (℃)	Specific resistance (Ω·cm)
				Atmospheric temperature	4.10×10 ¹⁰
				80	6.50×10 ¹¹
	Design Coal	0	500	100	2.00×10 ¹²
	Design Coar	PCA		120	2.20×10 ¹²
				150	4.10×10 ¹¹
-				180	6.50×10 ¹⁰
		Рса		Atmospheric temperature	1.80×10 ¹⁰
			500	80	1.90×10 ¹¹
-	Check Coal			100	1.10×10 ¹²
	Oneck Oddi		500	120	1.90×10 ¹²
1				150	3.90×10 ¹¹
•				180	6.30×10 ¹⁰

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Fuel coal consumption for 2×660MW units is listed in the following table.

ltom	Lloit	Desiç	gn Coal	Check Coal		
item	Offic	1 Boiler	2 Boilers	1 Boiler	2 Boilers	
Coal consumption per hour	t/h	294.9	589.8	329.5	659.0	
Coal consumption per day	t/d	6487.8	12975.6	7249.0	14498.0	
Coal consumption per year	10⁴t/a	200.5	401.0	224.1	448.2	

Note: Calculation basis of the fuel consumption:

- -- 6800 hours per year
- -- 22 hours per day
- -- Under BMCR condition
- 3.4 Coal transportation
- 3.4.1 Mode of coal transportation

Coal will be shipped to Karachi Port or Qasim Port by sea from oversea suppliers and transported to Yusaf Wala station in Sahiwal by Pakistan Railway, and then transported to the power plant by special railway line.

3.4.2 Conditions of transportation channels

3.4.2.1 Sea transportation

Coals will be shipped by the overseas suppliers (from Indonesia and South Africa) using dry bulk carrier.



Figure 3.4.2-1 Diagram of Coal Transportation by Sea

(1) Ship

Bulk carrier is generally classified by deadweight tonnage(dwt) into 4 size categories: Handysizer, handymax, Panamax, and Capesize. Bulk carriers of less than 35,000 dwt constitute the Handysize vessel category. Vessels with capacities ranging from 35,000 dwt to 60,000 dwt comprise the Handymax class. Bulk carriers in the 60,000t~80,000 dwt size class are termed Panamax vessels, which is the largest bulk carriers that can pass through the Panama Canal. The Ocean-going vessels extending 80,000 dwt fall into the Capesize class.

Classification of bulk carriers according to size is summarized in the following table:

				WORLD BULK AS C	CARRIER FLE DF JANUARY 1	ET (") PROFILE , 2013				
SIZE GROUP BY DWT	AVERAGE DIMENSIONS, SPEED				IN SERVICE			ON ORDER		
	LENGTH (Feet)	BEAM (Feel)	DRAFT (Feet)	SPEED (Knots)	SHIPS	DWT (000s)	Average DWT	SHIPS	DWT (000s)	Average DWT
	•			Handy S	Size (10,000-29,	999 dwt)				
10.000-19.999	463.6	71.2	28.9	13.6	513	7,894	15.388	19	235	12.368
20,000-29,999	522.3	80.4	31.5	13.8	1,184	31.047	n/a	58	1,519	
				Handyn	nax (35,000-59,	999 dwt)				
30,000-39,999	599.8	92.2	34.1	14.1	1,340	46,422	3.443	315	11,175	35,474
40,000-49,999	625.0	101.4	37.4	14.3	896	40,509	45.211	111	5,128	46,194
50,000-59,999	628.0	106.0	40.7	14.3	1,786	98.918	55,385	303	16.928	55,869
				Panam	ax (60,000-79,9	99 dwt)				
60,000-79,999	737.9	106.3	44.3	14.2	1,490	108,360	72.725	304	21.616	71,104
				Cape Siz	te (80,000 dwt a	ind over)				
80.000 - 99.999	757.6	117.5	46.6	14.3	776	67,145	88.527	356	30.024	84,338
100.000-119,000	833.0	142.4	47.6	14.3	106	11,963	112.262	33	3.625	109,843
120.000-159,999	892.1	142.4	55.8	13.9	137	20,283	148.050	1	120	120,000
160.000 & over	971.2	154.2	59.7	14.6	1262	246,628	195.426	211	45.844	217,269
TOTALS	678.8	107.6	41.0	14.2	9,490	679,169	71,567	1.711	136,214	79.610

(2) Port in Coal Source Place

Coals from the South Africa can be loaded into the Capesize bulk carrier in Richards Bay.

Coals from Indonesia can be loaded into the Capesize bulk carrier by using the offshore cranes or floating loading facilities. The coal port in Balikpapan can accommodate the Capesize bulk carrier. KPC can accommodate the Capesize bulk carrier. International bulk terminal (IBT, Adaro) can only accommodate the Panamax bulk carrier, but Adaro terminal can accommodate the Capesize bulk carrier through the offshore cranes.

(3) Traveling Distance and Transportation Frequency

According to the annual consumption of the power plant, 4 ships will arrive at the port each month if the Capesize bulk carrier is used for transportation; 9 ships will arrive at the port each month if the Panamax bulk carrier is used. It will only need 11 days if starting from the Richards Bay of the South Africa; and it will need about 12 days if starting from Balikpapan of Indonesia.

From the above, the sea transportation capacity is guaranteed in accordance with the experience and current situation of the international trade and logistics for coals, but there is a risk of freight fluctuation. Currently, the freight by sea has been decreasing for years.

3.4.2.2 Port

The ports connecting with the Karachi~Lahore national railway in the south of Pakistan include the Karachi Port and Qasim Port; their channel depth is about 30m, and the port apron has sufficient water depth. Currently, transportation of imported coals in these two ports most vessels are self-unloading, and it need about 2 days to unload 45,000t coals by using self-equipped unloading equipment; At present, berth for coal is not provided with fixed mechanical unloading equipment, and mobile unloading equipment is usually used for coal bulk carrier. It needs about 4-5 days to unload the coals of a 45,000t vessel.

(1) Karachi Port

Karachi Port is the largest port in Pakistan, and the water depth alongside the port
is 16m; it can accommodate vessels of 100,000t and above. There are 30 berths for coal, cement, petroleum, chemicals, containers, etc, in the port currently. Among them, four 60,000t coal berths have a throughput capacity of $7,000,000t \sim 8,000,000t$, and the annual actual coal throughput is about 4,000,000t. Karachi Port currently has about 18 ha of storage yard, and the storage yard area will be increased by 6 ha through reclaiming land from sea. At present, three 55000 dwt coal vessels can be unloaded at same time in Karachi Port.

In accordance with the development plan of Karachi Port, it is planned to reconstruct the existing 3 berths (No. 15, No. 16 and No. 17) to specialized coal unloading berths. After reconstruction, the specialized coal ports have a throughput capacity of 8,000,000t, and the unloading equipment in port will use the bridge grab ship unloader with an output of 1200t/h. It is planned to be completed and put into operation in 2016, and currently financing is in progress.



Figure 3.4.2-2 Plane and Planning Diagram for the Karachi Port

The current capacity of Karachi Port is as follows:

1	Coal loading & unloading capacity	8,000,000t/a					
2	Current loading & unloading of coals	4,000,000t/a					
3	Storage yard	180,000m ²					
4	Increased storage yard (being reclaiming land from sea)	60,000m ²					
5	Available storage capacity	700,000t					
6	Handling capacity of current Karachi Port	55,000t coal carrier (3 carriers can be handled at the same time)					

(2) Qasim Port

Qasim Port, which is located about 20km in the east of the Karachi Port, is the second largest port of Pakistan; the port apron has a water depth of 10.5m, and it can accommodate 45, 000t ships; there are 7 berths currently in the port for coal, cement, petroleum, chemicals, containers, etc. Among them, the annual actual coal throughput of three 45,000t coal berths is about 2,500,000t, while the capacity is 4,000,000 \sim 5,000,000. Qasim Port currently has about 4 ha of storage yard.

In accordance with the development plan of Qasim Port, PIBT (Pakistan International Bulk Terminal Co., Ltd) is constructing two 45,000t specialized coal unloading berths in the Qasim Port in BOT mode, and each berth has a throughput capacity of 8,000,000t. These berths will be completed and put into service in June 2016 according to the plan. In addition, one 75,000t specialized coal unloading port is proposed in the Qasim Port in BOT mode, and it will have a throughput capacity of 12,000,000~16,000,000t. It will be completed and put into service in 2017 according to the plan, and currently this project is in the funding phase.

PORT QASIM - LAYOUT PLAN



Figure 3.4.2-3 Plane and Planning Diagram for the Qasim Port

Maximum handling capacity of 2-4 berths	5,000,000t/a - draught 10.5m					
Loaded and unloaded coals since 2001	66 ships, 2,500,000t, largest ship 45,500t (a small amount loaded and unloaded coals since 2010)					
Storage yard	53 acre (currently, 10 acres are used for coal storage - each acre can store 20,000t coals)					
Coal unloading facilities	4-5 days will be required if using the coal unloading bucket wheel machine/mobile cargo unloading facility					

Current Capacity of Qasim Port

From the above, the existing berths as well as the conditions of coal unloading facilities, coal transfer and railway loading, etc cannot meet the transportation demands of coals required by this project. In order to meet the requirement of planning coal-fired plant in Pakistan, corresponding updating plan is made for the 2 ports, and the existing ports will be reconstructed to specialized coal port or 100,000t specialized coal ports will

be constructed in coming years. The port loading and unloading equipment will use the bridge grab ship unloader with an output of 1200 t/h. After implementation of the plan, 6,000,000t coals can be conveyed to this project each year.

The sponsor has signed MOM about coal handling and unloading with the port management. Further agreement with more details about the reconstruction of coal berths, provision of additional coal conveying belt and railway loading facilities, etc should be signed with port management, port BOT operator and Pakistan Railways.

3.4.2.3 Railway

The railway from Karachi Port to Yusalf Wala railway station in Sahiwal is a double-line railway, with a total length of about 1100km, track gauge of 1676mm, 54kg/m steel rail, diesel locomotive traction, traction tonnage of 3200t~3500t, 40 marshaling sections of train (each section has a dead weight of about 20t and load of 60t) and effective length of 700m. The designed through capacity of this railway is 90 pairs/day, the current volume is 40 pairs/day and there is still a surplus capacity of 50 pairs/day. 50% section rail lines of the whole railway can meet the designed capacity. Currently, PAKISTAN RAILWAYS is making invitation for bid for the reconstruction project of section rail lines of the railway from Karachi Port to YUSAF WALA railway station of Sahiwal, and the reconstruction will be started at the end of this year according to the plan. The railway after reconstruction can meet the coal transportation demand of 6-7 pairs/day of the power plant. PAKISTAN RAILWAYS has issued a commitment letter for transportation of the plant.

Yusaf Wala railway station in Sahiwal currently has 2 main tracks, 2 arrival-departure tracks and 1 goods line. In accordance with the site investigation, 1 arrival-departure track close to the station building is not put into service. The special railway line of power plant proposes to connect with the northeast throat of Yusaf Wala railway station. About 22km power plant special railway line will be constructed from the Yusaf Wala railway station to the power plant. A bridge with a span of 30m shall be constructed at the location crossing over the LBDC canal; single-slot coal unloading chute shall be arranged in the power plant to meet the coal unloading demands of half of a train (20 sections); the railway is the passing through type.

-24-

Chapter 4 Site conditions

4.1 Technical Conditions of the Area

4.1.1 Location

The site of Power Plant is located about 15km northeast to Sahiwal, Punjab province, Pakistan. (30°43'10"north latitude ,73°14'30"east longitude of Greenwich).



Fig 4.1.1-1 Boundary of site land

The land can be used for power plant consists of two parts, government owned land and private owned land. The land owned by government is about 240 ha (inside blue line, the land inside black line should be reserved). The land owned by private department is about 450 ha (inside yellow line). The 500kV transmission line goes across the private land. The plant, ash yard, reservoir are all inside these two parts of land.

LOWER BARI DOAB CANAL is adjacent, to southeast of the site. The further southeast is the railway from Karachi to Lahore and National Highway-N5. Yusaf wala railway station is 4km southwest to the site.

4.1.2 Physiognomy of the site

The topography of site is flat. The average height above sea level is about 173.2m. Most of the site is farmland, and a small part is used for husbandry.



Fig4.1.2-1 Present situation of site

Inside the boundary of site, no demolition is required. The land will be acquired through the government. The land will meet the requirement of 2×660MW coal fired plant, ash yard and reservoir. And the site can further hold 2×1000MW generating units.

- 4.2 Transportation
- 4.2.1 Railway

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4.2.1.1 Railway network



Fig 4.2.1-1 Updating of Pakistan Railway in process

The railway from Karachi to Lahore passes by the site to its southeast. The Pakistan Railway introduced that current capacity of railway can meet the 500×10^4 t coal transportation required by the power plant. And Pakistan Railway is updating the rail and signal system, planning new lines, buying locomotives and wagons. The government promised the transportation need of the power plant will be guaranteed.

4.2.1.2 Special railway line

The special railway line of the power plant will connect from Yusaf wala railway station to the plant. The special railway line starts from the northeast of Yusaf wala station, and goes along the existing railway lines, then across the canal to the plant. The whole length of special railway line is about 22km.

- 4.2.2 Road transportation
- 4.2.2.1 Roads network



Fig 4.2.2.1-1 Pakistan National Highway network

Most of highways in Pakistan are in the north-south direction. National Highway-N5 (GT Highway) on the east bank of Indus River and National Highway-N55 (Indus River Highway) on the west bank of Indus River are the two main traffic arteries. Most industrial and commercial activities are concentrated in the corridor along the two highways.

4.2.2.2 Access road

The access road is connected from south to National Highway –N5, across the canal and railway, and is 1100m long. The access road will be completed by reconstructing the existing road and shared with the villages around. The width of access road is 9m, cement concrete paved.

4.3 Heavy equipment transportation

Most heavy equipment will be purchased in China, and will be transported to seaport by highway or railway, and they will arrive at Karachi by sea. Highway transportation is a preferred choice for the heavy equipment that can be transported by

-28-

highway such as main transformer (single-phase transformer is adopted), generator rotor. Generator stator, deaerator water tank (transported in separate parts) and so on can be transported by road or railway to the plant directly.

4.4 Engineering geological condition

4.4.1 Regional geological

4.4.1.1 Geomorphology and stratum

Sahiwal 2×660MW Coal Fired Power Plant is located at east of Sahiwal city, Punjab, Pakistan. The site is situated on north side of main dual track road network from Sahiwal to Lahore.

Geomorphology of the area is alluvial plain; topography of the area is characterized by plain.

Stratum is covered by Quaternary alluvium which presumably overlies semi-consolidated Tertiary rocks or metamorphic and igneous rocks of Precambrian Age. Except for a small area in the northeastern part of the Doab where basement rocks are encountered by deep test holes, no information is available at present regarding the distribution of Tertiary and Precambrian rocks in the Doab. Most of the test boreholes were terminated in unconsolidated sediments.

4.4.1.2 Geologic structure and earthquake

The proposed site isn't largely affected by earthquake.

According to PRELIMINARY SEISMOTECTONIC MAP OF PAKISTAN, there is no active fault in and around the proposed site area. The proposed site area is suitable for large engineering construction.

4.4.2 Engineering geological condition

4.4.2.1 Geomorphology

Geomorphology of the area is alluvial plain; topography of the area is characterized by plain.

4.4.2.2 Soil and rock layers

The investigations conducted through fourteen exploratory boreholes namely BH-1 to BH-14 in the geotechnical report GEOTECHNICAL INVESTIGATION REPORT 2×660MW SUPERCRITICAL COAL FIRED PLANT AT SAHIWAL have revealed that

-29-

subsurface at the proposed site consists of soft light brown silty clay/ clayed silt top soil layer of 1.0m to 8.0m thickness, underlain by soft to firm light brown silty clay/ clayed silt of 1.0m to 9.0m thickness, underlain by medium dense to dense light grey to dark grey silty sand/ fine sand, underlain by dense light grey to dark grey silty sand/ fine sand, underlain by dense light grey to dark grey fine sand layer which extends down to the investigated depth of 39.0m. The silty sand/ fine sand soil layer is interrupted in some boreholes by hard stiff brown to dark brown silty clay or medium dense silty sand/ fine sand lenses.

The subsoil is divided into three strata in the geotechnical report of GEOTECHNICAL INVESTIGATION REPORT 2×660 MW SUPERCRITICAL COAL FIRED PLANT AT SAHIWAL:

I silty clay/ clayey silt(NSL-3.0m to 8.0m);

II silty sand/ fine sand(3.0m to 8.0m-15.0m);

III dense to very dense fine sand(15.0m-60.0m).

According to the logging of boreholes, combined with in-situ test result, the subsoil is re-stratified according to Chinese codes GB50021-2001 and DL/T 5160-2002. Subsoil stratifications are presented as below:

 Clayey silt: This layer of soil consists of brownish grey silt having a few small sized nodules and a few fine mica flakes covered by agricultural soil of about 0.5m thick. Thickness varies from 1.0 to 8.0m. The characteristic value of bearing capacity is 90-110kPa, and the compression modulus is 4.0-8.0MPa.

②Clayey silt: This layer of soil consists of brownish grey soft to firm silt. Thickness varies from 1.0 to 9.0m. The characteristic value of bearing capacity is $100 \sim 120$ kPa, and the compression modulus is 4.0-8.0 MPa.

③Silty fine sand: This layer of soil consists of medium dense to dense light grey to dark grey silty sand/ fine sand. Thickness varies from 3.00 to 11.00m. The characteristic value of bearing capacity is 130-150kPa, and the compression modulus is 6.0-10.0MPa.

④Silty fine sand: This layer of soil consists of dense light grey to dark grey silty sand/ fine sand. Thickness varies from 5.00 to 25.45m.The characteristic value of bearing capacity is 130-150kPa, and the compression modulus is 6.0-10.0MPa.

-30-

⁽⁵⁾Silty fine sand: This layer of soil consists of dense to very dense light grey to dark grey fine sand layer. This layer is interrupted in some boreholes by hard stiff brown to dark brown silty clay or medium dense silty sand/ fine sand lenses. The holes are not advanced to bottom of the layer this time, the depth of the top of this layer varied from 18.00 to 29.50m. The characteristic value of bearing capacity is 160-190kPa, and the compression modulus is 9.0-15.0MPa.

4.4.3 Groundwater condition and corrosion effects of groundwater on building material

4.4.3.1 Groundwater condition

Groundwater is mainly Quaternary phreatic water, recharges from atmospheric water and discharges through evaporation and surface runoffs. Groundwater level varies periodically with seasonal, meteorological change and landform change.

According to 2×660 MW COAL FIRED POWER PLANT NEAR SAHIWAL REPORT ON WATER RESOURCE STUDIES, the Quaternary alluvium complex within the Doab consists of unconsolidated sand, silt and silty clay. As mentioned earlier, the area lies in Bari Doab, where the thickness of aquifer is more than 1,000 ft. (300 m). Most ground water is being utilized by the farmers for irrigation. There is no legislation on ground water use.

Therefore, exact drawdown of groundwater in the project area cannot be predicted for future. Currently groundwater is available at a depth of about 40 feet underlying the site area. Considering the historical trends, water table is going down at rate of 1ft/a (0.3 m/a).

Accordingly, the adopted/recommended hydraulic conductivity values range from 16 to 50 m/day with average value of 35m/day.

During investigation, depth of burial of groundwater observed from bore holes was between $5.90 \sim 7.90$ m, the groundwater level vary from $165.23 \sim 167.23$ m. According to the geological report presented by DECON, perennial highest groundwater level may be considered at 0.0m for design.

4.4.3.2 Corrosion effects of groundwater (subsoil) on building material According to 'Summary of Laboratory Test Results' presented by Attachment-VII in

-31-

GEOTECHNICAL INVESTIGATION REPORT 2×660 MW SUPERCRITICAL COAL FIRED PLANT AT SAHIWAL, pH value of groundwater is $7.3 \sim 7.6$, concentration of Chloride ion is $115.0 \sim 160.0$ PPM; concentration of sulphate ion is between $329.0 \sim 452.0$ PPM.

Based on above data, according to code for investigation of geotechnical engineering (GB50021-2001), it can be concluded that the groundwater has weak corrosive effect on concrete structure and steel bar in concrete structure in site II circumstance.

The analysis and evaluation of corrosive effect of subsoil on concrete structure and steel structure is being performed now (preliminary design).

4.4.4 Adverse geologic phenomena evaluation

According to the site exploration circumstances, we didn't find adverse geologic phenomena, for example karsts, landslide, crag, rock fall, debris flow, mined-out, land subsidence, etc.

4.4.5 Frost depth

Perennial minimum air temperature is above 0 in this area, so influence of frozen soil can be ignored.

4.4.6 Mineral resources and cultural relic

According to the feasibility investigation design data of this project, there is no antiques and mineral. It is recommended to follow the government documents about mineral resources and cultural relic in this project area.

4.4.7 Seismic effect

4.4.7.1 Parameters of ground motion

According to the Building Code of Pakistan, the suggested value of ground motion peak acceleration is 0.12g, and corresponding basic earthquake intensity is 7.

4.4.7.2 Foundation soil type and site class

According to Attachment-VIII in GEOTECHNICAL INVESTIGATION REPORT 2×660 MW SUPERCRITICAL COAL FIRED PLANT AT SAHIWAL, the equivalent velocity of shear wave of subsoil to a depth of 20m vary from 222 to 235m/s, a depth of 5~20m vary from 312~320m/s. Referring to Tab 4.1.3 in Code for seismic design of

buildings, subsoil type for seismic effect is classified to moderately soft soil to moderately hard soil.

According to shear wave velocity of subsoil and depth of overlying stratum, Site is classified to grade II -III in Code for seismic design of buildings.

4.4.7.3 Liquefaction of foundation soil

According to analyses in GEOTECHNICAL INVESTIGATION REPORT 2×660 MW SUPERCRITICAL COAL FIRED PLANT AT SAHIWAL, it is gathered that the soils at the project site are safe against liquefaction failure for a PGA of 0.16g with factor of safety ranging from 1.98 to 9.06/non-liquefiable for earthquake magnitude of 6.0 and with factor of safety ranging from 1.16 to 5.32/non-liquefiable for earthquake magnitude of 7.0. The subsequent conclusions shall prevail.

4.4.7.4 Area division for earthquake resistance of buildings

As per Table 4.1.1 in Code for seismic design of buildings (GB50011-2010), the site can be considered as a common seismic fortification area.

4.4.8 Characteristic value of subsoil bearing capacity

According to the feasibility investigation design data of this project, N value of SPT and the site exploration circumstances to determine characteristic value of subsoil bearing capacity. The detail is as follows:

①Floury soil: fak=90 \sim 110kPa, E_s=4.0 \sim 8.0MPa;

2 Floury soil: fak=100~120kPa, E_s=4.0~8.0MPa;

③ Silty-fine sand: fak=130~150kPa, E_s=6.0~10.0MPa;

④ Silty-fine sand: fak=130 \sim 150kPa, E_s=6.0 \sim 10.0MPa;

(5) Silty-fine sand: fak=160 \sim 190kPa, E_s=9.0 \sim 15.0MPa.

4.4.9 Foundation soil evaluation

4.4.9.1 Evaluation of natural foundation

(1)Clayey silt comprises soft constituent material, $fak=90 \sim 110$ kPa, $Es=4.0 \sim 7.0$ MPa, (2)Clayey silt comprises soft to firm constituent material, $fak=100 \sim 120$ kPa, Es = $4.0 \sim 8.0$ MPa. If the above-mentioned strata are evaluated to satisfy the design requirement, the stratum can be taken as natural bearing stratum for subsidiary constructions with lighter load.

③Silty fine sand consists of medium dense to dense light grey to dark grey to dark grey silty sand/ fine sand. If strength and deformation are evaluated to satisfy the design requirement, it can be taken as natural bearing stratum for lighter subsidiary construction in the project construction.

Combined with the local construction technology, pile foundation can be performed for key construction in power house region.

4.4.9.2 Evaluation of pile foundation

(1)Pile type

Constituent material of ③ silty fine sand consists of silty sand/ fine sand. It is possible that pile sinking is difficulty. According to geotechnical engineering condition and local construction experience, cast-in-situ pile is suitable for the buildings that shallow foundation cannot be adopted.

(2)Bearing stratum for pile tip

Based on analysis of stratum distribution, lithology, burial depth and physical and mechanical parameters of each stratum, ④ and ⑤ silty fine sand could be considered as the appropriate load bearing layer.

4.4.10 Dewatering and excavation of foundation pit

According to engineering properties of site soil and engineering geologic condition of site, considering burial depth of groundwater level varies periodically with seasonal, meteorological variation and landform variation, so orthostatic of slope may be bad. Walls of pit should be shaped as slope or reinforced when excavating. If slope height is less than 5m, ratio of slope is suggested to be 1:1 if slope height is greater than 5m but less than 10m, ratio of slope is suggested to be 1:25. Surcharge loads on top of slope must be prohibited and must consider dynamic load of construction machine on top of slope.

If bottom of pit under the groundwater level, dewatering should be performed before excavation. Method of well point dewatering or open ditch drainage (for shallow pit or large burial depth of groundwater) may be applied. Whichever method is applied, groundwater level should be kept 0.5-1.5m under bottom of pit during construction, and foundation soil should not be soaked.

-34-

4.4.11 Conclusion

To sum up, there is no active fault in and around the proposed site area, and we didn't find adverse geologic phenomena. The proposed site area is suitable for large engineering construction.

4.5 Water Source

The water consumption of the power plant is 2991m^3 /h, the yearly water consumption is $2034 \times 10^4 \text{m}^3$. The water source of this project is Lower Bari Doab Canal (LBDC) in the southeast of the power plant which will have one month shut down at January. Groundwater and raw water reservoir will be supplied to satisfy the power plant water consumption during the canal shut down period. The probability of water supply is 97%.

4.5.1 The landscape of LBDC

The landscape of LBDC is shown in figure 4.5.1-1





Figure 4.5.1-1 LBDC Canal landscape plan

Lower Bari Doab Canal (LBDC) running in the immediate vicinity of the proposed site is the major source of water for cooling and consumptive use. Irrigation Department of Punjab is the controlling authority for running and maintenance of the entire irrigation network. Design discharge of the LBDC is 244m³/s and the sanctioned discharge of LBDC is 190m³/s; however, it actually operates at less discharge. Near the site, the design bed width is 59.4m and bed level is 172.5m .As per data provided by the Irrigation Department, actual deliveries by the canal, during last 30 years, are as follows:

- (1) Highest discharge 147.2 m³/s
- (2) Average discharge 121.8 m³/s
- (3) Lowest ever $67.1 \text{ m}^3/\text{s}$
- 4.5.2 Groundwater

According to the verification report of water source, the quaternary aquifer is mainly composed of unconsolidated sand, silt, silty clay. Furthermore, the maximum thickness of the aquifer is up to 300m within Bari Doab region.

Within Sahiwal and Okara area, groundwater is widely used for drinking, industry, agricultural irrigation and other areas. In addition, groundwater is the only source of living water, and there are no local laws that restrict the extraction of groundwater.

The current groundwater extraction depth is about 12m. According to historical data, the lowering speed of groundwater level is 0.3m/year.

According to the verification report of water source, the recommended values of permeability coefficient range between 16 and 50m/day, and the average value is 35m/day. The drilling of eight deep wells with flow of about 2.5 cubic feet per second within the plant area can meet half of the requirements of power plant for the water flow of 29.33 cubic feet per second (the other half of power plant water has to be taken from the surface water in a 1 million m³ reservoir). Two wells serve as standby wells, and one month of water flow is taken in every year. Groundwater can gradually return to normal levels.

In order to avoid the adverse effect of saltwater intrusion that affects groundwater water quality, it is required to reasonably control the annual total extraction of groundwater and continuous extraction time.

-36-

4.5.3 Conclusion and suggestion

The max water consumption of the power plant is $2991m^3/h$, the yearly water consumption is $2034 \times 10^4 m^3$.

The irrigation authorities sound agreeable on this arrangement verbally. A written consent has yet to be arranged.

But the canal is normally closed during the month of January for the purpose of cleaning and maintenance. During this period requirement of makeup water would be about 0.83 m³/s, which is requirement to be arranged by developing ground water resource underlying the project area or by constructing the regulating reservoir. Guarantee rate of water supply is 97%.

At the same time, it is suggested that the yearly maximum, minimum flow, the highest and lowest water level of LBDC canal and Ravi river including relief map cross vertical and horizontal section of river channel should be collected for detailed argument.

4.6 Hydrometeorology

The proposed project site is situated at a distance of 18 km east of Sahiwal city, Punjab, Pakistan. The project area is a part of the Indus Basin, which was formed by Indus River and its tributaries i.e. Jhelum, Chenab, Ravi and Sutlej. The project area falls in the Bari Doab, which is bounded by Ravi River on the north and Sutlej River on the south. Ravi River is located towards north of the project area at a distance of about 18 km and flows in south-western direction.

The project area comprises fertile agricultural lands, which is irrigated by 5R Yousafwala Distributary taking off from LBDC. LBDC runs from east to west about 600m south to the site. The Landform of the site is shown in Figure 4.6.1-1.

The site area is flat, and the elevation is about 173.2m (MSL).Considering Ravi river affluent Sluggish flood, the rivers characteristics, and terrain factors, the preliminary conclusion is that the flood level of site which return period is 100-year is 174.4m ,the depth of submerge is 1.2m.



Figure 4.6.1-1 The Landform of the site

4.6.2 Meteorology

4.6.2.1 Meteorological Condition

The climate is arid to semiarid and is subtropical monsoon climate, with four distinct seasons. The mean annual precipitation in Bari Doab (Land between River Bias and River Ravi) ranges from 4 inches in the South-west and 28 inches in the north-east. Two third of this precipitation occurs in the four summer months, the remainder is spread over the rest of the year.

The following tables show recent climate conditions taken at the nearby Sahiwal Weather Station. For the power plant, at least thirty years of climatic data is desired, but Sahiwal Weather Station was built on May, 2004. This is the only station suitably close to the proposed site with a useful amount of climate data. The distance between the proposed site and Weather Station is 15km.

4.6.2.2 Meteorological Parameters

Date	Pressure reduced to MSL/GPM(hPa)	Dry Bulb (℃)	Wet Bulb (℃)	Relative Humidity (%)	Speed at time of observation(m/s)		
20110713	995.4	35.6	28.2	57.5	0.4		
20110625	991.8	35.7	28.2	56.8	1.1		
20130706	996.5	35.2	28.2	58.6	0.6		
20110802	995.8	34.0	28.2	63.8	1.6		
Statistics Period: $2011 \sim 2013$. The data in the last one of table should be proposed.							

Table 4.6.2-110% Meteorological Parameters

4.6.2.3 design wind speed

By computing according to the wind data of meteorological station in Lahore and Faisalabad ,The design wind speed(10m above the ground ,10min mean maximum wind velocity) which the return period is 50-year is 29.7m/s, and The design wind speed which the return period is 100-year is 31.9m/s.Local basic design wind pressure value which return period is 50-year is 0.55kN/m²; ,and Local basic design wind pressure value value which return period is 100-year is 0.64kN/m².

	Table 4.6.2-2				Mete	eorologio	cal Parar	neters						
	Month	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Average
	Wind Velocity (m/s)	0.5	0.7	0.8	1.0	1.3	0.9	1.1	1.0	0.7	0.6	0.5	0.4	0.8
	Temperature (°C)	11.8	15.5	21.6	27.8	32.4	33.3	32.5	31.3	29.0	25.6	19.6	13.4	24.5
	Relative Humidity(%)	74.5	69.5	64.0	48.7	43.9	53.4	67.8	72.4	72.9	64.0	66.6	71.6	64.1
	Pressure (hpa)	1019.8	1012.6	1010.9	1003.9	999.9	1003.0	1002.8	1001.0	1003.5	1022.1	1010.3	1092.4	1015.2
	Rainfall (mm)	9.1	22.3	12.5	12.7	20.9	63.4	74.8	102.3	83.6	1.7	2.4	6.9	412.3
40-														
												-		
						-								
	Statistics Period: 2005	~2012					·	· · · · · · · · · · · · · · · · · · ·				L		

1 able 4.0.2-3	Та	ble	4.6	.2-3
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Meteorological Parameters

												· · · · · · · · · · · · · · · · · · ·	
Month	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Extreme
Highest Maximum Temperature (℃)	25.4	31.2	37.5	44.0	47.8	46.5	44.5	40.8	40.3	38.2	34.0	28.7	47.8
Date	2007-1-28	2008-2-29	2010-3-23	2010-4-18	2010-5-27	2005-6-24	2012-7-5	2005-8-6	2005-9-5	2009-10-2	2008-11-3	2008-12-1	2010-5-27
Lowest Maximum Temperature (°C)	0	-1	7	10.8	16.3	19.5	20.7	20.7	18.8	11.5	6.1	0.5	-1
Date	2011-1-6	2012-2-9	2012-3-1	2006-4-12	2012-5-2	2010-6-10	2007-7-15	2006-8-29	2012-9-26	2009-10-26	2005-11-30	2011-12-25	2012-2-9
Heaviest Rainfall in one day (mm)	9	37.4	14	30	36.5	58	78.3	138.3	94	11.4	20.5	13	138.3
Date	2008-1-18	2005-2-15	2005-3-10	2009-4-8	2005-5-3	2006-6-30	2012-7-14	2008-8-1	2012-9-9	2006-10-20	2006-11-22	2d	2008-8-1
<u> </u>													
		· [
	Statistics Period: 2005~2012												

-41-



风频比例 1.1%

Frequency value Wind direction Time interval Wind frequency ratio Statistics Period: 2011-2012 Figure 4.6.2-1 wind rose

4.7 Ash yard

4.7.1 General

In order to facilitate recycling of lime-ash, reduce construction cost, decrease environmental impact of seepage when the ash disposal area is in operation and save fresh water resource, dry storing ash scheme is adopted for this project.

Plain dry storing ash scheme is adopted for this project. The recent ash yard that will be constructed in this phase is near the site which can serve 5 years to store all the solid waste generated from the power plant. The planned ash yard considered is on the

-42-

west of the power plant. It can serve 22 years. The recent ash area is about 30.4ha. , the program ash yard area is 109 ha..

4.7.2 Principle for the ash yard position

Ash yard of this phase is on the north of the power plant, the distance is 0.6km. The planned ash yard is on the west of the power plant. Ash yards are in the prevailing downwind direction.

4.7.3 Planning and design standards for ash disposal area

According to local market survey, there is little market for the solid waste. Ash yard will be provided with 5 years capacity to accommodate all ashes generated from the 2×660MW Project.

4.7.4 Solid waste volume

Solid waste includes fly ash, bottom ash and desulfurization gypsum, the details volume is shown in Table 4.7.4-1.

Table 4.7.4-1

List of power plant waste

List	Mass Weight(×10 ⁴ t/a)	Volume Weight (×10⁴m³/a)		
ash	34.60	34.60		
pyrite	2.0	1.0		
desulfurization gypsum	6.1	4.88		
total	42.7	40.48		

4.7.5 Planning and design of ash disposal area

The ash yard of the current phase is 30.4 ha, the dam is about 3m height. When the ash level is higher than the dam, it can be stored with 1:4 slope to provide additional storage capacity. It can form $220 \times 10^4 \text{m}^3$ when the ash is 10 meters from the natural ground so that the ash yard can provide 5.1 years volume for all the solid wastes. The planned ash yard is about 109ha.

Chapter 5 Engineering Envisage

5.1.1 Overall plan

5.1.1.1 Special railway line of plant

The special railway line of the power plant will connect from Yusaf Wala railway station to the plant. The special railway line starts from the northeast of Yusaf Wala station, and goes along the existing railway lines, then across the LBDC to the plant. The length of special railway line is about 22km, and a 30m railway bridge will be built above LBDC.

5.1.1.2 Access road

The access road is connected from southeast to National Highway –N5, across LBDC and railway.

5.1.1.3 Power outgoing

The outgoing lines from the power plant will be connected to the 500kV transmission line from Sahiwal to Lahore. The outgoing power line goes toward east, turns to south and then to west connecting the 500kV transmission line. The outgoing line is about 2.5km.

5.1.1.4 Water source

The plant will take water from LOWER BARI DOAB CANAL which is about 600m south to the plant. Because LBDC needs desilting, examination and maintenance every January, there is no water in the canal, and reservoir with 100×10⁴m³ storage capacity will be built southeast to the plant, to ensure the reliability of plant's water consumption.

5.1.1.5 Ash yard

Current period ash yard is arranged north of the plant, about 30.4 ha (including greening land). It has a 220×10⁴m³ ash (5.1 years) storage capacity. The future ash yard (22 years), about 109 ha, will be arranged west of the 500kV transmission line.

5.1.1.6 Construction area

The construction area is arranged west to the plant, which is about 24 ha, living area is about 8 ha.

-44-

5.1.1.7 Flood prevention

The one-hundred year return period flood is 174.40m, the outdoor ground level of the main power block and unloading ditch area is 174.90m, which is 0.5m higher than the level of flood with one hundred-year return period. The outdoor ground level of other area of the plant is 174.40m.

5.1.1.8 Demolishment

There is no demolishment inside the boundary of site.

5.1.1.9 Living facilities

Most staffs of plant will live inside the plant. There will be administration building, living building, staff apartment (for 350 staff) in the plant.

5.1.1.10 Main economic and technical index of site

Table 5.1.1-1 Main economic and technical index of site

NO	ITEM	UNIT	QUANTITY	REMARKS
1	TOTAL AREA OF SITE	ha	262.76	
1.1	AREA OF PLANT	ha	51.06	
1.2	AREA OF ROADS OUTSIDE PLANT	ha	4.00	
1.3	AREA OF ASH YARD	ha	139.40	
1.4	AREA OF RESIVIOR	ha	25.00	
1.5	AREA OF PUMPHOUSE AND PIPES OUTSIDE PLANT	ha	1.90	
1.6	AREA OF RAILWAY EXTENTION	ha	7.90	
1.7	PRODUCING AREA FOR CONSTRUCTION	ha	24.00	
1.8	LIVING AREA FOR CONSTRUCTION	ha	8.00	
1.9	OTHERS	ha	1.50	Slope protection etc.
2	LENGTH OF ROADS OUTSIDE PALNT	km	2.65	
2.1	LENGTH OF ACCESS ROAD	km	1.10	
2.2	LENGTH OF FREIGHT ROAD	km	0.45	
2.3	LENGTH OF ROAD TO ASH YARD	km	1.10	

NO	ITEM		UNIT	QUANTITY	REMARKS
3	LENGTH OF RAIWA	Y EXTENTION	km	8.00	
4	LENGTH OF WATEF OUTSIDE PLANT	R SUPPLY PIPE	km	0.50	
5		EVACUATION	10⁴m³	16.20	
	SITE	BACKFILLING	10 ⁴ m³	101.80	
5 1	EARTHWORK OF	EVACUATION	10 ⁴ m ³	0.00	
0.1	PLANT	BACKFILLING	10 ⁴ m ³	80.00	
5.2	EARTHWORK OF	EVACUATION	10 ⁴ m ³	0.00	
5.2	PLANT	BACKFILLING	10 ⁴ m ³	1.00	
53	EARTHWORK OF	EVACUATION	10 ⁴ m ³	0.00	
0.0	EXTENTION	BACKFILLING	10 ⁴ m ³	6.00	
5 1	EARTHWORK OF	EVACUATION	10 ⁴ m ³	1.20	
5.4	ASHYARD	BACKFILLING	10 ⁴ m ³	4.80	
5.5	EARTHWORK OF	EVACUATION	10 ⁴ m³	15.00	
5.5	RESERVIOR	BACKFILLING	10 ⁴ m ³	10.00	
	EARTHWORK OF PRODUCING AREA	EVACUATION	10 ⁴ m ³	0.00	
0.0	FOR CONSTRUCTION	BACKFILLING	10 ⁴ m ³	0.00	
57	EARTHWORK OF	EVACUATION	10 ⁴ m ³	0.00	
5.7	CONSTRUCTION	BACKFILLING	10 ⁴ m ³	0.00	

5.1.2 General layout of plant

Ι.



Fig 5.1.2-1 General layout

Four-row arrangement layout is adopted for the plant area. Substation - natural cooling tower area—main plant house - coal yard are arranged from east to west. Auxiliary and ancillary facilities area—main production facility area—construction production area are arranged from south to north. The fixed end is the south; the main house extends to the north.

1) Location and Layout of Main Power Block

Turbine house, deaerator bay, coal bunker bay, boiler house, forced draft fan, electrostatic precipitator, flue gas duct and chimney, and the FGD facilities are arranged from east to west. The A row of the turbine house faces the east.

2) Layout of natural draft cooling tower

Two natural draft cooling towers are arranged between the main power block and

the switchyard.

3) Layout of electrical facilities

The main transformer, auxiliary transformer and startup/standby transformer are arranged outside Row A. A 500kV switchyard is arranged east to the main power block. The relay communication building is arranged closely next to the west side of 500kV switchyard area.

4) Arrangement of unloading, storage, coal handling facilities systems

The coal yard of power plant is located west to the main plant house. Two bucket wheel machine coal yards are set in the plant. They could supply the two units for 30 days.

5) Arrangement of auxiliary ancillary facilities

The ancillary and auxiliary production facilities in the plant area are mainly arranged at the east of the plant area. The boiler makeup treatment facility, industrial wastewater treatment facility, auxiliary drive cooling tower, utility water pump house, water storage pool and water purification station, oil tank area are arranged from east to west. The water discharging pump house, wastewater treatment facility, material storage and maintenance room are arranged in the south of the oil tank. The hydrogen generation station is arranged in the east of the substation.

The coal handling complex building, FGD process complex building are arranged between the stack and the coal yard from east to west. The startup boiler house is arranged at the northwest corner of the main power house area.

6) Front area buildings

The power plant administration building, multi-functional living building and staff apartment are set middle of the plant's south part.

7) Arrangement of plant entrance & exit

The main entrance to the plant is set in the middle of the south barrier wall, which rightly faces the front area of the plant and supply the access for stream of people.

The freight transport access is set at the southwest barrier wall for the entry and exit of the oil, acid and materials.

The ash transport access is set at the middle of north barrier wall for the exit of the

-48-

ash and gypsum.

8) Main advantages & disadvantages of the scheme

The advantage and the disadvantage:

The advantages:

a. The land is less, and the earth volume is less.

b. The coal yard and the ash yard are located in the west of the site, which are not in the main wind direction, in a better environment.

c. The quantity of the transfer tower is 2 less than other schemes. The belt is shorter, and the reentry coal is more convenient.

d. The intake pipe off-site is shorter.

e. The length of the access road to the plant is shorter and it is exclusively for the power plant, not in common use with the nearby village.

The disadvantages:

a. The distance is longer for outgoing line of the plant.

b. The length of special railway line is longer.

5.2 Installation scheme

According to the planning of Pakistan government, electricity will not realize balance between demand and supply until 2019. To promote the quick development of electric power, Government of Pakistan published the state 2013 electric power policy, and takes coal fired power plants as the key to meet the power demand of Pakistan. At the same time, Government of Punjab also proposed to add 6000MW electric power during 3-5 years, to develop economy and elevate the living standards. According to this principle, two supercritical units with capacity of 660MW each will be built in this project, to add the local electric power capacity and to meet the demand of electric power.

Now, there are a lot of supercritical units with 660MW capacity already in operation, the technology is mature and export is allowed.

The parameters of 600MW unit in service are 24.2MPa/566°C/566°C. Three manufacturers in China have the capability to provide 600MW class main equipment with supercritical parameters. Thus, it is a good choice to propose the selection of mature Chinese equipment in order to ensure both high technical performance

-49-

standards and cost competitiveness for this project.

The specification of the main equipment will be modified according to bidding.

- 5.3 Main equipment specifications
- 5.3.1 Boiler

I

Supercritical, single reheat, single furnace, balanced draft, dry bottom, steel structure, outdoor type, once-through and pulverized coal boiler.

Description	Unit	Date B-MCR	Date BRL
Flow of SH steam	t/h	2179	2074.7
Temperature of superheater outlet	°C	571	571
Pressure of superheater outlet	MPa (a)	25.5	25.5
Pressure of RH inlet	MPa (a)	5.722	5.456
Temperature of RH inlet	°C	345.1	342.6
Pressure of RH outlet	MPa (a)	5.459	5.206
Temperature of RH outlet	°C	569	569
Flow of RH steam	t/h	1708.322	1628.057
Feedwater Temperature of economizer inlet	°C	300	297

Main specification for E	Boiler
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5.3.2 Steam Turbine

The turbine is of supercritical parameter, single reheating type, three cylinders and four exhausts, single-shaft, condensing unit.

Type: N660-24.2/566/566	
Rated rotation speed:	3000r/min
The rated load:	660MW
Maximum rate:	693.4MW
Main steam inlet flow:	1979t/h
Maximum main steam flow:	2179t/h
Rated main steam pressure	24.2MPa (a)

-50-

Rated main steam temperature	566 ℃
Reheated steam inlet flow	1641.2t/h
Reheated steam inlet pressure	5.105MPa (a)
Reheated steam inlet temperature	566 ℃
Rated exhaust pressure	7.2kPa (a)
Maximum exhaust pressure	10.5kPa(a)
Cooling water temperature	27.2 ℃
5.3.3 Generator:	
Rated power	660MW
Rated voltage	22kV
Power factor $(\cos \Phi)$	0.9(lagging)
Rated rotation:	3000r/min
Cooling type	water-Hydrogen-Hydrogen
Rated Hydrogen pressure	0.4MPa(a)
Efficiency	98.9%

5.4 Thermodynamic system

5.4.1 Main steam, reheated steam, turbine bypass system

Main steam pipe, hot and cold reheat steam pipes are all designed as unit system, the layout type is 2-1-2.

Main steam pipe and hot reheat steam pipe is separately elicited from the different sides of the superheater and reheater exit header, then collect to one manifold, before turbine the manifold separates to two branches and separate connect to main steam stop valves and reheat stop valves of HP cylinder and IP cylinder. Cold reheat steam pipes are elicited from two exhaust exits of HP cylinder and collected to one manifold at turbine side, the manifold separates to two branches and separate connect to reheater inlet header at boiler side.

Main steam pipe use the seamless pipe produced according to standard ASTM A335P91.

Hot reheated steam pipe and drain pipe use the seamless pipe produced according to standard ASTM A335P91.

Cold reheat steam pipe use the welding pipe produced according to standard ASTM A672 B70 CL32.

This project adopts 40%B-MCR high pressure and low pressure bypass system in series

Cold reheat steam system also provide standby steam for feed-water pump turbine, auxiliary steam system and deaerator.

5.4.2 Extraction Steam system

The turbine unit has eight stages of unadjusted extractions, the No.1, No.2 and No.3 stage extraction supply steam to relevant three HP heaters respectively, the No.4 extraction supplies steam to feed water pump steam turbine, deaerator and auxiliary steam system, the No.5, No.6, No.7 and No.8 stage extraction supply steam to relevant four ILP heaters respectively.

5.4.3 Feed water system

Feed water system is designed as unit system, feed water pipe material is 15NiCuMoNb5-6-4.

The feed water system will deliver feed water from the deaerator storage tank to the boiler economizer inlet header. During this process, the feed water is heated to improve cycle efficiency utilizing turbine extraction steam in three HP feed water heaters. The HP heaters have one common bypass stations.

For each turbine-generator set, 2×50% steam driven and 1×50% motor-driven boiler feed water pumps will be furnished. Each set of pumps will be furnished of one booster pump, and the motorized pump also has one hydraulic coupling, one main feedwater pump and one common motor. The pumps will be furnished with suction strainers (type of drawer) to remove the impurity and protect the pump.

The feed water system will also supply high-pressure spray water to super-heater desuperheater, reheater desuperheater (emergency condition) and HP bypass desuperheater to control steam temperatures at the desired levels.

5.4.4 Condensate system

The condensate system will remove condensate water from the condenser hotwell and deliver it to the deaerator storage tank. During this process, the condensate will be

-52-

heated and deaerated.

The condensate will be heated by turbine extraction steam in low-pressure heaters and deaerator.

The condensate will be deaerated in both the condenser and deaerator heater.

The condensate system will also provide water to various desuperheaters, seal water to equipment and makeup water to miscellaneous systems as required by system operating.

Capacity and type of CEP is 2×100% vertical centrifugal design, with suction strainer before CEPs inlet, one operating and one standby under normal circumstances. Avoiding the HP water from the operating pump goes into the standby pump, a relief valve is behind the motor valve on the pipe at CEP inlet.

Main and subsidiary control valve furnished in parallel are on the outlet pipe of the gland seal condenser. When the load is below 30%, the subsidiary valve operates, if the load is higher than 30%, the main control valve operates. When the deaerator meets the "high-high" level, the main control valve, motorized bypass valve and the drain valve of No.3 HP are closed, the recycle valve open.

The system combined with four surface LP heaters and one integrative deaerator, No.5 and No.6 LP heater will be furnished with its own bypass. In case of tube leakage, the relevant heater will be switched off. No.7 and No.8 LP heater are furnished with the common bypass.

The deaerator operate in slide pressure condition, steam is drawn from No.4 extraction in normal condition, auxiliary steam in startup condition. Inner reboilling pipe can shorten the start-up time and increase the deaerating quality by heat the water in deaerator.

5.4.5 Heater Drains and Vents

In normal condition, the heater drain water drain in a cascading manner, No.3 HP heater drain to deaerator, No.8 LP heater drain to condenser, the water from deaerator overflow to condenser.

Except the normal drain, emergency drain pipe is provided to each heater. Under emergency conditions, the HP heaters will drain through emergency drain flash tank to

-53-

condenser or to condenser directly, the LP heater will drain to condenser directly.

On each heater normal drain and emergency drain pipe, there will be one control valve.

5.4.6 Auxiliary Steam system

One startup fuel oil boiler with capacity of 35t/h will be equipped.

The auxiliary steam system is a manifold system. Each unit has an auxiliary steam header. There is a connecting pipe between two headers.

When the load rises to a certain parameter and the exhaust steam temperature of HP cylinder is a little higher than the temperature of the auxiliary steam, the supply of auxiliary steam can be switched to exhaust steam of HP cylinder. Along with the unit load rising, the supply of auxiliary steam can be switched to NO.4 extraction when the parameter of NO.4 extraction reaches the parameter of the auxiliary steam.

The steam of cold start and hot start can be supplied by NO.4 extraction of the normal operation unit. The auxiliary steam system of all the units can act as mutual standby after this project is completed.

5.4.7 Cooling water system

The circulating cooling water system supplies cooling water which corresponds to requirements in quality, capacity and temperature for all sorts of main or auxiliary equipment in the main power building .The circulating water system will be classified into open cycle cooling water system (OCCW) and closed cycle cooling water system (CCCW).

The open cycle cooling water system (OCCW) is to transport cycle water coming from cycle water header fed by circulating water pump, then to filter cycle water in electrically operated filter and to lift its pressure by lifting pressure pump then to cool some equipment. Water will be returned to CW return pipe system. Equipment that are not exigent in water quality will adopt open cycle cooling water.

One 100% capacity electrically operated filter will be installed in OCCW system.

The CCCW system will adopt demineralized water as working medium. It can decrease pollution or corrosion of equipment, so cooling devices will hold higher heat exchange efficiency. Also it can avoid flow way being jammed to improve security and

-54-

reliability of main or auxiliary equipment reducing maintaining workload as a result.

Two 100% capacity closed cycle cooling water pumps and two 100% capacity water-water heat exchangers will be installed in CCCW system. One set of the pump and the heat exchanger works and another standby. One overhead closed cycle cooling water expansion tank will be installed also.

5.4.8 Air Evacuation System

The condenser air evacuation system will perform two basic functions;

To initially evacuate air in the main condenser and ancillary piping and equipment to reduce the pressure therein to required starting levels (hogging mode);

To remove non-condensable gases collected in the condenser air removal zone (holding mode) during normal operating models.

Three 50% capacity mechanical rotary vacuum pumps will be provided, two pumps work together under normal operation condition, three pumps work together to shorten the start up time during start up period.

5.5 Boiler Combustion and pulverized coal preparation System

5.5.1 Configuration of pulverized coal preparation System

The type of the mills and the pulverizing system shall be based on the coal quality and the possible variation of the coal categories, load characteristics, applicable conditions of the mills as well as the structures of boiler furnaces and burners, and determined after technical and economical comparison. When the category of coal is suitable for the large capacity unit, the medium speed mills shall be the priority choice. Base on "Power Guide for Selection of Pulverizers and Pulverizing System", medium speed mills and the positive pressure cold primary air system shall be adopted for this project.

Main equipment of pulverized coal preparation System

Six (6) medium speed mills will be provided with five (5) in service and one (1) standby when specified design coal is fired at BMCR, and six (6) mills will be in service when check coal is fired at BMCR. When the design coal is pulverized, the total output for medium mills (except the standby mill) shall not be less than 110% of the coal consumption of boilers at the maximum continuous evaporation. When the check coal is

-55-

pulverized, the total output of all the mills before maintenance shall not be less than the coal consumption of boilers at the maximum continuous evaporation.

Six gravimetric type coal feeders shall be provided for mills. A feeder shall have 10% spare capacity to convey design coal with 100% BMCR.

Corresponding to mills, there are the same number of raw coal bunkers for each boiler. The boiler is equipped with six (6) raw coal bunkers, total storage could meet 8 hours boiler maximum continuous rated running while firing design coal, and which meet the relevant requirement of "Code for design of fossil fired power plant".

5.5.2 Air and Flue Gas System

Combustion system adopts balancing ventilation mode, it includes a tri-sector rotary air heater and the primary air and secondary air are heated in the air heater at the same time. This design and configuration could achieve one-side operation when the boiler is at low load or the fans in one side are out of work. There are silencers both for PAF and FDF at suction. In order to prevent the cold end of the air heater from being eroded, steam air heaters are mounted on the duct at the outlet of the FDF and PAF, meanwhile, the boiler manufacturer is requested to use anti-corrosion steel at the low temperature section of the air heater. There is an interconnecting duct between the outlet of two FDF, and electrically operated shut-off dampers are mounted both at the inlet and outlet of the air side and inlet of the gas side in the air heater. When any of the FDF is out of work, the secondary air could go through two air heaters to get into the furnace from both sides of the boiler. At normal condition, the interconnecting duct could make the air pressure at the outlets of two fans have a balance. Total flow rate that entered the mill and the proportion between temperating air and primary air are determined by quantity of heat and flow rate that needed to dry the coal and carry the pulverized coal, these parameters could be controlled by the adjustable damper.

Main equipment of Air and Flue Gas System

Two (2×50%) sets variable moving blade axial fan type FDF shall be provided for each boiler, the fan is combined controlled by constant-speed motor.

Test block condition: Based on Chinese Code GB 50660, fan sizes will be selected based on Design Coal, and air flow margin: 5%; head margin: 15%; Temperature

-56-
margin: The Outdoor Design Temperature of Summer Ventilation will be taken as the fan inlet design temperature for test block condition.

Two (2×50%) sets variable moving blade axial fan type PAFs shall be supplied for each boiler. The fan is combined controlled by constant-speed motor.

Test block condition: Based on Chinese Code GB 50660, fan sizes will be selected based on Design Coal, and air flow margin: 20%; head margin: 20%; Temperature margin: The Outdoor Design Temperature of Summer Ventilation will be taken as the fan inlet design temperature for test block condition.

Two (2×50%) sets variable moving blade axial fan type IDF integrated with the desulphurization booster fan as one large coal-fired unit shall be provided for each boiler unit. The fan shall be with effective measures of anti-erosion and high temperature corrosion proof to ensure the safety and reliability of operation.

Test block condition: Based on Chinese Code GB 50660, fan sizes will be selected based on design coal, and air flow margin: 10%, head margin: 20%. Temperature margin: Inlet flue gas temperature will plus 10°C for test block condition.

2×100% centrifugal type sealing air fans per boiler shall be provided for 6 mills plant, one of which is as standby.

Test block condition: Based on Chinese National Standard GB 50660, fan sizes will be selected based on Design Coal, the air flow margin for sealing fans shall be 10% and the pressure head margin for sealing fans shall be 20%.

The boiler will be provided with two high efficient Electric-static precipitators, ESP shall be of two-chamber and five-field. ESP should guarantee the dust concentration of outlet less than 50mg/N.Cu.m.

Two boilers share one twin-flue chimney which is 180m high and outlet diameter each flue is 7.5m.

5.5.3 Ignition and combustion-supporting system

The light diesel oil system is used to the burners for lighting up of the boiler. The boiler ignition system is that high energy igniters light up light diesel oil guns, then LDO guns kindle coal powder. In order to reduce oil consumption, the small oil gun technology is recommended in this proposal and the boiler original oil burner system will

-57-

be reserved.

Tanker trucks are used to transport diesel oil. The fuel oil storage area equipment includes two set of 500m3 diesel oil tank, two sets of diesel oil unloading pump (one operation, one standby), three sets of diesel oil supply pumps(two operation and one standby), one set of dirty oil pump, one set of dirty water pump, and related inlet strainers.

5.5.4 Start-up boiler

During the start-up period, one 35t/h light diesel fired start-up boiler and auxiliary equipment shall be provided which can generate steam for the first 660MW unit start-up purpose.

5.6 Coal handling system

The coal handling system will be designed for two boilers.

5.6	5.1	Raw	coal	consumption
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ltom	Lloit	Desi	gn Coal	Check Coal		
nem	Unit	1 Boiler	2 Boilers	1 Boiler	2 Boilers	
Coal consumption per hour	t/h	294.9	589.8	329.5	659.0	
Coal consumption per day	t/d	6487.8	12975.6	7249.0	14498.0	
Coal consumption per year	10 ⁴ t/a	200.5	401.0	224.1	448.2	

Note: Calculation basis of the fuel consumption:

-- 6800 hours per year

-- 22 hours per day

-- Under BMCR condition

5.6.2 Coal handling system design scope

The scope of the coal handling system is from the wagon unloader hopper in the power plant to coal bunkers including coal unloading system, coal storage system, screening and crushing system, belt conveyor system and accessory devices and facilities.

5.6.3 Coal Unloading System

The daily coal consumption of two boilers is 14,498t based on the worst-quality coal.

-58-

The maximum daily delivered coal transported by bottom dump wagons is 18847.4t, there will be 314 bottom dump wagons each day as the load of each wagon is 60t. Because there will be 40 wagons per train, so a maximum of 8 trains will be delivered to the power plant per day.

One (1) single railway wagon unloading ditch will be constructed with effective unloading capacity for 20 wagons.

Three (3) bridge type as-received wagon sampling devices will be installed for coal sampling.

One (1) Motion weighing electronic railway track scale will be installed upstream of railway switch.

Four (4) rotary plow feeders will be installed under the wagon unloading hopper with a design capacity of 1200t/h.

Double stream of belt conveyors will be installed under the wagon unloading hopper with belt width 1200mm, belt velocity 2.8m/s, design capacity 1200t/h.

5.6.4 Coal Storage System

Two (2) coal storage yards will be constructed within the power plant. The capacity of coal stockyard will be 434,000t that can serve two boilers for 30 days based on the check coal.

Two (2) bucket wheel stacker-reclaimers will be envisaged on coal stockyards with boom length of 35m, the design stacking capacity will be 1200t/h and the design reclaiming capacity will be 1200t/h.

Wind-break and water sprinklers will be installed around the coal storage yards for environment protection.

Two (2) bulldozers and two (2) wheel loaders will be envisaged.

5.6.5 Belt Conveying System

The belt conveyors will be designed with B = 1200 mm, v = 2.8 m/s, Q = 1200 t/h.

The double route belt conveyors will be designed with double route.

In general, one of the double belt conveyors will be in operation and the other on standby. However, the double belt conveyors could be able to operate simultaneously.

The belt conveyors will be enclosed in gallery or tunnel except the belt conveyors

-59-

installed on coal yards.

The electric driving two-side ploughs will be installed on belt conveyor in coal bunker bay.

5.6.7 Accessory devices and facilities

Accessory devices will be provided for measurement, calibration, iron removal, sampling, hydraulic cleaning and conveyor protection.

5.6.8 Auxiliary buildings

Necessary buildings such as coal complex building and dozer garage will be envisaged

5.7 Ash handling system

5.7.1 Calculated ash quantity

As per the design coal and check coal analysis and the coal consumption, the calculated ash quantity under BMCR is as follows.

Table 5.7-1

Calculated ash quantity

Bottom ash and fly ash		Design coal				Check coal			
		Bottom ash	fly ash	Total ash	pyrites	Bottom ash	fly ash	Total ash	pyrites
Bottom ash and fly ash	One unit	2.54	22.90	25.44	1.47	3.20	28.79	31.99	1.65
quantity/hour(t/h)	Two units	5.08	45.80	50.88	2.94	6.40	57.58	63.98	3.30

Note:

a. The preferences of BA and FA equipment are based on 10% and 90% of the total ash.

b. The preferences of pyrites are based on 0.5% of the coal consumption at B-MCR.

5.7.2 Main design principle

(1) Ash handling system adopts separate handling of fly ash and bottom ash, separate handling of dry fly ash and wet fly ash in order to facilitate re-utilization of fly ash and bottom ash.

(2) Bottom ash in the bottom ash bin and fly ash in the silo will be transported to

outside the plant.

(3) The bottom ash will be conveyed directly to a bottom ash bin by dry-type slag extractor in the plant.

(4) Fly ash handling system for two boilers is as one design unit. All fly ash from ash hopper will be grouped convey to a common fly ash silo through pipes by compressed air in the plant. There are two fly ash silos in five ash yards. It will be transported to outside the plant.

(5) One common compressed air house will be designed for instrument, service, ash conveying.

(6) Water-saving measures should be taken into consideration, wastewater or sewage from operation of the power plant should be used to the extent possible.

(7) Mill rejects system will use mobile hoppers and forklift truck scheme, and the pyrite is transported to ash yard by trucks.

5.7.3 Fly ash handling system

The fly ash of ESP system capacity shall satisfy the quantity of 150% fly ash production when burning design coal.

Pneumatic pressure type conveying system shall be provided for handling fly ash from the precipitator hoppers to storage silos. One dense phase conveying vessel shall be installed under each precipitator hopper. Fly ash collected in hoppers shall be transported sequentially to the fly ash silos through the dense phase vessels and pipes by the compressed air. A series of ash conveying pipes shall be provided for each boiler, and fly ash from each pipe can fall into either of two fly ash silos. The whole ash conveying system shall be automatically controlled by DCS. Each fly ash silo shall have fabric filter located on top floor. The clean air exhaust from each filter separator shall be vented to atmosphere.

Two steel structure construction conical bottom type fly ash silos will be provided for two units' fly ash storage, whose inner-diameter is Φ 12m. Each silo can store fly ash for 24 hours for one boiler.

There are two types of unloaders beneath the bottom of each fly ash silo: One type is dry ash unloader for comprehensive utilization by tank car, another type is double

-61-

paddle mixer for ash yard storage by trucks.

5.7.4 Bottom ash handling system

One dry bottom ash conveyor of air cooling system shall be used in bottom ash handling system, which shall be continuously operating, and one boiler as one design unit. A continuously adjustable conveyor shall be provided for one boiler. The important part of the dry bottom ash conveyor is convection belt which is composed of double stainless steel net and hard alloy plate. The automatic adjusting device installed on driven wheel can be automatically adjusted according to the belt strain.

The cool air shall be sucked into the conveyor through the plate interstice, and the hot bottom ash from the hearth be cooled. For cooling the bottom ash of belt, the inlet pipe shall be provided on the head of the conveyor and under the belt.

One steel structure bottom bin, whose useful volume of the bin shall be able to store about 24 hours bottom ash discharged from one boiler when burning design coal. There is an unloading control room at the height about 2m under each bottom ash bin. The bottom ash shall be transported for utilization or to ash yard by vehicle under the steel bin.

There are two outlets beneath the bottom of each bottom ash bin: One dry ash unloader for comprehensive utilization by tank car, one outlet with ash conditioner for ash yard storage by trucks.

5.7.5 Compressed air system

A common compressed air system is considered for fly ash convey, instrument and service, and 7 sets of 40m³/min stage screw type air compressors will be provided in the compressor house for the compressed air system.

The same type, capacity and head of screw compressor will be adopted. All the outlet pipes from each compressor will be led to a common raw compressed air header. Firstly, the raw compressed air goes through separate receivers for first dewatering and cushioning, then separately enters ash conveying and instrument air purge devices. Finally, the clean compressed air enters separate receivers to supply all kinds of eligible compressed air for different use purposes of two boilers.

Two isolation valves will be installed for outlet header pipe from each compressor,

-62-

so air for instrument and ash conveying air can be separately supplied according to power plant actual operation demands.

There are three combined freezer & adsorption air dryers (two working and one standby) for instrument air. Two sets of 50m³ air storage tanks for instrument air.

There are Four fly ash conveying freeze air driers (three working and one standby) ash conveying air. Two 30m³ air storage tanks shall be provided for ash conveying air.

5.7.6 Mill rejects system

Each boiler shall have a separate and identical mill reject handling system, and one boiler as one design unit.

One set of mobile hopper will be provided for every coal mill. The pyrites will be discharged form mill into a mobile hopper, and then will be conveyed out by forklift, and will be conveyed to ash yard by truck. There are weighting equipment for mobile hopper.

5.8 FGD and DeNOx system

5.8.1 FGD

5.8.1.1 Selection of desulfurization technology

Worldwide, the desulfurization methods can be divided into three kinds: desulfurization before combustion, desulfurization during combustion and desulfurization after combustion (flue gas desulfurization, FGD). FGD technology has been put into large-scale commercial application all over the world and it is proved to be the most efficient method for thermal power plant to control SO₂ emission.

As the most representative method of FGD, Wet Limestone FGD technique features high SO₂ removal efficiency, applicable to various kinds of coal, high utilization rate of absorbent, mature and advanced and function reducing dust emission. At present, over 80% of FGD plants all over the world are of this type.

Considering the above technology analysis and requirements of this project, Wet Limestone FGD technique is preferred to satisfy the SO₂ emission limit of Pakistan state environmental protection standards. And the desulfurization efficiency will be not less than 80%.

GGH and FGD BUF will not be adopted in this project, thus investment cost, operation cost and operation cost of FGD system will be decreased. One-boiler

-63-

one-absorber solution is adopted. FGD system mainly consists of absorbent preparation system, SO₂ absorption system, flue gas system, gypsum dewatering system, process water system and draining system, etc.

Main chemical reaction equations are shown as follows

 $2CaCO_3+H_2O+2SO_2=2CaSO_3\cdot 1/2H_2O+2CO_2$

 $2CaSO_{3} \cdot 1/2H_{2}O + O_{2} + 3H_{2}O = 2CaSO_{4} \cdot 2H_{2}O$

5.8.1.2 Consumption of Limestone

At present, there are two ways to prepare absorbent in wet FGD system: concocting slurry using limestone powder, milling limestone particle into slurry. The resource and quality of limestone is not specified, FGD system is designed based on the limestone feedstock size no more than 20mm and wet ball mill system will be arranged. The following consumption of limestone is calculated based on the assumed limestone quality: CaCO₃≥90%, MgCO₃≤4%, SiO₂≤2%.

Considering the factors of transport distance, an emergency limestone storage area (with shed protection) shall be set for the project. Limestone is conveyed into limestone silo and sent into wet ball mill by weight belt conveyor. Limestone is milled in the ball mill into limestone slurry.

Refer to Table 5.8.1.2 -1 for limestone consumption of 2×660MW units.

Table 5.8.1.2-1	Limestone Consumption (Based on BMCR operating condition)
	Emercence concerning to have a manual of prior operating concernent

		1×660MW		2×660MW	
Item	Unit	Design coal	Check coal	Design coal	Check coal
Hourly limestone consumption	t/h	3.0	2.87	6.0	5.74
Annual limestone consumption	×10 ⁴ t/a	2.04	1.95	4.08	3.9

Note: Figures in the table calculated based on annual utilization hours of 6800h.

5.8.1.3 Desulfurization by-product

Gypsum slurry discharged from absorber is condensed in gypsum hydro-cyclones, of which the underflow enters vacuum belt filter. The dewatered gypsum with 10% moisture rate drops into gypsum storage (3 days storage capacity).

Refer to Table 5.8.1.3-1 for gypsum production of 2×660MW units:

		1×660MW		2×660MW	
Item	Unit	Design coal	Check coal	Design coal	Check coal
Hourly gypsum production	t/h	4.5	4.3	9.0	8.6
Annual gypsum production	×10⁴t/a	3.06	2.925	6.12	5.85

Table 5.8.1.3-1Gypsum Production

Note: Figures in the table calculated based on annual utilization hours of 6800h.

Gypsum can be used as primary material of construction material industry.

At present, there is no comprehensive utilization of gypsum, thus gypsum will be transported to ash yard stacked separately a retaining the possibility of comprehensive utilization.

5.8.1.4 Introduction of FGD system

5.8.1.4.1 Design parameters of FGD system

Refer to Table 5.8.1.4-1 for gypsum production of 2×660MW units:

Table 5.8.1.4-1Design parameters (for one unit)

Item	Design coal	Check coal
Coal consumption (t/h)	294.94	329.52
Sulfur content (%)	0.40	0.34
FGD inlet flue gas temperature ($^\circ \!\!\!\!\!^\circ \!\!\!\!^\circ$)	126.69	126.65
Quantity of flue gas (wet, Nm ³ /h)	2226002	2295921
Quantity of flue gas (dry, Nm ³ /h)	2051119	2083564
SO ₂ concentration at FGD inlet(mg/Nm ³) (6%O ₂)	976	912.6
Desulfurization efficiency (%)	≥80	≥80
SO ₂ concentration at FGD outlet (mg/Nm ³) (6%O ₂)	195.2	182.5
FGD outlet flue gas temperature (℃)	52.1	54.7

5.8.1.4.2 Brief Description of FGD

Reaction of desulfurization occurs in absorber. There is a sump at the low level of

the absorber, where the limestone slurry is mixed with the gypsum slurry. Limestone functioned as absorbent to provide alkalinity and a source of calcium ions (Ca^{2+}). Limestone slurry that is added to the FGD system, reacts with and neutralizes the acidic SO_2 in the flue gas. The byproduct is calcium sulphite. The calcium sulphite is then oxidized to calcium sulphate by oxygen.

One-boiler one-absorber solution is adopted. GGH and FGD BUF will not be adopted in this project, meanwhile bypass will be arranged. FGD system mainly consists of absorbent preparation system, SO₂ absorption system, flue gas system, gypsum dewatering system, process water system and draining system, etc.

5.8.1.4.3 Flue gas system

Flue gas system mainly consists of raw gas duct, bypass duct, clean gas duct, flue gas dampers etc. Raw gas dampers, clean gas dampers and bypass dampers with double-vane are adopted.

Gas-gas heater (GGH) will not be adopted in the project; FGD booster fan will be combined with IDF. Boiler flue gas from main duct enters into absorber through raw gas duct. Clean gas from absorber is discharged into atmosphere through clean gas damper, main gas duct and chimney.

In the case that FGD is out of operation for maintenance, the boiler unit is still operating, bypass damper will be opened and raw gas and clean gas dampers will be closed, the flue gas will enter into chimney directly through bypass duct.

5.8.1.4.4 SO₂ Absorption System

SO₂ absorption system mainly consists of absorbers, mist eliminations, spraying layers, recirculation slurry pumps, and oxidation air fans, etc.

Each unit is provided with one independent cylindrical steel structure absorber with extended sump. The slurry sump with four absorber sump agitators and oxidation air lances is arranged at the bottom of the absorber, the top of which arranges three spraying layers and two layers mist eliminators. Three recirculation slurry pumps for each absorber are installed. Each of recirculation slurry pumps is corresponding to each spraying layer. Within the absorber the SO₂ in flue gas will be scrubbed by limestone slurry and generate CaSO₃. Oxidation air oxygenates CaSO₃ to CaSO₄ which exists in

-66-

the form of gypsum in absorber slurry sump. Two oxidation air fans for each absorber are installed (one in operation, one on standby). Gypsum slurry is pumped out of the absorber by gypsum bleed pump into gypsum dewatering system. Two gypsum bleed pumps are installed (one in operation, one on standby) for each absorber.

5.8.1.5 Absorbent Preparation System

In this project, 2×660MW units share one set of absorbent preparation system.

FGD system is designed based on the limestone feedstock size no more than 20mm.

Considering the factors of transport distance, an emergency limestone storage area (with shed protection) shall be set for the project. Limestone is conveyed into limestone silo with a capacity of 3 days consumption at 100% BMCR and sent into wet ball mill by weight belt conveyor. Limestone is milled in the ball mill and then separated by limestone hydro-cyclone. Limestone slurry with concentration of about 30% is stored in limestone slurry tank, and then sent into absorbers by limestone slurry pump. Absorbent preparation system includes two wet ball mills. Output of each one is designed as 100% of the limestone consumption of two set of units under BMCR operation condition. Every wet ball mill is equipped with 100% limestone hydro-cyclone. One limestone slurry tank and four limestone slurry pumps are installed for two absorbers (two in operation, two on standby).

5.8.1.4.6 Gypsum dewatering system

Gypsum dewatering system mainly consists of gypsum hydro-cyclones, vacuum belt filters, vacuum pumps, filtrate water pit and pumps and gypsum storage.

Gypsum slurry discharged from absorber contains 12%-18% solid is condensed in gypsum hydro-cyclones, of which the underflow enters vacuum belt filter. Then the dewatered gypsum with 10% moisture rate drops in gypsum storage. Gypsum can be transferred into ash-yard by truck stacked separately for future comprehensive utilization.

The capacity of vacuum belt filter is designed as 100% of the gypsum production of two boilers under BMCR operation condition. Gypsum will be stored on the ground floor of gypsum dewatering building that has a storage capacity for 3 days operation.

-67-

FGD must discharge a certain volume of waste water continuously in order to meet the technique requirements. Wastewater is purified in wastewater treatment system. FGD waste water must be treated to meet the local discharge standards.

5.8.1.4.7 Draining system

Emergency slurry tank is designed to store absorber maintenance discharging slurry saving as original Gypsum crystals for next FGD system start-up. And drain pits are arranged in different area to store the discharging slurry temporarily.

Draining system mainly includes the following components:

One emergency slurry tank

One emergency slurry pump

Two absorber sumps

Absorber sump pumps.

Slurry is discharged in FGD normal operation, during maintenance, which is collected to corresponding sump. Sump pump will start up automatically according to the slurry level and send slurry to absorber or emergency slurry tank. For sumps, anticorrosive lining shall be provided, and continuous running agitators are equipped to avoid slurry deposition, condensation or obstruction.

5.8.1.4.8 Other auxiliary system

Process water is supplied from power plant water system, which is mainly used as flushing water of equipment and pipes etc. Service water is supplied from power plant service water system; it is used as gypsum wash water, cooling water and sealing water of oxidation air fans and other equipment.

Process air consists of instrument and maintenance compressor air. Compressed air for instrument and maintenance comes from air compressor system of main plant and FGD without independent air compressor station.

5.8.1.4.9 Arrangement of FGD

Preliminary arrangement of FGD Island is shown in the drawing of Layout of Power Plant.

5.8.2 Flue Gas DeNox

Low nitrogen combustion technology shall be used for this project, the NOx

-68-

emissions can be controlled no more than 300mg/Nm3 at the export of boiler. It is reserved to install DeNox system in the future when appropriate.

5.9 Chemical water treatment system

5.9.1 DM water treatment system

5.9.1.1 Source of make-up water and water quality:

The raw water will be taken from Lower Bari Doab Canal (LBDC). The water quality analysis provided by the sponsor list as follow table. The analysis data is not enough for the system design, twelve water analysis reports with all ions of one year is required to check the system process.

Table 5.9-1 Data sheet of water quality analysis in 2005 and 2007

Na	Paramoters	Unit	Jun	c 2005	Septer	nber 2005	Jun	ə 2007
			Canal Water	Tube Well No. 2	Canal Water	Tuba Wall No. 2	Canal Water	Tube Well No. 2
1.	рН		7.5	7.6	7.5	7,5	7.4	7.5
2.	Conductivity	jie/cm	165	350	160	330	145	350
Э.	TDS	ppm	122		120	247	116	280
4.	p-Alkalinity	ppm	Nil	Nil	Nil	Nil		
5.	Total Alkalinity	ppm	50	210	60	190	50	180
6.	Total Hardness	ρ p m	120	340	110	200	100	290
7.	Calcium Hardness	ppm	35	140	42	115	35	100
8.	Mg Hardness	ppm	85	200	68	85	65	190
9.	Silica	ppm	4	10	1,1	2.3	8	14
10.	Cholrides	ppm	15	100	15	130	10	120
11.	Sulphate	ppm	10	21	8	15	10	22

Exh	ibit	5.2;	Results	\mathbf{of}	Water	Quality	Analysis
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 Table 5.9-2
 Data sheet of water quality analysis in 2011 and 2013

Directorate of Land Reclamation Punjab, Lahore

IRRIGATION DEPARTMENT GOVERNMENT OF THE PUNJAB

Att Additional Sicritary (T)

No. 96/26 2 5000



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Dated: 8-01-2014

CHEMICAL ANALYSIS OF SURFACE WATER AT RIVER RAVI, BALLOKI HEAD WORKS

Sr. No	Parameters	Units	Calculated Values Oct. 2011	Calculated Values Oct. 2012	Calculated Values Oct. 2013	Permissible Limits NEQS
1	Electrical Conductivity	dS/m	0.30	0.34	0.33	
2	pH		6.61	7,96	7.00	6.5-8.5
3	Turbidity	NTU	13.2	82.0	48.0	<5NTU
4	TDS	mg/L	192.0	217.6	211.2	<1000
5	TSS	/mg/L	0.1	-	~	*
6	Total Hardness	mg/L	104.4	119.7	124.5	<500
7	COD	mg/L	9.0	~	*	
8	Carbonate	mg/L	NIL	NIL	NIL.	
9	Bicarbonates	mg/L	134.2	122.0	140.3	~
10	Chloride	mg/L	24.85	17.75	17.75	<250
11	Sulfate	mg/L	4.80	43.2	24.0	
12	Calcium	mg/L	26	40.0	38.0	•
13	Magnesium	mg/L	9.6	4.8	7.2	-
14	Sodium	mg/L	18.4	20.7	16.1	
15	Potassium	mg/L	3.9	3.9	3.9	~
Heavy	y Metais					
16	Cu	mg/L	0.18	*	*	2
17	Zn	mg/L	0.18	•	*	5.0
18	Pb	mg/L	0.13	*	*	\$0.05
19	Ni	mg/L	0.02	*	٠	≤0.02

Note: Although contamination (drains having industrial and sewage water) add into river Ravi, but due to dilution contamination strength reduces at site in the month of October. The debris and other material accumulated at Head Balloki cause unpleasant smell and create impression of contamination at site, which is not present actually in flowing water.

* Analysis of heavy metals for 2012-2013 are in process

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Director Land Reclamation Punjab Irrigation Department Moghalpura, Lahore

5.9.1.2 the capacity of DM water treatment system

NO.	ITEM	UNIT	QTY.	WATER	REMARKS
1	Circulating normal loss	t/h	67	DM WATER	
2	Steam for plant area fuel oil	t/h	7	DM WATER	WINTER
3	Steam for outdoor protection	t/h	7	DM WATER	WINTER
4	Steam for ash hopper heating	t/h	9	DM WATER	WINTER
5	Total	t/h	90	DM WATER	

The steam and water loss of 2×660MW units

DM water treatment system capacity is 2×100 t/h, one series is in service and the other is in standby.

5.9.1.3 DM water treatment system

According to the analysis of the raw water, considering the units' steam-water quality requirement, the DM water treatment system is chosen as follows.

Raw water from water supply (after flocculating and clarification) \rightarrow double-layer mechanical filter \rightarrow UF \rightarrow RO \rightarrow cation exchanger \rightarrow anion exchanger \rightarrow mixed bed \rightarrow DM water tank \rightarrow DM water pump \rightarrow Condensate makeup water tank near main building.

5.9.2 Condensate polishing plant system

Condensate polishing plant system is medium-pressure system, and the system scheme is as follows.

Condensate water \rightarrow filter \rightarrow high speed mixed bed \rightarrow Gland steam cooler \rightarrow LP heater

The condensate polishing plant system for each unit includes 2 pre-filters with capacity 50% of the condensate quantity and 3 mixed beds of high flow rate with capacity of 50% of the condensate quantity.

One set of external regeneration system will be furnished for two units.

5.9.3 Chemical dosing system for thermal cycle

There is ammonia dosing equipment for feed water, condensate water and closed cooling water. There is one oxygen dosing system for feed water and condensate water.

5.9.4 SWASS of thermal cycle

Steam & Water Analysis Sampling System (SWASS) device will be furnished in order to supervise and control the steam-water quality: one set per unit.

5.9.5 C.W chemical dosing system

One set of acid and the scale inhibition and stabilizers dosing device with two dosing pumps and one tank should be supplied to prevent the circulating cooling water system from corrosion.

There are two sets of chlorine dioxide generators to prevent the bacteria generation in C.W. system and keep the residual chlorine in C.W. system less than 0.1mg/L.

5.9.6 Industry wastewater collection and centralized treatment

Irregular waste water will be treated as follows:

Irregular effluent \rightarrow waste water pit \rightarrow Flocculation tank \rightarrow Inclined plate settler \rightarrow Final neutralization pit \rightarrow Clear-water basin \rightarrow discharge

Regular waste water will be neutralized by acid or alkali and reused or discharged. The capacity is 100t/h. The total volume of waste water ponds is 7500m³.

5.9.7 Hydrogen station

The hydrogen generation system consist of one set of Q=10m³/h middle pressure hydrogen generation and four sets of hydrogen storage tanks.

5.9.8 Chemical feeding and sampling system of the auxiliary boiler

A set of chemical feeding and sampling system of the auxiliary boiler will be furnished.

5.9.9 Desulfurization wastewater treatment system

The waste water will be reused after treatment.

5.9.10 Transformer oil purifying

A set of movable vacuum filter will be furnished for transformer oil purifying.

5.9.11 Laboratory

The table, instrument in lab will be provided according to the requirement of 660MW unit standard.

5.10 Electrical

5.10.1 Main circuit single line

This project consists of newly built 2*660MW plants, each unit consists of a generator and a transformer, and generator-transformer-line group is adopted for 500kV substation. The substation adopts one and a half breaker configuration. The connection to grid will be made via 2 numbers of new 500kV overhead transmission lines. One start-up/stand-by transformer (SST) is designed for each plant, connects to 500kV substation.

There is no generator circuit breaker. The neutral of generator is earthed through transformer.

5.10.2 Main electrical equipment

Generator Cooling Method is water-hydrogen-hydrogen. Excitation type is static excitation. The generator rated output is 660MW, and rated voltage is 22kV.The generator rated power factor is 0.9(Lagging), and the generator power factor 0.95(leading).

According to Chinese National Standard GB/T 7064-2008 and IEC60034-3: 2007, MOD 4.4:

"It is recommended that the generator should be capable of providing 0.95 underexcited power factor at rated MW."

The 600MW-class generators manufactured according to the Chinese standard GB/T 7064-2008 (equivalent to IEC 60034-3: 2007) shall be designed as follows (please refer to Article 6.2 of GB/T 7064-2008 - Specification and Series):Basic Series of Hydrogen-cooled and Water-cooled Generators (50Hz)

Rated Power PN/MW	Rated Capacity SN/MVA	Rated Voltage UN/kV	Rated Power Factor cosφ	Efficiency η(Tolerance of overall losses at ratings + 10%) ^a				
100 125 135	117.7 147 158.5	10.5, 13.8	0.85	98.4				
200	235.3	15.75	0.85	98.6				
300	353	18, 20, 24	0.85	98.7				
600	666.66	20, 22, 24	0.9	98.8				
900	1000	24, 27	0.9	98.9				
1000	1111.1	24, 27	0.9	98.9				
1200	1333.33	24, 27	0.9	99				
1500	1666.66	27, 30	0.9	99				
^a Allowable tolerance of overall losses + 10%								

Single-phase transformers would be adopted as step-up transformer. The parameter of step-up transformer is 3*270MVA, $\frac{525}{\sqrt{3}} \pm 2 \times 2.5\%$ /22kV, YN, d11. One auxiliary phase would be adopted for the two units.

There will be one split winding type unit auxiliary transformer for each unit. The rated capacity of unit auxiliary transformer is 70/42-42MVA (The capacity of unit auxiliary transformer would be confirmed in next stage of this project). Two units have one split winding type start-up/stand-by transformer, OLTC. The capacity of start-up/stand-by transformer is equal to unit auxiliary transformer.

The step-up transformer is directly fed from generator terminal with isolated phase bus duct. The 10kV unit sections are directly fed from unit auxiliary transformer & start-up/stand-by transformer LV side with non segregated bus duct.

5.10.3 Outdoor substation

500kV AIS would be adopted for this project. One and a half breaker scheme is adopted for the design of 500kV switchyard. The step-up transformers connect to 500kV switchyard by overhead lines, and there are two outgoing lines. The start-up/stand-by

-74-

transformer connects to 500kV main bus.

5.10.4 Layout of unit auxiliary electrical facility

Step-up transformers, unit auxiliary transformers and start-up/stand-by transformer are all located outdoors in front of A row of turbine hall

500kV switchyard is in front of the A row of turbine hall. The network relay room will be near the switchyard.

Generator and step-up transformer is connected by isolated phase bus duct. Unit auxiliary transformer is also fed from generator terminal with isolated phase bus duct. AVR and excitation thyristor is laid on middle floor of turbine hall, generator neutral point cabinet and PT & arrester and excitation transformer are all laid on middle floor of turbine hall.

5.10.5 Power plant electrical energy distribution system

5.10.5.1 High voltage (HV) auxiliary power

HV auxiliary system adopts 10kV system with neutral resistance earthed.

Two sections of 10kV bus would be set for each unit and auxiliary loads which are standby each other shall be fed from two sections respectively (The number of sections and the level of HV would be confirmed in next stage of this project).

5.10.5.2 Low voltage auxiliary power

380V/220V LV auxiliary system neutral point is directly grounding.

The LV (low voltage)motor is supplied from power center(PC) and motor control center(MCC). Motors larger than 75kW will be supplied from PC. The transformers are commutative standby. Double set motors and MCC are connected respectively to PCA and PCB. Single load is connected to MCC which is supplied from double power sources or to another PC.

5.10.5.3 Auxiliary power system

Central mode armored switchgear is used for 10kV cabinet. Dry type transformers (Class F insulation) will be used for LV transformers in the plant. Drawer type LV switchgear is supplied for LV PC & MCC.

5.10.6 Emergency power supply system

A quick start DG set should be considered as Emergency power supply for each

-75-

unit: Two sections of 380/220V AC Emergency power MCC should be set for each unit, which should be fed by powerhouse 380V unit section in normal condition and by quick start DG set in accident. When auxiliary power supply of each unit loses, emergency load should start-up in batches.

Emergency power supply system neutral point is directly grounding.

5.10.7 DC system

Each unit should have 3 sets of battery, 1 for motor and 2 for control device, without end cell. Motor battery voltage is 220V and control device battery voltage is 110V.

Two sets of 110V battery group should be adopted for switchyard DC system; other auxiliary workshop shall be equipped with 1-2 battery sets.

5.10.8 UPS system

A 2 \times 100% static UPS system with single-phase output should be set for each unit.

One set of static UPS system should be set for network relay room.

One set of static UPS system should be set for desulfurization.

5.10.9 Wiring of control, relay protection and automatic equipment

This project introduces the central control mode with boiler, turbine and electricity. There should be one system for two units. Electric system of unit should be monitored in DCS.

Electrical devices whose SOE and SCS signals will be brought into DCS through hard wire: other signals (measurement, alarm, indication) will be send to DCS by communication through electrical control and monitor system (ECMS).

The NCS system will be adopted for 132kV switchyard control. The station level devices should be located in main building CCR and network relay control room, and the bay level equipment should be located in network relay room.

5.10.10 Illumination & maintenance system, grounding and others

Normal AC lighting system. Emergency AC lighting system and DC supply emergency lighting system will be done for the project.

One lighting transformer is set for each unit, which supplies power to lighting loads in the main building. One maintenance transformer is set for each unit and reserved as

-76-

the standby lighting transformer at the same time.

500kV switchyard distribution equipment should have protection against lightning by lightning arrestor on the structure. Lightning protection shall be available for outdoor transformers, oil tank, oil pipe, hydrogen generation station and high buildings etc.

Grounding system will consist of a ground grid formed by a number of flat steel and pipe placed in a mesh formation by all welded joints, riser connections from ground grid and aboveground flat for grounding of equipment. All electrical equipment and the metallic parts of establishment must be reliably grounded.

5.10.11 Plant Communication System

Plant communication system contains Private Automatic Branch Exchanger(PABX), Dedicated Automatic Dispatching Exchanger (DADX), Public Address system, Digital Walkie-talkie Radio system and 48V DC power supply system.

5.10.11.1 Telephone System

One new PABX with 500 extensions will be provided for plant telephone system. And it can be expanded to 1000 extensions by adding matchable cards. The telephone network will cover the whole plant area. PABX can be trunked with PSTN (Public Service Telephone Network) by trunk lines so that persons in the plant can call outside parties. The final interface type of trunking to be used shall be determined by Owner/Employer. PABX is powered by 48V DC power supply.

At the same time, one Main Distribution Frame (MDF) cabinet is provided. And its capacity is 1200 pairs. Accordingly, communication cables, ducts, junction boxes, phone socket etc will be provided.

5.10.11.2 Dedicated Automatic Dispatching Exchanger

One Dedicated Automatic Dispatching Exchanger (DADX) is provided. Its preliminary capacity is 96 extensions. It will be dedicatedly used for production dispatching in the whole power plant. DADX contains one main station, one PC maintenance server, some dispatching consoles and indoor or outdoor user terminals which can be common phones, industrial stations with amplifier and/or loudspeaker etc. DADX is powered by 48V DC circuits.

5.10.11.3 Public Address system(PA system)

-77-

One Public Address system will be provided and can offer 50 industrial phone stations with loudspeaker. It is dedicatedly used for coal handling system. The CHP Control Room will be laid with one desktop control station. Every sub-control room in the coal handling area will be laid with one desktop station. Industrial phone stations will be installed indoor or outdoor. The type of every industrial phone station to be used is decided by its working environment. It may be waterproof, explosion-resistant, noise-resistant and so on. According to the different areas of the power plant, the phone stations can be divided into different groups. Every desktop control station will control one or more phone station groups. The industrial phone stations in one group are interconnected by multi-conductor cables. The system will be connected with PABX and DADX by trunking lines. The main station of PA system is powered by plant UPS power supply.

5.10.11.4 Digital Walkie-talkie Radio system

36 walkie-talkie radio sets will be provided. Every radio set will work at UHF band and has not less than 8 channels. The communication distance will be not less than 5km. But Employer shall be responsible for getting license for the frequency from the local government radio management committee. The working frequency scope can be between 300MHz to 480MHz. Walkie-talkie radio sets are used by persons responsible for patrolling and maintenance in the plant area.

5.10.11.5 -48V DC Communication Power Supply System

Such a system includes two separate high-frequency switch power supplies and two separate groups of lead-acid batteries. The capacity of each high-frequency switch power supply is 48V/200A, and the capacity of each group of batteries is 48V/500Ah.The capacity of every cell battery is 2V/500Ah.Each group of batteries consists of 24 cell batteries. One high-frequency switch power supply charges one battery group. So that two separate communication power supply systems are set up. Each high-frequency switch power supply is input two separate 380V AC, three phases circuits. These two circuits shall come from different busbars of the plant power supplies. The capacity of each circuit is not less than 15kVA.

5.10.11.6 Communication Room and Other Rooms Used for Communication

-78-

One Communication Room is prepared inside the Network Control Building. All the cabinets used to install all communication equipments are laid in the Communication Room. Beside the Communication Room, one communication battery room is provided and to be specially used to lay the two groups of communication batteries. All the equipments in the whole plant will be installed in the Communication Room with cabinets. They are PABX, DADX, Main Distribution Frame (MDF), PLCC terminals or optical communication equipments, -48V DC Communication Power Supply Systems etc. Public Address system will be installed in CHP COMPLEX BUILDING and be powered by UPS circuits.

At the same time, one communication keep-watching room and one communication instruments &meters room are provided. The PC maintenance servers of all communication systems and operator console of PABX will be laid in the communication keep-watching room. The communication persons working for patrolling and maintenance of plant communication will also work here. The instruments &meters room is used to deposit communication tools, instruments, meters, spare parts of communication equipments and so on.

5.11 Thermodynamic system control

5.11.1 Automation level

Centralized control mode will be adopted for boiler, turbine, generator and BOP. There is one Central Control Room (CCR) for two units. Automation systems of power plant will be composed of Distributed Control System (DCS) and the control system of auxiliary systems (BOP DCS). Design principle is control function decentralization and information centralized management. Startup/shutdown of unit, supervision of running state and handling abnormal condition and urgency accident etc. will be realized in CCR with the help of routine inspection and several operations on site. Automation level of units will meet requirement of auto startup/shutdown of function class.

5.11.2 Control mode

Supervision and control of units will be composed of DCS and other thermodynamic control systems, and DCS is the main part. In CCR, operator stations with LCD and keyboard / mouse and VDU (70", 6 sets for total plant) will be the main control and

-79-

monitoring interface.

When serious accident of DCS happens (for example loss of power, communication interrupt, all operator stations fault, important controller fault etc.), the unit can be shut down safely under the rule of "fail-safe" through the several hardwired emergent pushbuttons mounted on the operator console in order to protect persons and equipments. These pushbuttons will be independent from the DCS.

Circulating water pump house, compressed air system, Fuel Oil Pump House will be monitored and controlled by common DCS through remote I/O station. A common DCS network will be designed and connected with two unit DCS via net bridges. Separate operator station and Shift supervisor station will be provided in CCR. Electrical common system will be control through common DCS.

Except for auxiliary system directly controlled by DCS, other auxiliary systems will be monitored and controlled by microprocessor based BOP DCS control equipment. BOP DCS operator stations will be located in CCR and local control room. Ash handling system, water treatment system and coal handling system have local control room respectively. D.M plant, condenser polishing system, chemical dosing system and Steam and Water Analysis System, waste water treatment plant, comprehensive water pump system etc. auxiliary system will be control and monitoring in water treatment system local control room. ESP system will be control and monitoring in Ash handling system local control room.

Flue gas desulfurization (FGD) will be controlled and monitored in auxiliary DCS. Local EER of FGD area will be provided and local operation station of FGD and Ash handling will be combined. Flue gas denitrification of unit SCR part will be controlled in unit DCS, the common part (reducing agent storage and supply system) will be controlled in auxiliary DCS. Local EER and commissioning station of denitrification reducing agent storage and supply system will be provided.

5.11.3 I&C automation systems configuration

The parts of control system of this project as following

5.11.3.1 Distributed Control System (DCS)

(1) Distributed control system (DCS), the main function of DCS includes: data

-80-

acquisition system (DAS), modulating control system (MCS), burner control system (BCS), sequence control system (SCS), Electric Control System (ECS) etc. SCS will meet requirement of auto startup/shutdown of function class. In accordance with technical process system, automation systems will be divided into some independent sub-systems, i.e. sub-group control class and drive control class. FSSS will include furnace safety system (FSS) and burner control system (BCS). Monitor boiler operating conditions, and upon detection of a condition hazardous to personnel or to equipment, generate a Master Fuel Trip (MFT) signal. BCS will be a part of the DCS.FSS will adopt functional safety type system, fulfill the requirement of safety integrity level 3 (SIL3).

(2) Digital electro-hydraulic control system (DEH)and Emergency trip system (ETS) will be provided by turbine manufacturer. Machine electric-hydraulic control system (MEH) and machine emergency trip system (METS) will be provided by boiler feed pump turbine (BFPT) manufacturer. The hardware of DEH and MEH will be endeavored to unify with the DCS, and the control of DEH and MEH will be a part of DCS. MEH will adopt the same hardware as DCS. ETS and METS will adopt redundant PLC. ETS hardware will have SIL3 certification.

(3) Turbine supervisory instrument (TSI), turbine diagnosis management (TDM) and BFPT supervisory instrument (MTSI) will be provided by main equipment and auxiliary equipment manufacturer.

(4) Separated engineer workstation (EWS) of TDM, tube leak detection system and gas carbon measurement system will be provided and communicated with supervisory information system(SIS).

(5) Turbine bypass control system (BPS) will be controlled in DCS.

5.11.3.2 Balance of Plant Control System (BOP DCS): According to physical location and process features, water, ash and coal local auxiliary control room will be designed and there are operators on duty and workstations in each control room with equipment control cabinets. Other auxiliary workshop will be designed fully auto mode without persons on duty. Some auxiliary workshops which have few and distributed control points will adopt remote I/O technology. Control, operation & monitoring of these systems shall be implemented in auxiliary control system. Water, coal and ash control

-81-

points can be connected by auxiliary control network, and operators in CCR and local control room can supervise the process through LCD operator workstation. The centralized supervision function of auxiliary control system can be realized in CCR through auxiliary control network. The auxiliary control system shall have separated operator workstation in CCR and Separated engineer work station in Engineer Room. For the safety of the main plant, auxiliary control system shall be separate with main DCS and without interface signals.

5.11.3.3 Continuous Emission Monitoring System (CEMS): In this project, to monitor the concentrations of gas emission and dust a suit of flue gas analyzing system will be provided for two units. The monitored parameters include SO₂, NOx, CO, HC, PM. and Hg. Flue gas analyzing system will be hard wired to DCS.

5.11.3.4 Closed circuit television system (CCTV): One CCTV System for two units will be designed for plant security and vigilance monitoring. Supervision spot shall be located in ash control room, water control room, coal handling control room and CCR. CCTV shall be for main plant house, boiler, observing access road, entry gate, transformer area, switchyard and other important areas. CCTV will communicate with MIS.

5.11.3.5 Fire protection and detection system: according to local fire proof standards, realize fire monitor & alarm, covers the project's main building, fuel oil pump house, coal handling system, switchgear rooms and wherever prone to fire in Auxiliary system buildings.

5.11.3.6 Heating ventilation and air conditioning system (HAVC): the supervision and control function will be included in auxiliary control network, , and connecting to fire alarm and detection system.

5.11.3.7 Supervisory information system(SIS): the network of SIS and MIS will be combined.

5.11.4 I&C laboratory :Test and Maintains Equipment for I&C will be located in production service building. And there is one I&C maintenance room in main building. The area is assumed having maintenance assignment about 280m2.

5.11.5 Main I&C Equipment Selection Philosophy

-82-

All equipments of I&C that mentioned in the following must be good quality and performance:

(1) Unit DCS will adopt experienced product, BOP DCS will adopt Chinese products.

(2) Other experienced product

•Motor-driven actuators and pneumatic actuators shall be of standard & international make. Electric actuator, electric gate control devices shall be integral product.

•flame detection and cooling fan

•Smart transmitter: All process transmitters shall be intelligent (smart type) with HART protocol like local display facilities

•Pressure switch, DP switch and temperature switch etc.

•High temperature high pressure instrument valve.

•mass flowmeter;

•TSI & ETS

level transmitters

5.11.6 The instrument cable will choose fire retardant type. Cables for binary input signals will be overall shielded and cables for analog signals will be individual pair shielded +total shielded. Multi-conductor cables will be used for Compensating cable. Steel wire armored cables will be used for directly buried cables.

All instrument cables will be installed in galvanized steel cable trays. Galvanized covers will be installed in such place where protection from accumulation of dust or debris or sparkle is required.

5.11.7 Coding system for the project will comply with GB/T 50549-2010 Coding standard for power plant identification system.

5.12 Arrangement of main power house

5.12.1 The recommend scheme of main building:

(1)Using (turbine hall, deaerator bay, bunker bay, boiler house) "four row" arrangement

(2)Optimize main building arrangement reasonably, decrease the distance between

-83-

boiler and turbine, so as to decrease the important pipe consumption.

(3)The turbine generator centerline is at the middle of column A&B, the space in turbine hall is arranged reasonably.

(4)Deaerator is at 26m floor, the height is enough for feed water booster pump NPSHr.

(5)The central control room is at operation floor of coal bunker bay between unit 1&2.

(6)The bypass system adopts high pressure and low pressure bypass system in series.

(7) Data sheet of main power house layout plan

	Dimension recommended		
	10		
The E	The EL. of turbine hall operation floor		
	Span of turbine hall	30.6	
	The space between C.L. of turbine and C.L. of row A	15.3	
Turbine hall	The EL. of the top of the crane beam	25.5	
	The EL. of roof truss lower chord of turbine hall	28.6	
	Length of turbine hall	213.5	
	Span of the deaerator bay	10	
Deaerator bay	EL. of the deaerator bay	26	
	Length of the deaerator bay	213.5	
Coal bunker bay	Span of the bunker bay	13.5	
	The El. of the coal feeder floor	17	
	The El. of the coal belt conveyor	44.7	
	The El. Of coal bunker ceiling	52.4	
	No. of column and Length of the bunker bay	19/191.5 (19×10+1.5)	
	Distance between turbine hall and boiler	7	
Arrangement of boiler and rear of the boiler house	Length of boiler	50.2	
	Width of boiler	38.6	
	The EL. of boiler house operation floor	17.0	
	Space between back row column of boiler and C.L. of chimney	106.65	
Main house	Main house Space between row A and C.L. of chimney		

5.12.2 Turbine hall arrangement

Span of turbine hall is 30.6m, there are 20 column spaces and each one is 10m, there is 1.5m space for expansion, so the total length of turbine hall is 213.5m. The EL. of roof truss lower chord of turbine hall is 28.60m, and the EL. of the top of the crane beam is 25.5m. There are 13.7m floor, 6.90m floor and 0.00m floor in turbine hall.

At 0.00m floor of turbine hall, the condensate polishing equipment, main lubrication oil system, the condensate pump, mechanical vacuum pump, lubrication oil purifier equipment will be arranged at front of turbine, motor driven feed water pump, generator stator water cooling system, generator sealing oil tank, hydrogen cooling system equipment, mechanical vacuum pump, closed circulation cooling water heat exchanger, closed cycle cooling water pump, open cycle cooling water pump and open cycle cooling water strainer will be arranged at rear of generator. Condenser will be arranged at central section, tube taking out direction towards column A, high backpressure condenser will be arranged at generator side, low backpressure condenser, the elevation of condenser pit is–5.8m, the elevation of circulating water pipe pit between condenser and column A is -5.8m, there are circulating water inlet and outlet pipes, ball screen and valves. The lube oil supply equipments of BFP turbine are located between turbine foundation and column B. There is one common repair space about 300m² between unit 1&2.

Mezzanine floor of turbine hall is mainly used for piping routing, high pressure bypass system, turbine oil system equipments, seal steam supply system and GSC, shaft seal fan will be arranged in front of turbine, generator enclosed generatrix, 10kV power distribution equipment will be arranged at rear of generator. No.7 and No.8 low pressure heater will be arranged at the neck of condenser, the core will be taken out towards column A.

Turbine hall operation floor will adopt big platform, turbine-generator units, steam-driven feedwater pump and feedwater pump turbine will be arranged on this floor, low pressure bypass will be arranged near column A. Turbine front will be arranged towards extension end. Two sets of steam-driven feedwater pump will be arranged near

-85-

column B, exhaust of BFP turbine downwards and connected to condenser.

5.12.3 Envisaged arrangement of deaerator room

The span of deaerator bay is 10m. There are 0.00m floor, 6.90m floor, 13.7m floor and 26.0m floor. Steam-driven feedwater booster pump will be arranged at the ground floor. Beside column B will be a operation and maintenance passageway run-through the plant. Two sets of low pressure heaters and auxiliary steam header will be arranged on mezzanine floor. No.1, No.2 and No.3 HP heaters will be arranged at deaerator bay operation floor. Deaerator, closed circulating cooling water expansion tank will be arranged at 26m floor.

5.12.4 The arrangement of the boiler house, bunker bay and the area behind the boiler

The boiler is outdoor arrangement and steel structure type. The distance between the boiler first row column H and the last row column N is 50.2m. The distance between the boiler left column and right column is 38.6m. The distance of two boiler center line is 111.5m. The slag removal device, sealing air fan, flash tank, and flash tank drain pump are arranged on the 0m floor of the boiler. FDF, PAF, ESP, IDF and chimney are arranged accordingly behind the boiler. FDF, PAF are arranged under the SCR equipment. One passenger-good elevator will be installed on one side of each boiler.

The span of the bunker bay is 13.5m, and the column space is 10m. There are EL. 44.7m, El. 17m (tentatively): and El. 0.00m floors in the bunker bay. The coal belt conveyors are arranged on the El. 44.7m floor. The El. 17m floor is operation floor, the coal feeders are arranged on this floor. The steel raw coal bunkers are arranged in the space between the El.44.7m and El.17m. On the EL. 0.00m floor, six medium speed mills and corresponding auxiliary equipment are arranged in-line position for each boiler.

There are passages leading to the bunker bay at the fixed end, middle and extension end of the main power building on the El. 17m floor and EL. 44.7m floor, at the same time, there are passages between the boiler proper and the bunker bay on the El. 44.7m floor to satisfy the requirement of routine inspection of the equipment and transportation of maintenance components in the bunker bay.

On the El. 0.00m floor of bunker bay, there is a 7.0m width passageway between

the steel column of the boiler and row D of bunker bay for the air ducts and maintenance passage. There is a maintenance passage near row C for the maintenance of the mill.

ESP dimension (tentatively): longitude 37.72m x transverse 35.50m, and the space between the back brackets of the gas duct behind the boiler and the first row of the steel bracket of the precipitator is satisfied with the requirement of fire fighting passageway.

The two IDFs of each boiler are transversal arranged, by the outlet damper, they are connected to rectangular steel gas duct leading to the twin-flue chimney. The space between row A and the center line of the chimney is 217.95m

5.13 Architectural structure

5.13.1 Architecture

5.13.1.1 The Main Power Building Arrangement

The main power building will be arranged sequentially: turbine hall, deaerator bay, bunker bay, boiler house. Boiler is of outdoor installation type. There is an elevator beside each boiler.

Horizontal traffic: There are two main longitudinal passages at ground floor in main power building. One is located near Axis B in deaerator bay and the other is located between Boiler and axis D. A longitudinal passage is at operating floor in main power building, which located near Axis B. Several lateral passages are reasonably laid in each floor. There are exits at two ends at ground floor. The Turbine hall's maintenance area between two boilers, there is a gate in the Axis A which equipment can get in. On the ± 0.00 m, operating floor and deaerator floor, there are passages from turbine hall to bunker bay and Boiler. There are steel-footpaths from bunker conveyor floor to boiler.

Vertical traffic: There are three steel stairs which are in the fixed end, the extension end and middle of deaerator bay, and the distance between each stairs should be less than 90m. There are steel cat ladders for repairing which can reach the roof.

Turbine hall, deaerator bay, bunker bay and boiler belong to one fire compartment. It is surrounded by fire passage. The fire rating for the door of escape stairs, electrical room, cable vault and cable shaft will be 2 hours. The fire door must open toward the escape direction.

-87-

The principle of lighting in the main power building is that the natural sunlight is as the main method and the artificial lighting is auxiliary.

The external-wall upper 1.2m of the main power building is coated with colorful single corrugated metal sheets, and that below 1.2m is brick. The internal-wall is brick. Aluminum alloy windows are used for the main power building. According to the functions, steel doors, aluminum alloy windows, and fire doors are adopted properly. Steel handrail will be adopted for stairs.

5.13.1.2 Area of auxiliary buildings

Description	Area(m ²)		
General office building	4150		
Maintenance dormitory	1500		
Dining hall	800		
Bathroom room	300		
Employee dormitory	8750		
Work shop &Material house	5000		
Total	20500		

5.13.2 Subgrade and foundation

5.13.2.1 Site Geomorphology

Geomorphology of the area is alluvial plain. Topography of the area is characterized by plain.

The subsoil is divided into three strata in the geotechnical report, Silty clay: The characteristic value of bearing capacity is $90 \sim 110$ kPa.

Silty fine sand: The characteristic value of bearing capacity is $130 \sim 150$ kPa.

fine sand: The characteristic value of bearing capacity is $160 \sim 190$ kPa.

Silty clay: The characteristic value of bearing capacity is $120 \sim 130$ kPa.

Subsoil type for seismic effect is classified to moderately hard soil.

According to shear wave velocity of subsoil and depth of overlying stratum, Site is classified to grade II in Code for seismic design of buildings.

During investigation, the groundwater level vary from $5.90 \sim 7.90$ m below the ground. According to the geological report presented by DECON, perennial highest groundwater level may be considered at 0.0m for design. And the groundwater has weakly corrosive effect on concrete structure and steel bar in concrete structure in site II circumstance.

5.13.2.2 Subsoil treatment

According to the geotechnical investigation report, cast-in-situ pile foundation shall be adopted for main power building, boiler house, chimney, ash silo, crusher house and other buildings with heavier loads. For the building with lighter loads, such as guard house, natural foundation shall be adopted.

5.13.3 Structure design

5.13.3.1 Design of the main power building

1) The main power building consists of turbine hall, deaerator bay and bunker bay. The main load bearing frame will be of steel frame structural with bracing and connected with high strength bolts.

Lateral forces along the length of the building will be resisted by bracings in horizontal and vertical frames. Additional bracing or moment connection will be used to assure stability of the structures.

2) Roof of turbine hall will be of color coated sandwiched corrugated metal sheets on steel purlins placed on steel beam, with a section of 'H' type; Roof gutter shall be set in the two sides of double-pitch roof. The other floors will be of cast-in-situ reinforced concrete slab supported by corrugated sheet metal formwork which will be on steel beams. The shear connectors will be of studs.

3) Steel plate welded crane beams will be adopted for turbine hall.

4) T.G. pedestal will be of reinforced concrete frame structure and will be isolated by expansion joints from adjacent floors for vibration consideration.

5) The boiler supports will be of steel structure which shall be provided by boiler manufacturer.

6) The two gables of the turbine hall will adopt steel frame, with vertical bracing in transverse. Longitudinal wind load will be resisted by steel columns of gable, and then

-89-

be transferred to the space structures of roof and platforms respectively.

5.13.3.2 Chimney

One twin-flue chimney is adopted for two units. The chimneys will be of reinforced concrete structure and flues will be titanium-steel composite material.

5.13.3.3 Design of the other buildings

1) The Structures behind boiler

Support of ESP and flue duct will be of steel structure.

2) Structures in electric area

Structures of switchyard: The outgoing feeder gantry structures shall adopt steel pipe columns and steel truss beams. The lightning rods and ladders shall be supplied according to the electrical requirements. All switchyard structures will be of galvanized steel.

3) Structures in coal handling area

Crusher house and transfer towers will be steel frame structure. The underground structure will be of RC underground box structures with waterproofing treatment.

Conveyor gallery will adopt steel truss with steel bracing, and the deck slab will be of cast-in-situ reinforcing concrete supported by corrugated sheet metal formwork which will be on steel beams floors, the roofs and the walls will be of corrugated metal sheets. Underground conveyor gallery will be of RC underground box structure with waterproofing treatment.

The upper structure of wagon track hopper will be of steel structure and the underground structure will be RC underground box structures.

4) Structures in ash handling area

Ash silos will be of cylindrical RC shell .The foundations will be of RC circular thick slabs.

5) Structures in chemical water treatment area

DM water plant shall be of RC frame structure, DM water assay building adjoins the DM plant.

DM water assay building adjoins the DM water treatment plant, and it shall be of RC structure.

-90-

6) Structures in Desulfurization Area

Lime stone grinding building will be RC frame structure

7) Rack for common piping structures

Rack for common piping structures shall be of steel structure.

5.13.3.4 Seismic design

The seismic fortification intensity is 7° (0.16g).

In order to resist potential seismic action, vertical bracing system shall be installed in transverse and longitudinal directions for the main power building to ensure integral stability of structure.

Anti-seismic design for steel structure, it's materialized on calculating to the structure. Seismic action shall be controlled through three dimensional space structural analysis to restrict the stress and deformation of structure.

5.14 Water Supply and Drainage System

5.14.1 Circulating water flow

The exhaust steam flow for each LP turbine is 1235.4 t/h at TMCR Condition. C.W. cooling multiple is 60 .The circulating water flow at TMCR Condition is as table 5.14.1.

Unit No.	Unit capacity (MW)	Condensed steam (t/h)	Cooling water for condenser (m ³ /h)	Cooling water for aux.coolers (m ³ /h)	Total (m³/h)
1	1×660	1235.4	74124	2700	76824
2	2×660	2470.8	148248	5400	153648

Table 5.14.1-1 Circulating water demand at TMCR Condition

5.14.2 Water Consumption

The maximal water consumption of the plant at TMCR condition for 2×660 MW units is 2991 m³/h, as follows in table 5.14.2-1.

No	ltem	Demand m ³ /h	Recovery m ³ /h	Consumption m ³ /h
1	Evaporation loss of cooling tower	2080	0	2080
2	Wind loss of cooling tower	154	0	154
3	Blowdown of C.W. system	366	201	165
4	Process water for FGD	220	16	204
5	Service water for FGD	80	80	0
6	D.M. plant makeup water	130	53	77
7	Cooling water of air compressor	180	180	0
8	Cooling water for fan and oil station	80	80	0
9	Water for hydrogen station	20	20	0
10	Water for HAVC	94	30	64
11	Washing water for main power building	8	0	8
12	Humidification water for dry slay	22	0	22
13	Humidification water for dry ash	3	0	3
14	Water for oil area	9	8	1
15	Potable water	10	8	2
16	Coal handling washing water	15	11	4
17	Coal yard spray/dust suppression water	20	0	20
18	Bucket-wheel stacker-reclaimer water	9	0	9
19	Ash yard spray/dust suppression water	15	0	15
20	Water for plant horticulture	5	0	5
21	loss of raw water and wastewater treatment	8	0	8
22	Unpredictable water	150	0	150
23	Total	3678	687	2991

Table5.14.2-1 Water consumption of 2×660MW units at TMCR condition

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5.14.3 Circulating Cooling Water System
The primary function of the circulating cooling water system with natural draft cooling tower is to supply cooling water to the condenser. The system also supplies cooling water to some auxiliary equipment in the main building such as oil coolers etc.

Technical process of circulating water system is designed as follows:

Circulating water pump \rightarrow hydraulic butterfly valve \rightarrow C.W. supply pipe \rightarrow condenser and auxiliary coolers \rightarrow C.W. pressure return pipe \rightarrow natural draft cooling tower \rightarrow gravity flow trench \rightarrow suction basin of circulating water pump house \rightarrow steel gate \rightarrow brush screen cleaner \rightarrow circulating water pump.

2×50% (TMCR Condition) vertical mixed flow C.W. pumps will be installed for each unit. There are 4 sets of circulating water pumps for 2x660MW units. The design data for C.W. pump is as follows: Q=10.7m³/s, H=32m, N=4400kW, V=10kV.

Two lines of steel pipe DN3200 (including supply and return pipe) will be provided as circulating pressure pipes for each unit. Since the circulating water pipe will be buried underground, the anticorrosion measure of the pipe outside wall must be taken.

One RCC return trench (3.2m×3.2m) will be provided as gravity flow culvert from tower to circulating water pumping house for each unit.

One (1) 9500m² wet evaporative natural draft, counter flow type cooling tower with film type PVC fill material will be built for per unit, two (2) cooling towers for 2×660MW units.

5.14.4 Make-up Water System

The makeup water of the project will be drawn from the LBDC in the southeast of the power plant which will have one month shut down at January. Ground water and raw water reservoir will be supplied to satisfy the power plant water consumption during the canal shut down period. Because of the lack of LBDC and ground water related information, so the following processes of water supply are proposed:

From Feb to Nov every year, the processes of water supply is LBDC-open channel –forebay-make-up pump house-piping- raw water treatment system- service and fire fighting water pond.

In Dec., the processes of water supply is LBDC-open channel –forebay make-up pump house-piping- raw water treatment system and raw water reservoir- service and

-93-

fire fighting water pond.

In Jan., the processes of water supply is raw water reservoir-raw water pump house - raw water treatment system - service and fire fighting water pond and ground water- service and fire fighting water pond.

The make-up pump house and forebay will be located near LBDC where equips four make-up water pumps with the specification of Q=1500m³/h, H=20m, N=110kW, V=380V.

The raw water reservoir and pump house will be located near plant where equips three raw water pumps with the specification of Q=700m³/h, H=18m, N=55kW, V=380V.

Ground water is transported to service and fire fighting water pond by deep well pump.

One DN900 welded steel pipe will be provided from make-up water pump house to plant, and given off one DN600 branch to raw water reservoir.

One DN700 welded steel pipe will be provided from raw water reservoir to plant.

5.14.5 Raw Water Pretreatment System

The raw water will be taken by the pump installed in pump house near the river, and then delivered to raw water pretreatment station through boosting, and then water is delivered to water storage pond after treatment, at last water is transported to every water consumer.

The raw water pretreatment system consists of flocculation & deposition pond (two cells), chemical feed room, sludge pond and two sludge pumps.

The main design data are: (1) flocculation & deposition pond (two cells), $RCC,Q=2000m^{3}/h(each)$. (2) One chemical feed room consists of 2 sets of flocculants devices, 2 sets of coagulant devices, (3) two sludge pumps (one working one standby, $Q=20m^{3}/h$, H=20m, N=5kW).

5.14.6 Water Supply and Drainage System

The water supply system consists of service water system, washing water system, potable water system and fire fighting water system etc.

The drainage system consists of domestic sewage system, industrial waste water system and rain system etc.

One comprehensive water pump house, one potable water pond of 200m³, two service and fire fighting water ponds of 2000m³ will be built for the project.

One comprehensive water pump house is set up where equips three service water pumps with the specification of Q=141 \sim 282m³/h, H=74 \sim 60m, N=75kW, V=380V, two in operation, and one on standby; two air-preheater washing water pumps with the specification of Q=280 \sim 480m³/h, H=85 \sim 73m, N=160kW, V=380V, one operate, and the other standby. Wash pump of air preheater operates only when air preheater is washed; two chemical water pumps with the specification of Q=150m³/h, H=40m, N=25kW, V=380V, one operate, and the other standby. One operate, and the other standby. V=380V, one operate, and the other standby. N=25kW, V=380V, one operate, and the other standby. V=380V, one operate, and the other standby. One frequency converter water supply equipment with the specification of Q=35 \sim 65m³/h, H=70 \sim 65m, N=22kW, V=380V, two fire fighting pumps and one fire fight jockey pump with the specification seeing section 5.16.

Water is delivered to water storage pond after treatment, and then water is transported to every water consumer. Part of water supplied by D.M. plant is delivered to potable water pond for drinking.

5.14.6.2 Drainage System

The drainage system consists of domestic sewage system, industrial waste water system and rain system etc.

Generally, domestic sewage, coal waste water and oily waste water will be recycled after treatment without discharge.

Rain water without pollution and industrial waste water will be collected to the suction pond of drainage pump house, and then discharged into drainage ditch through drainage pipe after boosted.

5.14.7 Waste Water Treatment System

5.14.7.1 System Function

The waste water treatment system includes sanitary waste water, industrial waste water, oily wastewater, coal waste water etc.

According to the principle of 'diverting wastewater from clean water' and 'versatile utilities of water', all kinds of wastewater are been treated, also wastewater after treatment is considered to reuse, if discharge, which quantity and temperature can meet

-95-

the requirements of NEQS standard.

5.14.7.2 Treatment of domestic sewage

The domestic sewages of electric power plant comprise sanitary sewage, washing sewage from buildings within plant area, and domestic sewage from production auxiliary buildings. As for the sewage of this project, it is planned to apply the contact oxidation process, and select the buried integrated processing facility. The designed effluent quality shall be CODcr≤50, BOD5<20mg/I, SS<30mg/I, containing oil≤5mg/I, and the treatment process shall be:

Sludge tank

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Screen well \rightarrow regulating reservoir \rightarrow lift pump \rightarrow primary sedimentation tank \rightarrow contact oxidation \rightarrow secondary sedimentation tank \rightarrow disinfection tank \rightarrow recycling tank $\uparrow \qquad \downarrow \qquad \downarrow$

Aeration Sludge tank

Reuse

It is planned to install two 10t/h domestic sewage treatment units, and the qualified water after treatment shall be extended to the recycling tank for reuse purpose.

5.14.7.3 Treatment of coal-bearing and oil-bearing wastewater

Two domestic sewage treatments are installed in plant this phase with 10t/h capacity per unit, two coal water treatments with 15t/h capacity per unit and one oil separator with 15t/h capacity per unit are also installed.

5.14.8 Hydraulic structures

The hydraulic structures in the plant site mainly include: Induced draft cooling tower, raw water reservoir, circulating water pump house, comprehensive water pump house, foam pump house, transformer accident oil pool and some other pond or tanks served for the use of water supply and chemical.

5.14.8.1 Hydraulic building (structure) within plant area

(1) Natural cooling tower

According to the thermal computation, two natural draft cooling towers with a spraying area of 9500 m² for each unit will be set. The shell of the tower is of the hyperbolic cast-in-situation R.C.C structure, and the shell supporting columns are of

-96-

R.C.C structure with the shape of "X", and R.C.C ring foundation will be adopted for the cooling tower.

(2) Circulating water pump house

One circulating water pump house will be set in the plant. The superstructure of the circulating water pump house is of cast-in-site R.C. frame structure, and the roof system will adopt cast-in-situ reinforcement concrete with extrude steel sheeting as the bottom die. The sub-structures of the circulating water pump house are of cast-in-site boxing R.C. foundation. The air entraining concrete blocks will be used as the inner wall and external wall.

(3) Comprehensive water pump house

One comprehensive water pump house will be set in the plant. The superstructure of the comprehensive water pump house is of cast-in-site R.C. frame structure, and the roof system will adopt cast-in-situ reinforcement concrete slab. The sub-structure of the comprehensive water pump house is of cast-in-site boxing R.C. The air entraining concrete blocks will be used as the inner wall and external wall.

(4) Reservoir

There is a reservoir on the north of the power plant. The reservoir is formed by excavating downwards in the original ground; earthen dam will be constructed around the reservoir. The dam will be of rolled earth assumed temporarily. Seepage interception wall around the reservoir will be set to prevent water lateral seepage. According to the present geological datum, the bottom seepage prevention can depend on the nature clay layer of the underground.

(5) Other structures

For the other hydraulic structures, the sub-structures of hydraulic structures such as pump pit, underground basin and etc., cast-in-situ R.C. foundation will be adopted. The superstructure of hydraulic structures such as pump houses and other houses is of cast-in-site R.C. frame structure. The roof system will adopt cast-in-situ reinforcement concrete slab, the air entraining concrete blocks will be used as the inner wall and external wall.

5.14.8.2 Foundation treatment

-97-

According to the geotechnical investigation report in this work stage, the bearing capacity of the subsoil is not high, combined with the characteristics of the hydraulic structures ,subsoil treatment will be adopted for most of the hydraulic structures as following :

For the circulating water pump house, comprehensive water pump house and some other important hydraulic structures bearing more high loads, bored cast-in-place concrete pile foundation may be adopted. For the transformer accident oil pool and some other hydraulic structures which is less important, natural foundation shall be adopted, or the broken stone cushion is used to exchange the subsoil until to bearing subsoil stratum. The bearing subsoil stratum is ⁽²⁾ Silty fine sand.

5.15 Ash yard design

5.15.1 Design of the preliminary dam

Three meters height earth-fill dam should be constructed around the ash yard, and the top level of the dam is about 176.2 m (MSL) that is higher than the 100-year return period flood level 174.4m(MSL). The width of top dam is 3.0m, and the slope is 1:2.5 for both side slopes. The protection of side slope adopts 250mm thick dry stone block. In order to prevent the seepage, the geotextile filter layer should be set under the protection layer; broken stone liner should be set on both sides of geotextile to protect the geotextile. When the elevation of storing ash is up to the dam crest, keep storing with a 1:4 permanent lime-ash slope gradient inside of the dam, after the 1:4 permanent lime-ash slope formed, it should be covered with precast hollow plain concrete plate as a protection that can prevent the fly ash contaminate the environment.

5.15.1.2 Flood control system for the ash yard

The dam will be set around the ash yard that is higher than the 100-year return period flood level, so rainfall can't flow into the ash yard. At the same time the local average rainfall is 412.3 mm, so drainage system will not be set, depending on the evaporation..

5.15.1.3 Environment measures for the ash yard

(1) Seepage prevention measures

There are no specifications and rules about the seepage prevention of the ash

-98-

disposal area from the Pakistan government by consulting the local environment engineers; the geological survey documents of the ash disposal area field are insufficient, the design of the ash disposal seepage control based on the Chinese criterion of <the contaminative control criterion of the storing and disposed field for general industrial solid wastes >, for the time being the design is according to the scheme that lay polyethylene complex geotextile under the dam and the field of the ash disposal area. At last the man-made impervious barrier should have the same water-tight capability as the 1.5m clay pan which the permeability coefficient is 1.0×10^{-7} cm/s. In order to save the project's preliminary investment, the geotextile can be laid partly on the bottom ash yard that can meet the ash disposal requirement of one year's operation, in later period the polyethylene complex geotextile should be laid by subsection according to the ash disposal area's partition operation.

2) Other environment measures

The 10m wide trees must be set around the ash yard that can decrease the wind velocity and resist the pollution. The dry ash should be transported and compacted by adding water; the surface of the ash should be sprayed with water on schedule to avoid the re-entrain dust. When the height of storing ash gets to the designed elevation, the ash yard should be changed back to farmland by adding soil.

5.15.2 Management for ash yard

5.15.2.1 Management office for ash yard

Management office for ash yard will not be set because it is nearby the power plant; Garage will be set in the power plant.

5.15.2.2 Operation for waste solid store

The dry ash should be transported and compacted by adding water; the surface of the ash should be sprayed with water on schedule to avoid the dust. When the height of storing ash gets to the designed elevation, then the ash yard should be changed back to farmland by covering the soil. The ash will be rolled by the roller for 4 to 6 times .The work area of the roller compaction is about 50x50m and the work surface will be sprayed with water three times one day according to the air condition. Other area should be covered by 300mm clay. When the surface is higher than the ash disposal area's

-99-

preliminary dam crest, the compaction should extend toward the dam upstream by a 1:20 slope. The compaction is made up of two parts, one is permanent ash slope, and another is the ash disposal area's repository. Permanent ash slope should be compacted parallel with the axis of dam and the lap length should be no less than 0.5m, the compact quality should exactly fit the parameter from the requirements of design and the compact test on site. When the ash disposal is full, the ash yard should be changed back to farmland by adding soil.

5.15.2.3 Machine for the store operation

The instrument's allocation during the operation time has relationship with the quantity of ash. According to the operation test before, this project set two vibration compactor vibration roller, two crawler dozer, one towed scraper, and one small roller, and two multifunctional sprinklers..

5.16 Fire Protection System

5.16.1 Main principle for firefighting design

To implement the principle of combining prevention and control together with prevention first, prevention first-measure should be fully considered on the equipment choice and layout, effective measures should be adopted on fire break and structure design of construction in order to prevent the occurrence and spread of fire hazard. The two kinds or upwards of fire fighting method will be used for important building & equipment.

Independent fire fighting water supply system is adopted, fire pipes are laid to annular pipe network at the main construction site such as main power plant, coal yard, and oil storage tank, etc. Hydrant system should be installed in the necessary construction such as main power plant, office building, etc.

The fixed water spray system will be used for the fire protection of turbine main oil tanks and oil purification treatment units and transformers etc.

The foam extinguishing system will be adopted for oil tank area. Each oil tank will be equipped with over liquid foam injection system. And foam hydrants will be provided for the oil area.

Clean gas fire extinguishing system will be provided for electronic equipment room

-100-

etc. Carbon dioxide fire extinguishing system will be provided for primary coal bin.

Fire detection, fire-alarm and control system will be established fully.

One water fire truck and one foam- dry powder fire truck will be provided in this project.

The fire occurs once at the same time in this project.

5.16.2 Fire Water Supply

Independent fire water supply system is adopted this phase. The fire occurred simultaneously in the plant area is designed based on one fire a time. The fire water capacity is calculated based on the maximum fire water consumption in case of fire that is the sum of the indoor/outdoor fire water consumption.

Fire water supply: service and fire fighting water ponds of $2000m^3 \rightarrow$ fire fighting water pump \rightarrow fire fighting pipe network of plant.

In comprehensive water pump house two fire fighting pumps are installed, one is the motor-operated fire water pump; another is diesel engine-operated fire water pump for standby, which is guaranteed of normal operation of fire protection system in the accident that the whole plant loses electrical power supply. The criterions of fire protection pump as follows: $Q=402 \sim 804m^3h$, $H=95 \sim 83m$, switchgear N=250kW, V=10kV. In order to maintain water pressure of fire protection pipe network, one jockey system is installed this phase. The mainly passages(such as central control room of comprehensive water pump house and the zero meter floor, operation of main power plant, etc.) all equip button of starting fire protection pump, the button should be taken protect measures.

5.17 HVAC

5.17.1 Climatic Design Information

This project is located near Lahore, so the climatic information of Lahore will be used as design Basis.

 Table 5.17.1
 Outdoor design conditions (from ASHRAE Handbook)

Outdoor design summer dry bulb temperature and mean coincident wet bulb temperature corresponding to 0.4% cumulative	43.2℃/23.2℃			
frequency of occurrence				
Outdoor design summer dry bulb temperature and mean				
coincident wet bulb temperature corresponding to 1% cumulative	41.8℃/23.5℃			
frequency of occurrence				
Outdoor design summer wet bulb temperature and mean				
coincident dry bulb temperature corresponding to 4% cumulative	29.3℃/34.2℃			
frequency of occurrence				
Outdoor design winter dry bulb temperature corresponding to	300			
99.6% cumulative frequency of occurrence	0.0 0			
Outdoor design winter dry bulb temperature corresponding to	5 0°C			
99.0% cumulative frequency of occurrence 5.0 C				
Extreme maximum temperature	45.6℃			
Extreme minimum temperature	-0.1℃			

5.17.2 Heating

The annual mean temperature in winter is above 0°C, so central heating system is not considered. Heat pump air conditioners will be provided for offices in case of low temperature.

5.17.3 Ventilation

5.17.3.1 Ventilation for Turbine House

The turbine-generator units, auxiliary equipment and hot pipes are all arranged in the turbine house and the heat release is extremely large, so the all-around ventilation system is designed to remove the excess heat and moisture in turbine house.

According to ASHRAE "Outdoor design summer dry bulb temperature and mean coincident wet bulb temperature corresponding to 0.4% cumulative frequency of occurrence", Dry bulb temperature is 43.2° ,Mean coincident wet bulb temperature is 23.2° ,Relative humidity is 17.8%, Moisture content is 9.7g/Kg, Enthalpy is 68.7 kj/kg, Dew point is 13.4° . According to these parameters, Evaporative Cooling system is very suitable. Evaporative Cooling system uses the evaporative process, water absorb the heat and evaporate into air, at the same time, air lose heat and be cooled.

The mechanical air supply by Evaporative Cooling units (short for EC) and mechanical air exhaust by power roof fans will be provided for turbine house. Outdoor fresh air enters turbine house through EC units, which would be cooled and then removed outdoors by power roof fans after absorbing indoor excess heat and moisture.

The larger values of the following calculation results will be used for the exhaust air volume:

•The air volume required for the necessary heat discharge.

•The air change rate will not be less than 6/h.

In winter and monsoon, the EC units can be accommodated by operating a few of all units and turn off the others respectively according to the temperature outdoor to save energy.

5.17.3.2 Ventilation for Electrical Rooms

Mechanical ventilation will be provided for switchgear rooms, to meet the requirement of both keep indoor temperature under 35°C and air change rate no less than 12/h. The filter will be used when environment is not good.

Air supply by packaged air fan-coil units and mechanical air exhaust will be provided for battery rooms, to maintain indoor slight negative pressure, the air supply is not circulated. The battery rooms will be provided with the emergency exhaust fans and the air change rate will be no less than 12/h. Anticorrosive measures will be prepared for ventilation equipment, air duct and all relevant accessories. All motors and electric equipment will be explosion-proof and spark-proof type, and the fans will be directly coupled with motors.

2X100% Packaged air fan-coil units and emergency exhaust fans will be provided for excitation rooms, the chilled water come from the refrigerating plant of CCB. The emergency ventilation is also used as normal ventilation.

The ventilation and air conditioning equipment will be interlocked with the fire system and the power supply of the ventilation equipment will be cutoff automatically in case of fire.

5.17.3.3 Ventilation for other rooms

Mechanical air supply and mechanical air exhaust system will be provided for diesel room and the air change rate will be no less than 15/h. Fans and motors will be explosion-proof type, and the fans will be directly coupled with motors.

-103-

Natural fresh air louver and mechanical exhaust systems will be provided for chemical dosing, storage, measuring rooms and laboratory to remove the harmful gas, the minimum air change rate for laboratory will be no less than 6/h, for other rooms will be no less than 15/h. Anticorrosive measures will be taken into account for ventilation equipment, air duct and accessories. All fans and motors will be of explosion-proof type, and the fans will be directly coupled with motors.

The pump houses which have underground part will be provided with mechanical air supply and natural air exhaust.

Mechanical ventilation will be provided for underground part of the coal handling system to improve the air quality and the air change rate will be no less than 15/h.

Other auxiliary rooms which need ventilation will be provided with natural air supply and mechanical air exhaust according to the Code for design of fossil fired power plant (GB50660-2011).

5.17.4 Air Conditioning

5.17.4.1 Central Refrigerating Station

The Central Refrigerating Station will be set on the ± 0.000 m floor of Central Control Building to provide chilled water for air conditioning system in the Central Control Building and Turbine House.

The Central Refrigerating Station will be arranged with 3×50% water-cooled screw water chillers, 3×50% chilled water pumps, 3×50% cooling towers and 3×50% cooling water pumps.

5.17.4.2 Air Conditioning for Central Control Room and Electronic Equipment Room

Central Control Room and Electronic Equipment Room will be served with 2×100% air handling units so as to ensure safe and reliable operation of instruments, meters and control components. The chilled water comes from the refrigerating plant of CCB. The refrigerating and humidifying will be automatically controlled by air handling unit according to the given temperature and humidity to satisfy the indoor requirements.

The fresh air can be used largely to save plant electrical consumption according to the outdoor temperature. The air handling units will be interlocked with the fire system

-104-

and the power supply of the air handling units will be cut off automatically in case of fire.

5.17.4.3 Air Conditioning for Local Control Rooms

Split air conditioners will be provided for local control rooms and other rooms remote from turbine house to maintain the electronic and data processing equipment in good conditions.

5.17.5 Dust Extraction

Pulse fabric dust collectors will be provided for coal transfer house, coal crusher house and bunker bay on the basis that the coal handling equipment and skirtboard are sealed strictly. All motors and electric equipment will be of explosion-proof and spark-proof construction for dust collectors.

The dust collector will be matched with the coal conveying belt (one set of dust extraction system for one belt) and will be interlocked with the corresponding belt conveyor. The dust collector will operate if the corresponding belt conveyor is in operation, otherwise the dust collector will be stopped 5 minutes after shutdown of belt conveyor.

5.17.6 Vacuum Cleaning

Vacuum cleaning system will be provided for boilers and bunker bay.

The vacuum cleaning area includes the bottom floor, operation floor, top and body access door neighborhood of boiler and belt floor of bunker bay.

One mobile vacuum dust collection facility will be provided for the power plant.

Chapter 6 Environmental Protection

6.1 Environmental Standard

According to EIA approval, Pakistan standard<NATIONAL ENVIRONMENTAL QUALITY STANDARDS > will be used for emission levels. Limits for emissions are shown in Table $6.1-1\sim 6.1-3$:

Table 6.1-1	Air Pollutant Emissions Standards

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Pollutants	Units	Pakistan standard <neqs></neqs>	Pakistan standard <neqs></neqs>	
PM ₁₀	mg/Nm ³	500		
	mg/Nm ³	1700		
SO ₂	TPD	500 ¹	NATIONAL ENVIRONMENTAI	
	µg/Nm ³ (1-Year Average Ground Level Increment to Ambient)	50 ¹	QUALITY STANDARDS FOR INDUSTRIAL GASEOUS EMISSION	
NOv	mg/Nm ³	1200		
NOX	ng/J of heat input	300		
	µg/Nm ³ [Annual arithmetic mean of ambient air concentrations of nitrogen oxides (expressed as NO ₂) should not exceed]	100		
Mercury	mg/Nm ³	10		
PM.	µg/Nm ³ (24 hours)	150		
I IVI10	µg/Nm ³ (Annual Average)	120		
SO ₂	µg/Nm ³ (24 hours)	120	National Environmental	
	µg/Nm ³ (Annual Average)	80	Ambient Air	
NO	µg/Nm ³ (24 hours)	80		
NOX	µg/Nm ³ (Annual Average)	40		

Note: Unpolluted area

l able 6.1-2	Effluents Limits from Power Plant
Parameter	National Environmental Quality Standards for Municipal And Liquid Industrial Effluents (mg/L,Unless Otherwise Defined)
рН	6-9
TSS	200
Oil and Grease	10
COD	150
BOD ₅	80
Fe	8.0

Table6.1-3	Noise Level		
Category of Area/Zone	National Environmental Quality Standards For Noise		
	Day Time (6:00-22:00)	Night Time (22:00-6:00)	
Commercial area	65	55	
Residential area	55	45	

According to the collected data, the noise monitoring point should be located on the building within 2-kilometer distant from the factory bound in this project operation phase, and determine the noise limit according to the building function properties. If without building within 2-kilometer distant from the factory bound, the noise should be monitored at 2-kilometer distant from the factory bound.

Without special requirements for noise monitoring height in Pakistan, we should refer to 1.5 meters height of the Chinese standard.

The noise limit for residential area should be followed in the livestock breeding unit on the east of the power plant and the villages around the power plant. The noise limit for commercial area should be followed in buildings on the south of the power plant.

6.2 Flue Gas Pollution Control

(1) SO_2 emissions will be minimized by use of WFGD with SO_2 removal efficiency of 80.0%.

-107-

(2) Emissions of particulate matter will be minimized by use of electrostatic precipitator with dust removal efficiency of 99.70%.

(3) According to EIA report, NOx emissions will be minimized by use of low NOx burners. A space will be reserved for SCR system in each boiler.

(4) According to EIA report, Flue gas from the boilers is emitted by one stack with preliminary height of 180m.

(5) The continuous emission monitoring system (CEMS) with SO₂, PM $_{\sim}$ HC $_{\sim}$ CO $_{\sim}$ NOx and mercury will be used to monitor the flue gas emission.

(6) Mercury emissions will be minimized by use of Electrostatic Precipitators (ESP) and Flue Gas Desulphurization (FGD) with mercury removal efficiency of 70%.

(7) Air pollutant emission are shown in Table 6.2-1:

Table 6.2-1Air Pollutant Emission

			coal rank	
	Pollutant	Unit	Design Coal	Check coal
	Emission Concentration	mg/Nm ³	194.38	181.72
	Pakistan standard <neqs></neqs>	mg/Nm ³	1700	
SO ₂	Pakistan standard <neqs> 1-Year Average Ground Level Increment to Ambient</neqs>	µg/Nm³	5	0
	Discharge Amount	kg/h	842.62	800.22
	Discharge Amount	t/d	18.54	17.60
	Pakistan standard <neqs></neqs>	TPD	500	
	Emission Concentration	ma/Nm ³	31.69	39.22
Smoke	Pakistan standard <neqs></neqs>	mg/mm	500	
	Discharge Amount	kg/h	137.40	172.72
	Emission Concentration	mg/Nm ³	300.0	300.0
	Pakistan standard <neqs></neqs>	mg/Nm ³	1200	
NO _X	Pakistan standard <neqs> Annual arithmetic mean of ambient air concentrations of nitrogen oxides (expressed as NO₂) should not exceed</neqs>	µg/Nm³	100	
	Discharge Amount	kg/h	1300.46	1321.04
moreun	Actual emission concentration	ma/Nm ³	<10	<10
mercury	Acceptable emission concentration	пулян	10	

Note: NO_X emission concentration on boiler exit is 300mg/Nm³.

6.3 Contamination control of wastewater, ash, fine breeze and noise

6.3.1 Waste water treatment

According to the principle of 'diverting wastewater from clean water' and 'versatile utilities of water', all kinds of wastewater are been treated, also wastewater after treatment is considered to reuse, if discharge, which quantity and temperature can meet the requirements of NEQS standard.

6.3.2 Ash treatment

The 10m wide trees will be set around the ash pond that can decrease the wind velocity and resist the pollution. the surface of the ash should be sprayed with water on schedule to avoid the re-entrain dust. When the height of storing ash gets to the designed elevation, the ash yard will be restored to farmland by adding soil.

There are no specifications and rules about the seepage prevention of the ash disposal area from the Pakistan government by consulting the local environment engineers; the geological survey documents of the ash disposal area field are insufficient, the design of the ash disposal seepage control based on the Chinese criterion of , for the time being the design is according to the scheme that lay polyethylene complex geotextile under the dam and the field of the ash disposal area. At last the man-made impervious barrier should have the same water-tight capability as the 1.5m claypan which the permeability coefficient is 1.0×10^{-7} cm/s. In order to save the project's preliminary investment, the geotextile can be laid partly on the bottom ash pond that can meet the ash disposal requirement of one year's operation, in later period the polyethylene complex geotextile should be laid by subsection according to the ash disposal area's partition operation.

This is not multiple utilization approach for ash around the project area at present, It is advised that ash should be utilized if it is possibility in the future.

6.3.3 Fine breeze control

Wind-break and water sprinklers will be installed around the coal storage yards for environment protection. Coal waste water will be recycled after treatment.

6.3.4 Noise prevention

-109-

(1) Equipment noise limit requirements will be informed to main and accessory machine manufacturers. Noise reduction measures such as installing muffles for main noise generation equipment, adding sound insulation cover and sound insulation room for large power equipment so as to make influence of operation noise reduce to the minimum.

(2) In overall layout of the power plant, equipments and structures with large noise are as centralized as possible so as to reduce noise influence of the project on surrounding environment. According to EIA approval, the trees will be planted in and around the project area.

(3) During arrangement and design of pipe and selection of support and hanger, attention will be paid to the vibration and shock prevention so as to avoid noise.

(4) Noise muffler will be installed on wind scoop of forced-draft-fan, primary air fan and oxidation air fan. Sound-proofing cover will be installed on oxidation air fan. Compressor and water pump will be laid in the room.

(5) The noise barriers will be installed around natural draft cooling tower.

Next phase the environmental protection measures will be modified in accordance with the final EIA report and the EIA approval documents.

Chapter 7 Staffing of power plant

According to the relevant provisions of China Huaneng Group and the specific conditions of this project, it is planned to configure a team of employees with good quality, reasonable structure, and professional level of skills that master many skills while specializing in one.

Based on the above requirements, the personnel quota for 2×660MW unit shall be 350 persons, giving consideration to 10% of back-up personnel. The specific personnel quotas are listed as follows:

7.1 Production personnel

Ash & dust removal	16 Persons
Desulfurization	16 Persons
Chemistry	21 Persons
 Maintenance of units 	90 Persons
Mechanical	42 Persons
Electricity	27 Persons
I&C	21 Persons
• Fuel system	84 Persons
Operation	48 persons
Maintenance	21 Persons
Fuel management	15 Persons
• Others	25 Persons
Warehouse	5 Persons
Document management and driver	5 Persons
Security guards	15 Persons
7.2 Managerial personnel	8 persons

Chapter 8 Project implementation conditions and construction period

8.1 Project implementation conditions

(1) Construction site

The project site enjoys convenient traffic conditions, making it easy for the arrangement of construction, production and living area, as well as the transportation of equipments and materials required in the project construction. The construction production area is located at the expansion end of plant area, with the land occupation of about 24hm². It is mainly arranged with boiler combination field, turbine combination field, equipment stack yard, warehouse district, concrete mixing station, medium & small member precast yards, reinforcing steel processing plants and so on.

The construction living area is located at the east side of incoming road, with the land occupation of about 8hm².

The construction site is located at flat terrain, which is convenient for construction.

(2) Building materials

The building materials required in engineering construction, including bricks, tiles, cements, sands, stones, cements, steels & timbers, are available in the local market.

8.2 Envision of construction organization

(1) Power supply for construction

As for the power supply for site construction, it is considered to connect from the nearby substation. The location of power source point is to be determined, and the electric supply main within construction area presents circular arrangement.

It is planned to arrange six transformers. In the light of Design Guidelines for Construction Organization of Thermal Power Engineering prepared by the Electric Power Construction Division of National Electricity Corporation ([2002] No. 849), the electrical load is about 5000kW during the peak construction.

(2) Construction water

The construction and domestic water at this stage of project totals 400 \sim 450t/h, including 350-400t/h for the construction area and 50t/h for utility area. The construction water is taken from the irrigation canal or from groundwater, it is planned to build a $350m^3$ reservoir at the construction site and a pumping station.

(3) Construction communication

The communication lines for construction can be connected from telephone communication network at Sahiwal City, and the distance between the connection point and the construction site shall be provisionally considered as 15km.

(4) Energy supply

Oxygen: It is planned to apply the centralized supply mode, arrange the oxygen station at construction site, and provide, via pipelines, air supply for boiler combination field, steam turbine combination field, processing field, main power house and electrostatic precipitator construction site. Oxygen bottles shall be used in other sporadic constructions.

Acetylene: It is planned to apply the centralized supply mode, and arrange on-site acetylene stations to supply, via pipelines, acetylene to designated users.

-112-

Argon: Due to small amount of consumption, it is suggested to outsource bottled argons and apply the decentralized supply mode.

Compressed air: it is suggested to use portable air compressors and apply the partition supply mode.

(5) Configuration of construction equipment

To complete the construction tasks, it is suggested that the construction unit should equip or lease the following main large hoisting and conveying machinery:

No.	Name	Model	QTY.
1	Self lifting tower crane	FZQ1380/63t	2
2	Crawler crane	CC2400-1/400t	2
3	Caterpillar crane	P&H5170A/150t	2
4	Hydraulic Crawler Crane	KH180-2/50t	4
5	Tower crane	10t	2
6	50t truck-mounted crane		2
7	Hydraulic mold-stripping device		1
8	Vertical conveyor	SC200/200	2
9	Dedicated lifting device for generator stator	350t	2
10	Hydraulic jack-up translation device		2
11	Hydraulic lift self-discharging flatbed truck	200t Grade	2
12	100t trailer		2
13	40t trailer		2
14	25t low frame flatbed truck		2
15	Gantry crane	63t/42m	2
16	Gantry crane	40t/42m	2
17	Gantry crane	30t/42m	2
18	Concrete batching plant		1set
19	Concrete pump truck	70~100m ³ /H	10
20	concrete mixer truck	6m ³	44
21	Concrete fixing pump	60m ³ /H	2

-113-

8.3 Envision of Construction progress

Based on the provisions specified in Work-day Quota of Power Engineering Projects and the requirements stipulated in the production target reached between SPV and Punjab government, the preliminary arrangements for the outlined progress of project are listed as follows:

No.	Items	Milestone		
		Starting-date	completion date	
1	FSR approved by PPDB	2014.9.25	2014.10.05	
2	Negotiation with NEPRA on power factor of generator	2014.7.25	2014.10.03	
3	Approval of revised EIA.	2014.7.25	2014.10.03	
4	Execution of agreement on railway transportation, ports unloading and storage and land purchase.	2014.8.25	2014. 10.03	
5	Approval of tariff and issuance of generation permit by NEPRA	2014.10.07	2014.10.15	
6	PPA execution with NTDC	2014.10.15	2014.10.25	
7	IA execution with PPIB	2014.10.25	2014.11.05	
8	Availability of traffic , electricity, water, communication and drainage	2014.12.01	2015.01.31	
9	Excavation of main power house	2015.01.01	2015.01.31	
10	Concrete pouring of the main power house foundation	2015.02.01		
11	Civil works of the main power house	2015.02.01	2016.02.28	
12	Civil construction of chimney	2015.03.01	2016.05.30	
13	Hoisting of # 1 boiler steel frame	2015.04.01	2015.08.31	
14	Installation of # 1 boiler heating surface	2015.09.01	2016.05.31	
15	Hydrostatic test of # 1 boiler	2016.06.01	2016.06.20	
16	Acid cleaning and recovery of # 1 boiler	2016.9.21	2016.10.10	
17	On station of # 1 steam turbine platen	2016.02.01	2016.02.28	
18	Lock cylinder of # 1 steam turbine	2016.03.01	2016.09.31	
19	Qualified water from chemical water system	2016.05.10		
20	Energizing of #1 unit house power system	2016.07.01		

Milestone Project Schedule (preliminary)

	Items	Milestone		
NO.		Starting-date	completion date	
21	Ignition blowpipe and restoration of # 1 boiler	2016.11.01	2016.11.20	
22	168 trial production of # 1 unit	2016.11.21	2016.12.31	
23	Hoisting of #2 boiler steel frame	2015.10.01	2016.02.28	
24	Heating surface installation of # 2 boiler	2016.03.01	2016.11.30	
25	Hydrostatic test of # 2boiler	2016.12.01	2016.12.20	
26	Acid cleaning and recovery of # 2boiler	2017.03.01	2017.03.21	
27	On station of # 2 steam turbine platen	2016.08.01	2016.08.28	
28	Lock cylinder of # 2 steam turbine	2016.09.01	2017.03.31	
29	Ignition blowpipe and restoration of # 2 boiler	2017.04.11	2017.04.20	
30	168 trial production of # 2 unit	2017.04.21	2017.6.31	

Chapter 9 Risk Analysis

According to the features of this project and local situation of Pakistan, the major risks related to this project are analyzed in the table below:

No.	Risks	Causes	Recommended Solutions
1	Commercial risks		
1.1	Tariff risks	There are uncertainties in efficiency, O&M costs and other costs which are used as the basis for determining the tariff. These costs might exceed the estimates.	Establish PPA negotiation strategy, including the bottom line and acceptable adjustments.

No.	Risks	Causes	Recommended Solutions
1.2	Exchange rate risks	Exchange rate risks occur due to international balance of payments, foreign exchange reserves, loan interest rates, inflation, political situation and other factors. The PPA is priced in US dollars and paid at a fixed exchange rate in Pakistan rupees. As a result, there are exchange risks when costs during construction and expenditures of fuel during operation are paid. In particular, the exchange rate between US dollar and rupee fluctuates significantly, posing high exchange risks.	 (1)During construction, the consortium is advised to obtain loans and pay for equipment and construction activities in US dollars to avoid risks associated with fluctuating exchange rate. (2)During operation, assistance should be sought from financing institutions and the Chinese government to avoid exchange risks. Once the tariff is paid, it should be exchanged to US dollars as soon as practical. (3)Make insurance arrangements for exchange risks.
1.3	Rise of prices	Rise of prices of equipment and materials in China	Contingency fee is set. Strictly control EPC cost, arrange reasonable ordering time.
1.4	Taxations	Little knowledge about taxations in Pakistan	SPV is to take full advantage of its local partners to carry out early studies on local taxations.
1.5	Contract risks	The standardized IA and PPA template are used for negotiation, which may contain provisions to the disadvantage of the IPP.	The provisions of these agreements should be well studied and efforts should be made to revise those unfavorable provisions in negotiations.
2	Technology risks		*
2.1	Heat efficiency	The actual operation of generating units and their degradation are not considered in the tariff.	Practical indicator should be measured based on selected equipment for further negotiation.
2.2	Availability Factor	NEPRA requires an availability of 85% (max. 7446 full load operating hours per year)	According to international practices and operation data of Chinese and foreign power plants, particularly foreign power plants with Chinese units, an availability of 80%-82% is practical for Chinese equipment. This needs to be accepted by NEPRA through negotiations.
3	Implementation risks	·	<u> </u>
3.1	Procurement risks	Manufacture quality and progress may result in cost rise and project delay.	Better management of the EPC contractor; Improved quality control and manufacture supervision; Improved contract and payment management to reduce risks.

No.	Risks	Causes	Recommended Solutions
3.2	Transport risks	Large quantities of goods, large-sized equipment, many suppliers, complicated transport procedures involving harbor, marine transport, and inland transport.	 (1)Choose first-class transport contractors in China; (2)Improve the management of plan and process of packing, shipping and delivery; (3)finalize the inland transport scheme.
3.3	Local labors	Local labors may cause inefficiency and delayed schedule due to lack of training and skills	Recruit and train local labors in advance, and use skilled Chinese labors whenever possible. Seek help from the Pakistani government for visas.
3.4	Local environment and medical care	Poor hygiene and medical care	Develop emergency plans; Strictly enforce the OHSE system; Properly arrange the schedule and holidays; Make available sufficient medical personnel and facilities; Make insurance arrangements.
3.5	Project quality risks	Equipment and its installation quality will affect operation of the plant	Strengthen sound management and supervision in design, manufacture, erection, commissioning and operation.
3.6	Extended schedule	Given the actual conditions in Pakistan, it is very difficult to put the two units into operation in 2017.	A more reasonable schedule should be agreed on with Pakistan; Conditions to be provided by Pakistan should be clearly stated; The contractors should be better managed; An early start of preparations for construction should be considered.
4	Operational risks		
4.1	Tariff recovery risks	The power sector in Pakistan is deeply entangled in circular debts. It is difficult to recover tariff. Due to reasons of debt, the Pakistani power plants generally have a low plant availability.	 (1)Further investigate the tariff recovery of power plants in Pakistan; (2)Make provisions on the breach by the Power Purchaser and the government guarantee when signing the PPA and IA to reduce delayed payments and probability of bad debts and

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No.	Risks	Causes	Recommended Solutions
			avoid any economic or retum risk. Strive for tariff recovery assurance measures in the agreement, such as government guarantee; (3)Make insurance arrangements for breach of PPA to reduce the tariff recovery risk.
4.2	O&M costs	Pakistan lacks commissioned large coal-fired power plants, and O&M materials may be not readily available or their prices are high.	 (1)Investigate the supply and prices of materials in Pakistan; (2)Work out multiple procurement options to reduce the O&M costs.
4.3	Policy risks	Pakistani tariff policies, tax incentives and other policies may change during the operation of the plant.	 (1)Define tariff compensation measures against policy changes in the PPA; (2)Adopt commercial insurance to reduce the operation risks.
5	Security risks	In recent years, Pakistan experienced more and more terrorist activities. Armed conflicts, terrorist attacks, and security incidents present security risks to the development of the Project.	 Strengthen the internal management, and the cooperation between the SPV and the Pakistan government. Efforts are being made to include the security costs into the upfront tariff model to reduce the additional investment. Allocate sufficient safety personnel;

Chapter 10 Cost Estimate and Economic Analysis

10.1 The company has decided to opt for upfront tariff as notified by NEPRA. The project cost and source of finance and returns are envisaged as per upfront tariff.

Chapter 11 Conclusion, Pending Issues and Advice

11.1 Conclusion

The following necessities and advantages are concluded as result of the feasibility study.

1) Effectively mitigate electricity shortage in Pakistan

The Sahiwal 2×660MW coal fired power plant will takes up 6.3% of total installed capacity of Pakistan once built, which will improve power supply capability in Pakistan and Punjab as well as stability of the grid, mitigating the power shortage.

2) Produce significant economic and social benefit

After the project is put into service, 8.9TWh will be generated annually which will greatly improve local development of industries, economies and power consumption of the people.

3) Comply with the China-Pakistan development strategy

Chinese Premier Li Keqiang has brought out and set up long-term goals of China-Pakistan Economic Corridor Program with Pakistan Leaders during his visit to Pakistan in May 2013. As one of the key energy projects in the Program, Sahiwal coal fired power project got great support from Pakistan government and Chinese government.

4) Availability of construction conditions

With great support of Punjab government, most conditions of pre-construction are available.

5) Sponsor has great strength

Huaneng Shandong is experienced in thermal power plant construction and operation and has rich financial strength and human resources. Shandong Ruyi is the

-119-

largest private textile corporation in China, has invested in Pakistan and established good cooperative relations with local government. The combination of Huaneng Shandong and Shandong Ruyi has paid sound foundation for successful implementation of the project.

In summary, all construction conditions has been ready The technical solutions are advanced and adapt Pakistan local conditions. The technical and economic targets are reasonable. The Sahiwal 2×660MW coal fired power generation project is feasible.

11.2 Pending Issues and Advice

11.2.1 As the upfront tariff does not include investment in the off-site outgoing lines and according to international practice, this feasibility study only covers the cost of the on-site section of outgoing line to the busbar in the substation. Next NTDC will be urged to build the off-site outgoing line beyond the busbar in the substation to satisfy the COD requirements of the project.

11.2.2 As the upfront tariff does not include the cost of special railway line of the project, the cost is not covered in the feasibility study and need reimbursement by NEPRA. The feasibility study of the special railway line is not in the work scope of SDEPCI and is assigned to other firm by the Sponsor. Next the Sponsor should negotiate with NEPRA on investment in the special railway line and reimbursement in tariff.

11.2.3 Generator power factor needs to be discussed with NEPRA. In the feasibility study the power factor is determined in compliance with the Chinese National Standard with associated cost computed accordingly.

11.2.4 It is recommended to coordinate with the NTDC to complete the interconnection package report as soon as possible and provide the official approval documents for the interconnection.

11.2.5 The underground water demonstration report indicates the volume of underground water could not satisfy one-month consumption of the project. As such, the Sponsor should engage with competent company to conduct well cluster test to determine the quantity of wells.

11.2.6 Agreement on port, land, water and railway transportation is not available yet and need to be signed as soon as possible.

11.2.7 Initial negotiations on PPA and IA have not started yet. The two agreements need to be signed as early as possible.

Attachment 1



NO. PPDB/<u>638</u>/2014 PUNJAB POWER DEVELOPMENT BOARD ENERGY DEPARTMENT

1st Floor, CentralDesignBuilding, Irrigation Secretariat, Old Anarkali, Lahore (Ph: 99213877,Fax:99212796)

M/s Huaneng Shandoug Ruyi Group Ruyi Industrial Park Jining National High-Tech, No.72, Guanghe Road, Jiming Shandong Province, P.R. Chinas, 0537-2933039

Sub:

LETTER OF INTEREST (LOI) FOR 2 x 660 MWCOAL BASED POWER PROJECT AT QADARABAD, DISTRICT SAHIWAL IN PUNJAB

Reference:

Your Statement of Qualification (SOQ) in response to Expression of Interest invited by the Punjab Power Development Board through advertisement in the daily "The News" dated 28-01-2014,has been considered by Punjab Power Development Board, whereby your firm 7 company has qualified the eligibility criteria as set out in the policy of the Provincial Government regarding power generation i.e. the Punjab Power Generation Policy, 2006 (Revised 2009) (hereinafter referred to as the "Policy").

Performance guarantee No. MBL: FE: FG:15/2014 dated 14.05:2014 amounting to USD=1.320.000.00 issued by National Bank of PakistanMain Branch Laboresubmitted by you has been received and:

2. It is hereby acknowledged that Punjab Power Development Board (PPDB) has considered your Company as qualified to the eligibility criteria in accordance with the Runjab Power Generation Policy - 2006 (Revised - 2009).

3. PPDB has received the Bank Guarantee # MBL: FE: FG:15/2014-dated 14:05:2014 amounting to US\$ 1,320,000.00 issued by National Bank of Pakistan Main Branch Lahore submitted by you. The same shall be accepted after due verification.

3. Now, this letter of interest (LOI)is being issued on behalf of the Government of the Punjab, in terms of the provisions of the Policy. Government of the Punjab hereby confirms its interest in your proposal to conduct the feasibilitystudy (hereinalter referred to as the "Feasibility. Study") for the development of subject cited project subject to the following: -

- a As per policy, you are required to complete your Feasibility Study for the Subjected Project, at no risk and cost to, and without any obligation on the part of, the Govt, of the Punjab and its agencies, not later than one eighty five (185) days from the date of this LOI. You are further required to submit the monthly Progress report of the Feasibility Study to PPDB failing which PPDB may proceed against your Company for Cancellation of this LOI.
- b. You are required to carry out the Feasibility Study: complete, at internationally acceptable standards and in accordance with the terms and conditions stipulated in the Policy. The Feasibility Study must include an Environmental Impact Assessment Study, detailed design of power house, load flow and stability studies, design of interconnection / transmission lines, details pertaining to infrastructure, project cost, financing and, financing terms, tariff calculations and assumptions of financial calculations including economic / financial analysis. You are advised to liaise with the power purchaser while determining your plant size and site, project layout, transmission line and interconnection arrangements, etc.

-122-

- You will carry out the Feasibility Study according to the specific milestones appended herewith at Annex A, and submit monthly progress reports showing progress against these milestones.
- d. Youwill establish a Special Purpose Vehicle (SPV) company and shall maintain the shares in this company in accordance with Para 39 & 40 of Punjab Power Generation Policy 2006 (Revised 2009) and will submit copy of Memorandum &Articles of Association as the Form 29 duly attested by the Security Exchange Commission of Pakistan (SECP).
- e. PPDB will appoint a Panel of Experts to monitor the conduct of the Feasibility Study and its progress, to verify attainment of the aforesaid milestones and to ensure implementation of the project consistent with national and provincial needs.
- 1 The Main Sponsor will be liable for all obligations and liabilities of and on behalf of other Sponsors Further processing of the Feasibility Study is subject to Govt of thePunjab acceptance in accordance with the Policy
- g The validity of this LOI is one eighty five (185) daysfrom the date of its issuance, where after it willautomatically be lapse with immediately effect. Issuance of this LOI or the lapsing of its validity or your conducting a Feasibility Study there under, cannot form the basis of any claim for compensation or damages by the Sponsors or the project company or any party claiming through them against the Government or Punjab / PPDB or any of its agencies, employees or consultants on any grounds whatsoever, during or after the expiration of its validity.
- h. You are, therefore required to complete the Feasibility Study for the Subject Project within the validity of this LOI in case there is delay in completion of the Feasibility Study within the validity of this LOI, a one-time extension by the PPDB Committee referred in Section 2.2 Para 34 may be granted up to a maximum period of ninety (90) days, provided the Panel of Experts is satisfied that the Feasibility Study is being conducted in a satisfactory manner and is likely to be completed shortly. Furthermore, extension in validity of the LOI will only be provided upon submission of a bank guarantee in double the original amount and valid beyond 180-days of the extended LOI period.
- i In case, if you fail to meet the relevant milestones and standards, PPDB will terminate this LOI and encash the Bank Guarantee.
- j. This I OI has been issued in duplicate on the date hereof, and it shall come into effect when one copy hereof is received by PPDB after having been duly countersigned by you. Nevertheless, this LOI shall lapse if the countersigned copy is not received at PPDB within fifteen (15) days of its issuance.

(SarliyaAwais) MANAGING DIRECTOR PUNJAB POWER DEVELOPMENT BOARD

Accepted and agreed tor & on behalf of

End As stated above

CC -

Date

- 1 Secretary, Ministry of Water & Power, Islamabad
- 2 Chairman NEPRA, Islamabad
- Secretary to Chief Minister Punjab.
- 4 Chairman Board of Directors PPDB
- 5 Chairman, P & D. Govt. of the Punjab, Lahore
- Secretary Impation Department, Govt, of the Punjab, Lahore.
- Chief Executive Officer company
- 8 Chairman WAPDA Lahore
- 9 MD PPIB islamabad
- 10 Chief Executive Officer, DISCO MEPCO
- 11 Chief Executive Officer Alternate Energy Development Board. Islamabad
- 12 Flectrical Inspector Multan

No.	Milestone (M)	Time From	Due Date
		LOI	
]	Issuance of LOI from PPDB	0 days	2014-05-21
2	Return of duly signed LOI	3 days	2014-05-24
3	Procurement of Consultancy Services and Award of Contract	15 days	2014-06-05
4	Mobilize Consultant	21 days	2014-06-11
5	Coal based and other Data Collection along with coal togistic study	30 days	2014-06-20
6	Geo-Technical Investigation & Underground Water Analysis	60 days	2014-07-20
7	Topographic Survey and Related Details	70 days	2014-07-30
8	Alternative Layouts and Pre-Feasibility Design	80 days	2014-08-09
9	EIA, Social and Re-Settlement Studies	90 days	2014-08-19
10	Selection of Final layout and Sizing of Coal Based Thermal Power Project	100 days	2014-08-29
ŧ1	Load Flow Study of Power Project	120 days	2014-09-18
12	Final Feasibility Design	135 days	2014-10-03
13	Construction Planning, Unit Rate Analysis and Preliminary Costing	135 days	2014-10-03
14	Final Costing	135 days	2014-10-03
15-	Economic and Financial Analysis	140 days	2014-10-08
16	Draft Feasibility Report and Review of POE	145 days	2014-10-13

Specific Milestones of Feasibility Study Shandong Ruyi Group

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No.	Milestone (M)	Time From LOI	Due Date
17	Sponsor's Final Review	175 days	2014-11-12
<u>18</u>	Final Feasibility Report Submission and Approval of	185 days	2014-11-22

Attachment 2

To: Mr. Qiu Yafu : Director

Huaneng Shandong Ruyl (Pakistan) Energy (Private) Ltd.

Dear Mr. Qiu

Thank you for meeting us on 26 May and 29 May 2014 to discuss the Sahiwal 2x660MW project.

As informed by you, on the special request of the Chief Minister of Punjab the Consortium has conditionally agreed to use its best endeavours to achieve commissioning of the Project in 30 months. We recognize that this is an unprecedented time frame for a project of this kind. You have confirmed that the Consortium is well placed to achieve this time frame, provided you have our strong support and the support of other Pakistan authorities and we and other authorities deliver on the commitments and deliverables set out below. We acknowledge that performance of these commitments and deliverables is crucial for the development and construction of the Project in accordance with the requirements of the Chief Minister of Punjab.

NO.	Commitment	Deliverable
1. Project Land	The freehold title to the Project Land shall be transferred to the Project Company. The consideration for the Project Land based upon the land set out in the coordinates sent on 27 May shall not exceed USD23.8M (unless an increase is compulsionly required by Pakistan law). If the area of the Project Land is less than that set out in the coordinates, then the price of the Project Land shall be adjusted down accordingly. Of the consideration, USD2,379,000 has already been paid by the Consortium and received by the PPDB and this amount shall be treated as an initial deposit, that shall be refunded if the Project does not proceed or title is not transferred. The Project Company shall be permitted to	PPDB to provide the Statement of Conditions before 15 June (which shall specify a right to use the land free of cost until title is transferred). Consortium to provide final boundary confirmation and layout plan by third week of June.

-126-

use the Project Land free of cost from the date of the Land Purchase Agreement until payment of the balance of the consideration (which will be payable at or before financial close). Upon payment of the full balance of the consideration; title shall be transferred to the Project Company.

PPDB (and the Government of Punjab) shall confirm that at the date of the Land Purchase Agreement, all of the Project Land is owned by the Government of Punjab, can be used for the development; construction and operation of the Project and confirm details which will be set out in the detailed Land Purchase Agreement, but which shall include an obligation upon the Government of Punjab that if disputes; third party claims arise those shall be the responsibility of the Govt of Punjab.

Notwithstanding the PPDB's confirmation, if it transpires that any part of the Project Land is not owned by the Government of Punjab, the PPDB shall ensure that such part of the Project Land is immediately acquired by the Government of Punjab and transferred to the Project Company as soon as possible, but in any event before financial close.

RPDB confirmed that the Consortium will be permitted to access any part of the Project Land and conduct geological Investigations on the Project Land at any time after the date of this letter.

Approvals

PPDB agreed to assist and support the Consortium in dealing with all Pakistan authorities to expedite the obtaining of the approvals required by the Project Company.

1 PPDB confirmed that the EIA has been approved

2 PPDB confirmed it shall liaise with all relevant authorities to ensure that the PPDB shall take all steps necessary to liaise with the relevant authorities to facilitate the issuance of each approval by the relevant date set out in the Project Timeline agreed by the parties.

1.				
		Project may use entirely Chinese skilled		
		labour during construction:		
·*;		3 PPDB confirmed that if the final Project		
		specifications were significantly different		
		to that noted in the EIA, the Consortium		
		should re-apply for FIA approval.		
		However approval for amendmonths to the		State Stat
· · · · ·				
		Lin would be a shorter and simpler		
i.		process man for the original application.		
		4 Grid Interconnection Studies the Crid		1
9 2	- 19 - 19 - 19 - 19 - 19 - 19 - 19 - 19	completed (except, for short-circuit and		
		transient, analysis sections for which		
r.		technical specifications will be shared with		
		the NTOC by the Consortium).		
4				
		5 PPDB confirmed that the execution of the		1
		Water Use Agreement between the		
		Project Company and the Government of		
		Punjab is not a requirement for the FSR		
		Approval and the PPDB shall llaise with		
		the relevant departments to assist with the		
		execution of the Water Lise Agreement		
		6 PPDB confirmed that the following		
		approvals would be required before the		
j.		Project Company could commence key		
		nower plant construction worker		
		power plain constitución apixa.		The star of
6		A FSR Approval (including FIA and		
		Grid Internantian Study		
5 57				
		White and the second seco		
		B Generation Licence and Tariff		
		Americal or acceptance of uniform		
				ARAV
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		Minor, preparatory works can be commenced		
		prior la obtaining the above approvals		1
		prior to obtaining the above approvals.		
	3. Transport	The Consortium indicated that transport is a	PPDB said that Pakistan	
		key concern in respect of the Project. In	Railwave were proportion	
		particular	an implementation Dian	
			the events of the events	
	L		The subbin of coar	
	ingen State State			25
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<u></u>	Sec. Star	1 to ensure an uninterrupted supply of coal	Pakistan Railways will	
Sage a	1	to the Project; and	supply details of this	
			Implementation_ # "Plan	
		the Project Site	during a meeting with the	
		ane rioject site.	Consortium to be held on	
	2. Star 1. 2	The Consortium requested both undertakings	27 May	
		from Pakistan Railways and the Port	PPDB to provide a	
		Authorities and evidence of an	template Rail Transport	
		Implementation Plan, including, potential	Agreement before 3 June	
		infrastructure upgrades, to meet coal supply	2014.	
	17.4 ct 4	requirements for the Project,		
		PPDB sold that Devistor Politicity and the	The Consortium shall	
		Port Authorities had confirmed that the	provide details to Pakistan	
. ž.	14 1 4	existing port and rail infrastructure is adequate	Railways as to the weight	
		and suitable to provide an uninterrupted	and size of the oversize	
Car and		supply of coal to the Project.	to be supplied to the	
			Project by mid June	
		PPDB said Pakistan Railways has provided		
		an undertaking to the Consortium agreeing to	Pakistan 🦕 🥄 Railways	
		provide an uninterrupted supply of coal to the	confirmed : they shall	
		μ γοματ.	respond as to whether	
998 998 998	- A	PPDB confirmed transport cost increases can	they are able to transport	
		be passed through to the NTDC under the		
		РРА.	within 2 hitciness days	
	. 1	The consolitum said it was essential that it		
			₩	
10.00	e de se se an		·美国"王王"	
200 - 200 200	4: PPA and	The Consortium said that as agreed with the		
	[™] .IA , ™.st	Chief Minister and the Head of the Energy		
1000		Department, Government of Punjab there		
		would be no penalty payable to the NTDC or		
		any other authority for failing to achieve COO		
	19 . .		打 动机 空中之下的	ASA -
		PPDB confirmed the Consortium and NTDC.		. affor
	n - 1 - 1	could mutually agree upon a Scheduled		
		Commercial Operation Date (as defined in the		
		PPA).	and the second second	
	૾૱ૣૺ૾ૺૼૼૼૼૼ૿૾ૣૣૣૣૣૣૣૣૣૣૣ	PPDB said the existing standard PDA is		
		available and some changes may be required.		
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				19th
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	if the Project used the upfront tariff to meet the		
	requirements of this Project (given this is the		
	first project of its kind in Pakistan).		
	PPDB shall support the Consortium in		
	negotiating the best possible terms and		
	conditions for the PPA with the NTDC.		
	PPDB said the PPA and IA could be		n la st
	negonated with the NTDC and the	「井、」「「小乙論」	UME (
	Government of Pakistan/PPIB at the same		加速机
	time as obtaining the Generation Licence and		
	tanin approval. The Consortium noted that it		
n an	would prefer to start key site work when the		
	Erra and la are agreed in principle,		
5. Tariff	The Consortium indicated that in principle it	PPDB to set up simesting	T UL B
	can agree to the revised unfront tariff issued	with NFPRA in early line	
	by NEPRA May 2014. However the	2014	
	Consortium considered key parameters upon		i gi i i
	which the revised upfront tariff is based did not	Consortium to provide	
	reflect standard operational parameters for a	details of the specific	
	project of this nature. The Consortium would	amendments it would	uu -
	like to meet with NEPRA to discuss	require to the Upfront Tariff	
	amendments to these parameters and would	prior to that meeting.	
·	also be happy to invite NEPRA and the PPDB		以上
	to visit China as soon as possible.		
·	PPDB agreed to arrange a meeting with		PR zia
	NEPRA in early June. PPDB informed the		
	Consortium that if the Consortium adopted the,		
	upfront tariff, then that would be an		
	accelerated process, but that if the upfront		
	tariff was amended that would require a		
	detailed procedure to be followed which would		ille i ten
	delay the approval of the tariff.		
6 Jahour	The Concordium indicated that this the		ACA
	accelerated time frame for this Droject that		T SUV
	would need to evolusively use skilled Chinese		
	labour for the Construction Period The		
	Consortium said that local labour could be		Wind
	used during the operation stage	120 建建造的	
	The PPDB confirmed that there were no		
		Shi i Taji s	H 在 34 三 任 授 - 54 王 年
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restrictions in the law or required as conditions upon any Project approvals, for the Project Company, the EPC Contractor or the O&M Company to use local skilled labour. i The PPDB confirmed that they would provide all necessary support to secure visas for the Chinese labour in the ¶er a The PPDB, confirmed that the Punjab Government would ensure adequate, security arrangements are in place at the Project Site at all times during development, construction

Incentives and 📩 Return on Investme nt 📲

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and operation of the Project PPDB confirmed that the incentives promised in the various policies for the power sector in Pakistan would be available to the Project. There twas not need for a separate commitment to ensure the Project Company could benefit from such incentives. PPDB confirmed, that the following tax

incentives would be available to the Project:

1 No income hax would be payable by the Project Company,

2 No Sales tax would be payable on import of machinery by the Project Company;

5% mport duty would be payable upon the import of machinery, that is not manufactured locally, for the Project. No toustoms" duty "exemption is available, although in the case of a costs plus tariff Project Company can incorporate the customs duty in the tariff petition to the NEPRA; but in the case of an upfront tariff the Project Company customs duty is already_incorporated in the tariff.

The Project Company would seek an exemption from slamp duty from the concerned authorities, or in the case of not exemption, seek a concessionary rate of

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The PPDB shall facilitate the Project Company In approaching the relevant authorities for exemption or concessionary rate of stamp duty d and registration fees.

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We acknowledge receipt and confirm and agree the contents of this letter, including the above commitments and deliverables. N AT Huid

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Signed for and on behalf of A 195715

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Fang ei guan Huaneng Shandong Ruyl (Pakistan) Energy (Private) Ltd.

Ms. Saniya Awais

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W. W. Marth

Managing Director

Punjab Power Development Board, Energy Department, Government of Punjab

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	e le	ENVIRONMENT PROTECTION DEPARTMENT
		National Hockey Stadium, Ferenceur Road, Labore
		NO. DD (EIA)/EPA/F-20(EIA)/22,05/2014/868 Dated: 28 / 05 / 2014
	То	
		The Managing Director, Punjab Power Development Board, Energy Department, 1 ^a Floor, Central Decision Building
AND A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR OF A CONTRACTOR AND A CON		Irrigation Secretariat, Old Anarkali, Labore:
	Subject:	DECISION OF EPA PUNJAB RECARDING CONSTRUCTION OF A V
		660 MW COAL FIRED POWER PROJECT AT OADIRABAD, SAHIWAL (Under Section 12 of the PEP Act; 1997 (amended 2012) read with IEE/EIA Regulations, 2000):
	I. Descr 2. Locat	iption of Project: on of Project: Construction of 2 x 660 MW Coal Fired Power Plant. The project site is located at Chak No. 75/5-R. Ordirabed Schiwal
CHICLES STATE	3. Date of	of submission of application: 01.04.2012
	4.	After review of the Environmental Impact Assessment (EIA) Report. Site Inspection
	Report of Di	strict Officer (Environment) and other documents, the Environmental Projection Agency
A CONSTRUCTION OF A CONSTRUCTUON OF A CONSTRUCTU	Punjab has do	cided to accord its approval for the construction of the above mentioned project to referenced
	the environm	ental issues subject to the following conditions.
A CARL	i.	The proponent shall ensure compliance of National Environmental Quality Standards (NEQS).
	ii.	Mitigation measures suggested in the EIA Report and Environmental Management Plan shall be strictly adhered to minimize any negative impacts on soil, groundwater, air and biological resources of the project area.
	. III.	Monitoring shall be carried out during the entire period of the project activities. Monitoring reports of the whole operation shall be submitted to EPA, Punjab on monthly basis.
	iv.	The proponent shall install pollution abatement equipment/treatment plant i.e. Electrostatic Precipitator, cyclone & fabric filters etc. in compatible with NEOS.
	۷.	The proponent shall also install Mercury Control-System best available in the world as per requirement of Minamata Convention ratified by Pakistan in October, 2013.
	vi.	The proponent shall install waste water treatment plant and shall dispose of wastewater after proper treatment in conformity with the NEQS.
	vii.	Arrangements shall be made for safe disposal of solid and hazardous waste. The solid waste shall be retained within the unit boundary / premises and shall be disposed off in an environment friendly way at a suitable disposal facility.
	viii.	The proponent shall ensure that strict and efficient health and safety measures arc in place for protection of workers backed by a comprehensive emergency response system.
	ix.	The proponent shall provide proper firefighting arrangements.
	х.	The proponent shall take measures for proper storage of fuel
	xi.	At least 90% unskilled and to the extent possible skilled jobs shall be given to locals after providing them proper training.
	xii.	Compensation shall be provided to inhabitants in case of loss of agricultural land, crop, property, etc. in accordance with the rates that are agreed upon. All conflicting issues regarding compensation, etc. should be settled amicably before or during the project activities. $Q_{a,b}$

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- xiii. The proponent shall plant at least 30000 trees of minimum height 6-7 feet especially of indigenous species in and around the project area on available space in consultation with District Officer (Environment), within six months. The Proponent will also make necessary arrangements for the maintenance and protection of these trees.
- xiv. The proponent shall appoint an Environmental Manager and shall convey the name of the Environmental Manager (having at least qualification of BS Environmental Sciences along with his complete Mailing Address and Phone Numbers).
- xv. The proponent shall take effective measures for safe transportation of Fuel.
- xvi. The proponent shall install on line Air Pollution Monitoring Analyzers for major pollutants like particulate matter, CO, SO₂, NO₃, HC and Mercury.

5. The proponent shall be liable for correctness and validity of the information supplied by the environmental consultant.

6. The proponent shall be liable for compliance of Sections 13, 14, 17 and 18 of IEE/EIA Regulations, 2000, regarding approval, confirmation of compliance, entry, inspections and monitoring.

7. This approval is accorded only for the installation/construction phase of the project. The proponent will obtain approval for operation of the Project in accordance with Section 13(2)(b) and Section 18 of the IEE/EIA Regulations, 2000.

8. Any change in the approved project shall be communicated to EPA, Punjab and shall be commenced after obtaining the approval.

9. This approval shall be treated as null and void if all or any of the conditions mentioned above, is/are not complied with. This approval does not absolve the proponent of the duty to obtain any other approval or consent that may be required under any law in force and is subjudice to legal proceedings in any legal fora / court.

10. This approval shall be valid (for commencement of construction) for a period of three years from the date of issue under Section 16 of IEE / EIA Regulations, 2000.04

(AMEN HANIF) ASSISTANT DIRECTOR (EIA) for Director General, EPA, Punjab Ph: # (042)99232228

NO. & DATE EVEN.

**

A copy is forwarded for information to:

The District Officer (Environment), Sahiwal w.r.t. his letter No. 119/DOE/SWI dated 08.04.2014. He is requested to ensure compliance of the above-mentioned conditions measures under intimation to this office.

(AMEN HANIF) ASSISTANT DIRECTOR (EIA) for Director General, EPA, Punjab

Attachment 4:



NO.SO (Projects)ED/15-1414 GOVERNMENT OF THE PUNJAB ENERGY DEPARTMENT

Dated Lahore, the 28th August, 2014

To

Mr. Song Taiji, Deputy General Manager, Huaneng Shandong Ruyi (Pakistan) Energy (Pvt.) Lmited.

SUBJECT: LAND PURCHASE AGREEMENT (LPA) WITH CONSORTIUM OF RUYI HUANENG SHANDONG FOR DEVELOPMENT OF 2X660 MW IMPORTED COAL FIRED POWER PROJECT AT QADIRABAD, SAHIWAL

LETTER OF COMFORT:

Reference to the letter No. PPDB/918/2014 dated 28.08.2014 received from Monoging Director, Punjab Power Development Board.

2. It is stated that the consortium comprising Huaneng Shandang Ruyi (Pakistan) Energy (Pvt.) Emited has been awarded 1000-acre of land for the purpose of the installation of 2x650 MW Coal Fired Power Project at Sahiwal. The consortium has been given the possession of land and the work has been started. The said consortium has deposited an initial amount of US\$ 2.379 million as an advance for the partial cost of land with PPD3. This project is among the list of approved projects for early harvest in Pak China economic Corridor.

3. This letter of comfort in respect of purchase of lond is being issued to the consortium to furnish it before their authorities.

SECTION OFFICER (PROJECTS)

CC:

- 1. Managing Director, Punjab Power Development Board.
- 2. PS to Additional Chief Secretary (Energy). Energy Department.



No. PPDB/<u>978</u> PUNJAB POWER DEVELOPMENT BOARD ENERGY DEPARTMENT 1st Floor, Central Design Building, Irrigation Secretariat, Old Anarkasi, Labore (Ph. 042-99213877 Fax, 042-99212796) Dated: 2900 2014

The Additional Secretary Government of the Punjab Energy Department Lahore.

Attention: Deputy Secretary (Power)

Subject

LAND PURCHASE AGREEMENT (LPA) WITH CONSORTIUM OF RUYI HUANENG SHANDONG FOR DEVELOPMENT OF 2X660 MW IMPORTED COAL FIRED POWER PROJECT AT QADIRABAD, SAHIWAL.

This is with reference to our earlier communication dated 26.08.2014 (copy enclosed), it is informed that the Consortium of Ruyi Huaneng Shandong is an LOI holder of Punjab Power Development Board for development of 2x660 MW imported coal fired power project at Qadirabad, Sahiwal. The Company is currently carrying out the project Feasibility Study. Approximately 1000 acres of land has been set aside for development of this project. The private land has been acquired by Government of the Punjab as per assessment made by Price Assessment Committee (PAC) constituted for this purpose.

The Consortium has started work on the project and the ground breaking ceremony has also been held on May 30, 2014 by the Prime Minister of Pakistan. The Company, on instructions of Energy Department, has deposited an amount of US\$ 2,379 million with PPPDB as an advance for the cost of land. It is, therefore, requested that a letter of comfort in respect of land purchase purpose may kindly be issue to the Consortium enabling them to furnish this document before their authorities. It is further added that the said project is among the approved prioritized projects under Pak China Economic Corridor.

With best regards,

Managing Director Punjab Power Development Board

CC:

PS to Additional Chief Secretary (Energy) Government of the Punjab. Lahore



No. PPDB <u>528</u> 2014 **PUNJAB POWER DEVELOPMENT BOARD ENERGY DEPARTMENT** Ist Floor, Central Design Building, Infigation Secretariat, Old Aparkali, Labore (Phr. 042-99213877 Fax: 042-95212796)

Dated: 26-8- 2014

The Additional Secretary Government of the Punjab Energy Department, 8th Floor, EFU House, Jail Road, Lahore,

Attention: Deputy Secretary (Power)

Subject FINALIZATION OF LAND PURCHASE AGREEMENT (LPA) WITH CONSORTIUM OF RUYI HUANENG SHANDONG FOR DEVELOPMENT OF 2X660 MW IMPORTED COAL FIRED POWER PROJECT AT QADIRABAD, SAHIWAL.

You are aware that 2x660 MW imported coal fired power project at Qadirabad Sahiwal has been awarded to the Consortium of Ruyi Huaneng Shandong for development. The project was inaugurated by the Prime Minister of Pakistan on May 30th, 2014. The Consortium is in process of carrying out the subsequent project activities on fast track basis. A recent reference has been received by the undersigned from the Consortium regarding negotilations and finalization of project agreements. This includes Land Purchase Agreement (LPA) with Energy Department. Government of the Punjab.

In context of the above, you are requested to share with us a template of the LPA so that the same can be forwarded to the project development company for input and further discussion with Energy Department, Government of the Punjab

Managing Director Punjab Power Development Board

CC

PS to Additional Chief Secretary (Energy) Government of the Punjab, Lahore

Attachment 5:



NATIONAL TRANSMISSION & DESPATCH CO. LTD

NO. GM/WPPO/NTDCL/ C767-69

General Manager (WPPO) NTDCL

Dated: 24/07/.2014

M/s Huaneng Shandong Ruyi Group Ruyi Industrial Park Jining National High-Tech No.72, Guanghe Road Jining Shandong Province P.R.Chinaş, 0537-2933039

Subject:

Evacuation of Power from 2x660 MW Coal Fired Power Project at Oadirabad, Sahiwal

hippense : Your e-mail received boday 24-07-2014

It is clarified that NTDCL shall make the required arrangement for evacuation of Power from the proposed subject project as per the terms and conditions to be agreed between the Seller and Power Purchaser in the Power Purchase Agreement (PPA)

(Muhammad Azam Khan) General Manager (WPPO)

Copies:

1- Managing Director (NTDCL), 414-Wapda House, Lahore.

2- Managing Director (PPI8), H/No. 50, Nazimuddin Road, F-7/4, Islamabad.

220



Secretary/Chairman Raviways

D.O. No. 1-1/2013-T-1 Ministry of Railways (Railway Board) Government of Pakistan Islamabad. Tele: 9211991 - 9210527 Fax: 9203445 E-mail: secretary@railways.gov.pk

Islamabad, March . 2014

Letter of Comfort

Government of Punjab. Pakistan, as part of National Power Policy, is developing imported coal fired power plants in the Punjab (Pakistan) at six locations in the province. Six (660x2 MW) coal fired power plant would be developed under this Initiative.

The Ministry of Railways, Government of Pakistan, is working on a comprehensive plan to transport imported coal for these plants from the coast to the plant site. Pakistan Railways certifies that it would be able to transport coal for these projects before their Commercial Operation Date (COD): particularly for the first plant for which provisions are already in place. Ministry of Railway thus guarantees the provision of requisite infrastructure, rolling stock and management to ensure the provision of coal to the selected plant sites.

Government of Pakistan fully backs the plan of Pakistan Railways for which the required resources would be provided. This Letter of Comfort is being issued for the benefit of power plant sponsors who wish to avail the opportunity provided by Government of Punjab, Pakistan.

Ms. Parveen Agha Secretary to the Government of Pakistan Ministry of Railways March 25, 2014

Wagar Maspod Khan Secretary to the Government of Pakistan Ministry of Finance March 25, 2014



No. PPDB/ 9.27 /2014 **PUNJAB POWER DEVELOPMENT BOARD ENERGY DEPARTMENT** 1st Floor, Central Design Building, Irrigation Secretariat, Old Anarkali, Lahore (Ph: 042-99213877 Fax: 042-99213876 Date 2.9 108 /2014

M/s. Huaneng Shandong Ruyi Group, Ruyi Industries Park Jinning National High – Tech, No. 72, Guanghe Road Jining Shandong Province China.

Subject: MOVEMENT OF SIX MILLION TONS OF IMPORTED COAL FROM KARACHI TO SAHIWAL / QADIRABAD.

This is with the reference to the meeting between the delegation of Consortium of Huaneng Shandong Ruyi group and expert₃ from Punjab Power Development Board (PPDB) on August 28, 2014 at the office of Managing Director Punjab Power Development Board.

A letter regarding the movement of six Million Tons of imported Coal for power generation up to an extent 1320 (2X660) MW from Karachi port to Sahiwal / Qadirabad attached as Annex-A for your kind information and comfort.

MANAGING DIRECTOR

PUNJAB POWER DEVELOPMENT BOARD

CC:

PS to Additional Chief Secretary Energy, Energy Department.

PAKISTAN RAILWAYS Headquarters Office,

Dated: 12.01.2014

2-M8R/8050-R

dditional Secretary, y Department, mment of Punjab,

Movement of Six Million Tons of Imported Coal from Karachi to Sahiwal/Qadirabad.

conversation and E-mail dated 08.01.2014, Meeting dated 09-01-2014 With reference to subject above, a meeting conducted in Pakistan Railways Headquarters Office at Lahore on 09-1-2014, chaired by General Manager/Operations, in presence of delegation of SEPCOIII. Modalities and multifarious shades with regard to the movement of imported coal, from Karachi Port to Sahiwal/Qadirabad, were discussed in detail. Chinese delegation conveyed approximate demand of 6 million tons of coal for power generation up to an extent of 1320 (660 X 2) MW. Pakistan Railways assured that three years of reaction time is sufficient to make required arrangement. Pakistan Railways is already possessing double line from Karachi to Sahiwal, infrastructure and modern and traditional stock ample to move more than twenty trains of various commodities for up country. It has capacity to manufacture high capacity wagers at indigenous level as well. Pakistan Railways, therefore, takes this and as an opportunity to enhance its revenue and stands committed to 100 transport coal of required quantity (6 million tonnes per annum) for this protect. Detailed plan will, at due point of time, however, cover all shades of the activity in the light of precise demand and pattern of transportation.

This issues with the approval of competent authority.

(Zubair Shafi Ghauri) Chief Marketing Manager Zubair Shafi Ghauri Phone: 042-99201665

PAKISTAN RAILWAYS **HEADQUARTERS OFFICE** LAHORE

No.2-M&R/8050-R/Power Plants.

Dated: 14-07-2014

Mr. Israr Hussain Zaidi

General Manager Masood Textile Mills IId. Faisalabad

N#.

Sub: Meeting on 14-07-14 with regards to Yousafwata/Qadarabad Power Plant.

While expressing our warm regards.

to response to the questions put forth during this meeting, the position is explained trasma.

- 1 The section from Karachi to Kotn (174 km) is provided auto block signating with line capacity of 92 trains each way. Similarly, a project of modern signaling is under execution from Shahdara to Lodhran (498 km.) likely to be completed by December 2015 after which line capacity will increase to 92 trains each way. However, the stretch from Lodhran to Kotri 660 km is the grey area where the line capacity is 35 trains each way which needs up gradation.
 - 2 Pakistan Railways is capable of handling required number of trains to transport coal to Sahiwat power plant even without up gradation of signaling system.
 - 3 Up gradation will be completed within a span of 3 years.
 - 4 Pakistan Railways has already started the process to procure 4000 - 4500 H.P locomotives and hopper trucks for Sahiwal power project
 - 5. Pakistan Railways will sign agreement at appropriate time with power plant sponsors once all the irritants are removed and the queries, put forward are clarified.

t entire questions are required to be answered by the team of experts from your side as acti

1. There are serious confusions with regard to precise quantity of coal required to be transported from port to Sahiwal power plant. The figures haver between 16666 metric tans to 10,000 metric tons per day. In the meeting held with the representatives of M/s Ruyi Shangdong at 90-Shahrah-e-Quaid e-Azam on 01.07.2014. the requirement was indicated as 10,000 metric tons which has now been revised to 15.000 metric tons per day. This huge gap requires immediate clarification as it has serious impact on the whole transportation plan including terminal facilities, number of locomotives & hopper trucks to be purchased and number of trains that would ply between Karachi and the plant.

- 2. The port (KPT or Port Qasim) from where coal will be offered for loading may be indicated in clear terms. It may also be clarified whether the Railway siding will be provided along the jetty for unloading of the coal from the ship direct into Railway wagons Alternately it may also be clarified whether the coal will be transported to Pipri Yard through conveyor belt from Port Qasim.
- Unloading mechanism/ arrangements and carriage system of coal from unloading yard to the storage area be provided.
- 4. The coordinates of the land acquired for setting up the plant at Sahiwal may be provided to finalize the layout of the track from station to the plant and inside the premises of the plant.
- 5. The layout plan of the plant showing the arrangements at unloading point of coal and storage area for stacking may be provided in AutoCAD format. Maximum storage of coal to be kept as reserve may also be intimated.

Once again, expressing our warm regards, we remain at your disposal for any further assistance

Da. 14.7.14

(Zubair Shafi Ghauri) Chief Marketing Manager Telephone No.042-99201665 Fax No. 042-99201760



No. SO(Rev)(IRR)1-8/14(LBDC)Coal Project

GOVERNMENT OF THE PUNJAB IRRIGATION DEPARTMENT

Dated Lahore, the 7 th August, 2014.

ĩ0

Mr. Istar Zalai (Local Representative) Shandong Ruyi Science and Technology Group, China.

SUBJECT APPLICATION FOR WATER INTAKE AND DISCHARGE BY HUANENG-SHANDONG RUYI (PAKISTAN) ENERGY LTD FOR 2X660/AVI SAHIWAL COAL FIRED POWER PROJECT.

Lam directed to refer the request of Shandong Ruyi Science and Technology Group. China for the demand of 22.9 million m³ / annum canal victor from EBDC required for the operation of the subject Project and to inform C4 this Department, agrees to provide this volume in principle subject to consistion of usual procedures and payment of notified cost of water.

SECTION OFFICER (REVENUE)

CC:

- P.S to Secretary Irrigation
- P A to Additional Secretary (Operation), Irrigation Department.
 - P A to Deputy Secretary (Operation-II), Irrigation Department.



GOVERNMENT OF THE PUNDAB IRRIGATION DEPARTMENT Satur in the the Car June 2014

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SECTION OFFICER (REVENUE)



GOVERNMENT OF THE PUNJAB IRRIGATION DEPARTMENT

- Dated Lahore, the 12th June 2014.

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h 中国华能 CHENATEDIANENG

中国华能集团燃料有限公司

供煤承诺函

华能由东如意(巴基斯坦)能源有限公司:

贵司巴基斯坦萨希瓦尔 2×660MW 燃煤电站项目,为了保 证电站投产运行后的煤炭供应,我司作如下承诺;

一、每年向巴基斯坦萨希瓦尔燃煤电站项目提供
600万吨煤炭(主要煤源地为南非、印度尼西亚等国),并
保证连续很应。

二、 所供煤炭运至巴基斯坦卡拉奇港或卡西姆港码 头交货。

三, 具体供媒数量、年限、价格、交割方式双方另 行签订经济合同。

四, 煤质的具体要求由双方另行商定。

中国华能集团燃料有限公司 2014年7月30日

-147-

Attachment 12:

Huaneng Shandong Ruyi (Pakistan) Energy (Private) Limited Special Report on Generator Power Factor Selection for Sahiwal 2×660MW Coal Fired Power Plant Project

We communicated with NTDC on the generator power factor selection for Sahiwal 2×660MW Coal Fired Power Plant Project. NTDC stated that NEPRA requires the generators should have a rated lagging power factor of 0.8 and a rated leading power factor of 0.9. This requirement is mainly for small-capacity generators and does not comply with the Chinese standard - Specific Requirements for Cylindrical Rotor Synchronous Machines (GB/T 7064-2008) and the relevant international standards (IEC 60034-3:2007, MOD).

1. The 600MW-class generators manufactured according to the Chinese standard GB/T 7064-2008 (equivalent to IEC 60034-3: 2007) shall be designed as follows (please refer to Clause 6.2 of GB/T 7064-2008 - Specification and Series):

				()
Rated Power P _N /MW	Rated Capacity S _N /MVA	Rated Voltage U _N /kV	Rated Power Factor cosφ	Efficiency η (Tolerance of overall losses at ratings + 10%) ^a
100 125 135	117.7 147 158.5	10.5, 13.8	0.85	98.4
200	235.3	15.75	0.85	98.6
300	353	18, 20, 24	0.85	98.7
600	666.66	20, 22, 24	0.9	98.8
900	1000	24, 27	0.9	98.9
1000	1111.1	24, 27	0.9	98.9
1200	1333.33	24, 27	0.9	99
1500	1666.66	27, 30	0.9	99

Basic Series of Hydrogen-cooled and Water-cooled Generators (50Hz)

Rated Power P _N /MW	Rated Capacity S _N /MVA	Rated Voltage U _N /kV	Rated Power Factor cosφ	Efficiency η (Tolerance of overall losses at ratings + 10%) ^a	
^a Allowable tolerance of overall losses + 10%					

It is required in Note 2 of Section 4.4 of this Standard that generators shall be able to operate at the rated load at a power factor of 0.95 (underexcited), so generators for lead power factor operation shall be designed with a leading power factor of 0.95 at the rated load.

It is specified in the Technical Code of Design for Electric Power System (DL/T 5429-2009) that newly installed units shall be able to operate with a leading power factor of 0.95 at rated active power (please refer to Clause 7.2.4 of this Code).

It is specified in Section 115 of Shandong Electric Power Dispatch Regulation that the generators on Shandong Power Grid (with a total installed capacity of 50000MW) shall have a leading power factor of 0.97 at the rated active power and newly installed generators shall have the capability of leading power factor operation. This specification has been applied for years in Shandong and can fully meet the requirements.

It is specified in the Technical Code of Design for Electric Power System (DL/T 5429-2009) that rated lagging power factor of generators shall be determined according to the requirements of the power system: Generally, the power factor of generators directly connected to the sending end of 330kV and above power grids shall not be less than 0.9. The interconnection voltage for the Project is 500kV, so it is proper for the Project to adopt the lagging power factor of 0.9.

2. Hundreds of 600MW-class generators are currently operating safely, stably and economically in China and can meet the needs of the power market very well. The generators have a good capability of active power and reactive power. Figure 1 shows the P-Q capability diagram of a 660MW generator manufactured by Shanghai Electric Machinery Co., Ltd.

When the generator operates at the rated active power of 660MW, the reactive power can be increased up to 318Mvar. When the active power is decreased, the capacity of reactive power can be gradually increased. For example, the reactive power

-149-

can be increased up to 400Mvar and 480Mvar respectively when the active power is 75% and 50% of the rated power (corresponding 500MW and 330MW). In case of leading power factor operation, the reactive power can reach -170Mvar, -260Mvar and -280Mvar at 660MW, 500MW (75% of rated power) and 330MW (50% of rated power) respectively. Therefore, the generators in the said series have a great capability of reactive power with a wide range, and can meet the needs of the power market in the Chinese eastern coastal provinces which have developed economy and great reactive power demands, and it is believed that they can meet the needs of the Pakistani power market.



Fig. 1 660MW Generator P-Q Capability Curve

3. Reactive compensation of power system shall be based on the principle of local balance in areas. The units of the Project will be connected to a 500kV power grid, but loads are connected to 220kV and below power systems. In order to avoid too much reactive power current flow in the system and minimize grid losses, it is better to balance reactive power locally on the load side and there is no necessity to

have too stringent reactive power requirement for the Project.

According to the current power grid structure in Pakistan, the units of the Project will be the largest on the power grid in Pakistan and thus shall operate at base load. The power grid adjustments like peaking operation and reactive power voltage adjustment shall be done by small-capacity units which are close to load centers and operate at peaking load or mediate load.

4. NEPRA requires that the generator should be designed and manufacture with a rated lagging power factor of 0.8 and a leading power factor of 0.9. On the one hand, the power grids in Pakistan have the characteristics of relatively higher lighting and agricultural power load and thus lower inductive load, so it is not necessary to have such requirement. On the other hand, the major Chinese generator manufacturers have never manufactured any generator with such parameters, and the manufacturer has to provide an atypical design, which will not only greatly increase the cost of equipment but also lead to many uncontrollable factors as follows:

1) The design reasonableness of non-standard design generators has not been verified in market operations, and the generator operation may have great risk and its long, safe and stable operation cannot be guaranteed, and the stable operation of the power grids will be thus affected.

2) The generator with a lower power factor will have a relatively bigger size and bigger accessories, which may cause difficulties of match with its steam turbine and hard adjustment on site. The shafting balance of the generator will also change and thus cause unreasonable turbine shafting match and serious turbine vibration.

3) Because of atypical design, the generator manufacturer needs a process of design and demonstration, and the supporting parts have to be machined separately. The manufacturing time will be greatly increased, and the time of equipment delivery will be delayed at least six months and affect the duration of the Project. As a result, the unit can not be put into commercial operation by the end of 2016.

In summary, the 600MW-class generators manufactured according to GB/T 7064-2008 with a lagging power factor of 0.9 have a better applicability, reliability and operational stability than those with a lagging power factor of 0.8. Therefore, the

-151-

Chinese typical design is strongly recommended.

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